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Editor in Chief

Dr. Swapnesh Taterh

FOREWORD

I am pleased to put into the hands of readers Volume-5; Issue-10: 2018 (Oct, 2018) of **"International Journal of Advanced Engineering Research and Science (IJAERS) (ISSN: 2349-6495(P) | 2456-1908(O)"**, an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers. Now journal has also been indexed in **Qualis (Interdisciplinary Area) (Brazilian system for the evaluation of periodicals, maintained by CAPES).**

I thank all the authors of the research papers for contributing their scholarly articles. Despite many challenges, the entire editorial board has worked tirelessly and helped me to bring out this issue of the journal well in time. They all deserve my heartfelt thanks.

Finally, I hope the readers will make good use of this valuable research material and continue to contribute their research finding for publication in this journal. Constructive comments and suggestions from our readers are welcome for further improvement of the quality and usefulness of the journal.

With warm regards.

Dr. Swapnesh Taterh

Editor-in-Chief

Date: Nov, 2018

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Evaluation and Performance Improvement of Antasari Intersection Banjarmasin City

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Abstract—The problem of signalized intersection is caused by the traffic volume continually increasing each year, automatically contributing high delay and frequent congestion and One indicator of traffic congestion at the roundabout is a decrease in vehicle speed [1]. Today's operated traffic lights have not yet capable of overcoming congestion which often occurs in the peak hours. The existing condition on intersection has not yet been able to accommodate the populous traffic volume; it can be seen from each of intersection foot while experiencing the vehicles daley. The imprecised existing condition on the Antasari intersection in Banjarmasin, is seen from the 4-phase control with the cycle time at 177 seconds, the degree of saturation is ≥ 0.85, and the delay is ≥ 60 seconds; making it categorized as the intersection with F-level of service (the worst).

This research aims to analyse the existing condition of the Antasari intersection's performance, and to obtain some handling alternatives of Antasari intersection, with some approaches. To increase the performance of Banjarmasin's Antasari intersection, some handling alternatives are executed, such as: the control of Cycle Time, the control of phase direction (phase simulation), and the phase change by using KAJI program.

Based on the field data, obtained the performance of Banjarmasin's Antasari intersection in existing condition: the cycle time is 177 seconds, degree of saturation is 2,879 or ≥ 0.85, delay is 963 seconds/pcu or ≥ 60 seconds/pcu, and the worst service level (F-level). In some intersection handling alternative results, there comes one alternative that is able to increase the intersection performance: through the phase simulation stages, with the phase adjustment of the north – south of KolonelSugiono streetamd the east – west of PangeranAntasari street, then the acquired results of the Service Level-C are: the delay value (D) is 23.33 seconds/pcu or ≤ 25 seconds/pcu, the degree of saturation (DS) is 0.671 or ≤ 0.85, and the cycle time (CT) is 67 seconds or ≤ 80 seconds.

Keywords—Degree of saturation, cycle time, phase, delay, level of service.

I. INTRODUCTION

In accordance with the development of Banjarmasin City, then one of such development aspects –along with its activities—is the increasing of vehicles traffic volume, either of the street capacity side or even of its own traffic characteristic. What is meant by such characteristics are the volume, composition, and velocity. Especially in the peak hours, there can be seen the long queue of vehicles on many intersections causing the vehicles going through the long-enough average delay.

Like any other development countries, today's big cities in Indonesia, especially Banjarmasin, are on the high growth of urbanisation, as the result of its rapid economic growth rate, therefore the population's needs for movement are increasing as well. The private cars keep growing rapidly on their own, as the conveyances which have very big benefits for every individual especially in the movement mobility. Meanwhile, the development of transportation facility supply is very low, thus it is unable to follow.

The problems on the signalized intersection are the high delay and the frequent congestion occurrence. Recent traffic lights control operation have not yet been solving the congestion frequently occurred in the peak hours. The existing condition on intersection has not yet been able to accommodate the heavy traffic volume; this can be seen on each foot of intersection encountering the vehicle delay. The imprecise existing condition of intersection control is seen from the 4-phase control with the Cycle Time at 177 seconds, Degree of Saturation is ≥ 0.85, and Delay is ≥ 60 seconds/pcu, can be categorized as the intersection with the worst service level. According to the condition introduction survey, the volume of vehicles turning right with the vehicles total volume is bigger, compared to the vehicles heading straight and turning left, hence it causes queue and delay on the next green phase.

To increase the intersection level service in order to decrease the delay value of vehicle/second, this research analyses the recent performance of the intersection of KolonelSugiono street – PangeranAntasari street and PangarenAntasari street – KolonelSugiono street, and giving précised problem solving alternative, either using the cycle time control, phase control, and intersection geometrical control. This research will be devoted to observe the traffic condition on one intersection location which has the traffic lights with the turn left directlysigns. The observed study area is the intersection with the traffic lights on the Antasari section in Banjarmasin. The Antasari intersection in Banjarmasin is located in the district of Central Banjarmasin.

II. THEORITICAL REVIEW

An intersection can be defined as a public area where two or more streets are merged or intersected, including streets and side-street facilities for traffic movement inside; and intersection is divided into two; they are the plot intersection and the non-plot intersection. The plot intersection is an intersection where two or more main streets are merged, with each of the main street heads out of an intersection and forms part of it. The non-plot intersection is an intersection where two streets are intersected each other in different plots, without any relation and adjustment following the plot separator [2].

An intersection usually has four types of basic pattern of vehicle traffic movement which potentially causes conflicts of merging (merging with the main street), diverging (separating direction from the main street), weaving (shifting street occurs), and crossing (intersecting with vehicles from other streets) [3].

There are methods to decrease the traffic movement conflict on intersection [4]:

1. Time sharing (involving the utilization control of the body of the street for each direction of traffic movement in certain periods)
2. Space sharing (using the principle of changing the movement conflict, from crossing to braid or combination of diverging or merging)

In broad outline, the basic characteristics of traffic current are divided into three parameters [5]:

1. Traffic volume
2. Traffic velocity
3. Traffic density

The traffic volume data is calculated to get the value which represents the vehicles as many as 85% [6], velocity is the average speed in a space, density is the total vehicles of each main street length unit, and current is the total vehicles which pass through certain spots on the main street per time unit [7]. The headway can be seen on two sides: the time headway and the distance headway. Time Headway is the time interval between the moment where the front part of a vehicle passes a point until the moment where the front part of the next vehicle passes the same point, and the Distance Headway is the distance between the front part of one vehicle with the part of the next vehicle in a certain time [8].

The capacity of signalized intersection is based on the concept and the level of saturation degree [5]. Indeed that the junction capacity tabulation in all conditions is impossible to do, and the capacity on the thorough part of track is more needed than the capacity in the closed area. However, most street assembly will determine the limits of capacity and security from all tracks. The difficulty is to decide the total unit, either pedestrians or vehicles, that will use the facilities, and along with the level of safety and comfort. In the point of social view, in certain level, we have to be ready to be able to accept bigger traffic slowness to add its security level. However in most calculation which recovers traffic current, will be able to reduce the accident potential [9].

There are two types of main system in the traffic signal operation: the fixed-time signal system and the traffic responsive. Fixed-time signal system is a signal operating system which uses fixed cycle time, the modification of this fixed cycle time can be set for a certain time period, such as for daily or weekly simulation, or to peak hour from off-peak hour. Meanwhile the traffic responsive signal system is a signal operating system which uses the changeable cycle time setting, in line with the existed traffic current condition [10].

The intersection performance is to evaluate the performance of an intersection commonly can be seen from the following parameters [5]:

1. The Delay
2. The Number of Stop Vehicle
3. The Queue Length

The Intersection Delay is the total time of average barrier experienced by vehicles when passing through an intersection [11]. The average traffic delay in j approach can be determined based on the following formula [12]:

$$DT_j = c \times \frac{0.5 \times (1 - GR)^2}{(1 - GR \times DS)} + \frac{NQ_1 \times 3600}{c}$$

whereas:

DT_j = Average traffic delay for the j approach (seconds/pcu)

GR = Green ratio (g/c)

DS = Degree of saturation

C = Capacity (pcu/hour)

NQ_1 = Total amount of the left pcu from the previous green phase

Number of Stop (NS), is the average total of each vehicle (including continued stop in queueing) before passing through intersection, the following formula is calculated:

$$NS = 0.9 \times \frac{NQ}{Q \times c} \times 3600$$

whereas c is the cycle time, and Q is the traffic current (pcu/hour) from the explored approach.

The total of pcu queue average in the first green signal (NQ) is counted as the total of remaining pcu from the previous green phase (NQ_1) added by the total of incoming pcu during the red phase (NQ_2).

$$NQ = NQ_1 + NQ_2$$

$$NQ_1 = 0.25 \times c \times \left[\left\{ (DS-1) + \sqrt{(DS-1)^2 + \frac{8 \times (DS-0.5)}{c}} \right\} \right]$$

if $DS > 0.5$; otherwise, $NQ_1 = 0$

$$NQ_2 = c \times \frac{(1-GR)}{(1-GR \times DS)} \times \frac{Q}{3600}$$

whereas:

NQ_1 = total of remaining pcu from previous green phase.

NQ_2 = total of incoming pcu during red phase.

DS = degree of saturation

GR = green ratio

C = cycle time (sec)

C = capacity (pcu/hour) = degree of saturation times green ratio ($S \times GR$)

Q = traffic current in such approach (pcu/sec)

The queue length (QL) is acquired by the multiplication (NQ) with the used average area per pcu (20 m^2) and the division with the entrance width.

$$QL = NQ_{max} \times \frac{20}{W_{ENTRANCE}}$$

Technically, the intersection controls with Traffic Signal Device (APILL) are as follow [13]:

1. The traffic current is bigger than the approach width.
2. *Degree of Saturation*.
3. *Cycle Time*.

The traffic current calculation data is acquired based on the traffic survey result on the field

(Traffic Counting); that traffic current data is then changed from vehicle/hour to pcu/hour by using the passenger car equivalent (pce), on Table-1 below.

Table-1. Passenger Car Equivalent [13]

Vehicle Type	PCE	
	Protected approach	Provoked approach
LV	1.0	1.0
HV	1.3	1.3
MC	0.2	0.4

Degree of saturation (S) can be stated as multiplication result of the primary degree of saturation (So), that is the degree of saturation in standard condition, with the adjustment factor (F) for the distortion of actual

condition, from a group of conditions (ideal) previously stated.

$$S = So \times F_1 \times F_2 \times F_3 \times F_4 \times Fn$$

The protected approach of primary degree of saturation as the function of approach effective width (We).

$$So = 600 \times W_e$$

Whereas:

S_o = Primary saturation traffic current (pcu/hour)

W_e = Street width (meter)

According from several researches in several cities in Indonesia, the degree of saturation value on the field turns out to be bigger which is 1.3 times with the empirical formula corrected as follows [14]:

$$So = 780 \times W_e$$

The calculation of degree of saturation as follows:.

$$DS = Q/C = (Q \times c)/(S \times g)$$

Whereas:

DS = Degree of Saturation

Q = Total Traffic Current (pcu/sec)

C = Capacity (pcu/jam)

The signal time definition for the time control condition is still executed to minimize the total delay of an intersection [15]. The equation of Cycle Time as follows [13]"

$$C = (1{,}5 \times LTI + 5)/(1 - \sum FR_{crit})$$

whereas:

C = Cycle time signal (second)

LTI = Total of lost time per cycle (second)

FR = Current divided with degree of saturation (Q/S)

FR_{crit} = Highest FR value from all approaches leaving for a signal phase.

$\sum (FRcrit)$ = Ratio of intersection current = total of FRcrit from all phases on that cycle.

The recommended cycle time to be used depends on its control type. The phase control type and the suitable cycle time can be seen on Table-2.

Table-2. Phase Control and Cycle Time [13]

Control Type	Cycle Time (second)
Two-phase control	40 - 80
Three-phase control	50 - 100
Four-phase control	80 - 130

The size level of service of a signalized intersection can be seen on Table-3 and Table-4 as follow.

Table-3. Service Level on Intersection [16]

Level of Service	Delay(sec/pcu)	Information
A	<5	Very good
B	5.1 – 15	Good
C	15.1 – 25	Moderate

D	25.1 – 40	Less
E	40.1 – 60	Bad
F	>60	Very bad

Table-4.Service Level Criterion of the Intersection with Traffic Light [17]

Level of Service (LOS)	Control Delayper Vehicle (sec/vech)
A	≤ 10
B	>10 – 20
C	>20 – 35
D	>35 – 55
E	>55 – 80
F	>80

III. RESEARCH METHOD

There are two steps in analysing this research:
1. Data collecting.
2. Data analysis.

This research step is commonly elaborated as follows:
1. Problem Identification
   Identifying the problems on Antasari intersection as seen on the cycle time and phase control.
2. Determining the goal of research
   The goal of this research is done based on the acquired problems.
3. Data collecting
   The data collecting is based on two steps which are the secondary data collecting and the primary data collecting; the secondary data collecting is done by requesting data in the related agencies, and the primary data is done by the direct observation survey on the field.

4. Existing Condition Analysis
   The existing condition analysis is based on the result of existing condition data analysis using the KAJI program.
5. Evaluation and Improvement of Intersection Performance
   It is done based on the result of existing condition analysis, then the alternative handling is done using the KAJI program and based on existed theoretical approach.
6. Suggestion and conclusion
   The suggestion and conclusion is Kesimpulan dan saran achieved based on data analysis and whether it has been in line with the purpose and goal of the research.

IV. DISCUSSION AND RESULT

Based on the result of inventory survey and traffic survey been carried out, the intersection geometrical data can be obtained, along with the cycle time control, and the peak-hour vehicles volume data which are seen on Table-5, Table-6, Table-7, Figure-1 andFigure-2.

Table-5. Geometrical Data of Antasari Intersection

Location	Approach	Approach width		
		W$_A$ (m)	W$_{enter}$ (m)	W$_{exit}$ (m)
Intersection Antasari - Sugiono	North	12.6	7.38	14.46
	East	15.5	10.24	13.5
	South	12	7.1	6.63
	West	11	11	10.22
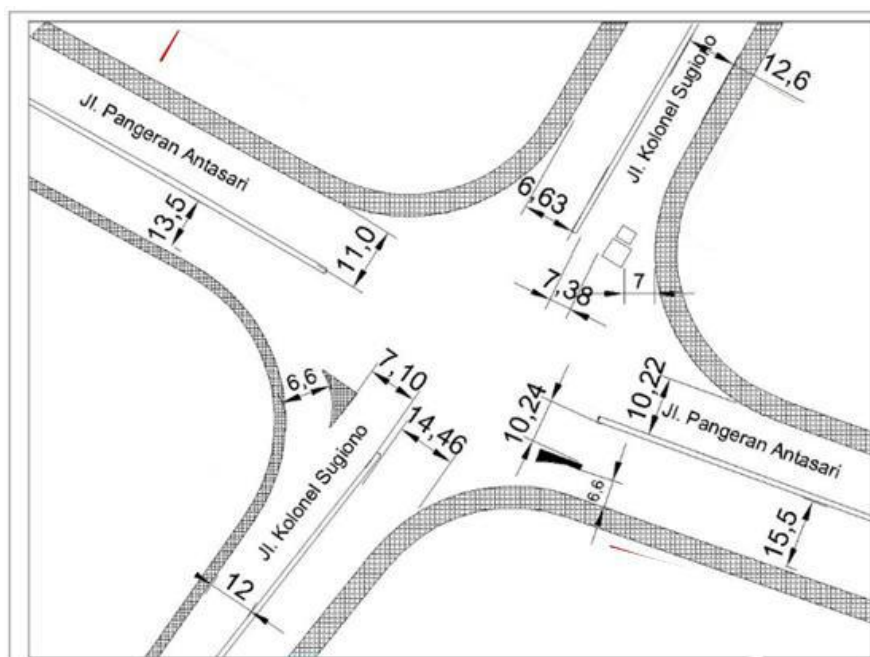
Fig.1: Intersection Geometry

Table-6.Existing Cycle Time

Location	Approach	Signal Time			All Red	Cycle Time (second)
		Red	Yellow	Green		
Intersection	North	144	3	28	2	177
P.Antasari –	South	154	3	18	2	177
K.Sugiono	East	141	3	30	3	177
	West	92	3	80	2	177
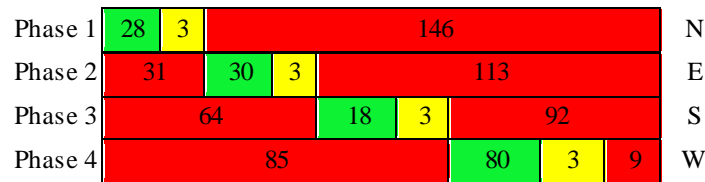
Fig.2: Diagram of Existing Condition Cycle Time

Table-7.Recapitulation ofTraffic Volume

Period	Location	Peak Hour	MC	LV	HV	UM	AMOUNT
Morning 06.00 - 10.00	K. SugionoSt. (N)	07.10 – 08.10	1168	201	5	28	1374
	P. AntasariSt. (E)		3297	603	0	76	3900
	K. SugionoSt. (S)		2650	225	0	110	2875
	P. AntasariSt. (W)		1280	131	0	23	1411
						AMOUNT	9560
Noon 10.00-14.00	K. SugionoSt. (N)	13.50 - 14.50	1198	487	29	15	1714
	P. AntasariSt. (E)		2422	721	2	63	3145
	K. SugionoSt. (S)		2050	499	56	57	2605
	P. AntasariSt. (W)		1510	183	0	29	1693
						AMOUNT	9157
Afternoon 14.00-18.00	K. SugionoSt. (N)	16.30 - 17.30	1815	389	11	20	2215
	P. AntasariSt. (E)		3196	592	1	58	3789
	K. SugionoSt. (S)		2201	234	1	66	2436
	P. AntasariSt. (W)		2443	253	0	66	2696
						AMOUNT	11136

Based on Table-7 above, it can be seen that the condition of existing traffic volume can be ranked: the first rank is the afternoon peak hour at 16.30 – 17.30 (Central Indonesian Time) with the volume of 11,136 vehicles/hour; the second rank is the morning peak hour at 07.10 – 08.10 (Central Indonesian Time) with the volume of 9,560 vehicles/hour; and the third rank is the noon peak hour at 13.50 – 14.50 (Central Indonesian Time). As the data in analysing the intersection performance, the used data is the highest peak hour which is the afternoon peak hour at 16.30 – 17.30 (Central Indonesian Time).

Using the 1997 KAJI program ver. 1.10, the existing condition analysis is done based on the most peak hour traffic volume data; the F can be seen on Table-8.

Table-8. Analysis ofExisting Condition

Peak Hour	Approach	Time Cycle (second)	Degree of Saturation (DS)	Delay(second /pcu)	ITP
Morning 07.10 – 08.10	K. SugionoSt. (N)	177	0.707	472	F
	P. AntasariSt. (E)		1.033		
	K. SugionoSt. (S)		2.018		
	P. AntasariSt. (W)		0.143		
Noon 13.50 - 14.50	K. SugionoSt. (N)	177	1.180	963	F
	P. AntasariSt. (E)		1.142		
	K. SugionoSt. (S)		2.879		
	P. AntasariSt. (W)		0.189		
Afternoon 16.30 - 17.30	K. SugionoSt. (N)	177	1.228	352	F
	P. AntasariSt. (E)		1.019		
	K. SugionoSt. (S)		1.801		
	P. AntasariSt. (W)		0.284		

According to the existing condition analysis, the condition of Antasari intersection has the F-level of service, means it is very bad; the worst condition is in the noon peak hour with the Delay (D) value of 963 seconds/pcu, and the Degree of Saturation of 2,879. From the result of existing condition analysis, there are some steps of intersection scenario control need to be done in order to increase the performance and service as follow:

1. Cycle time recovery
2. Phase simulation (4 phases)
3. Phase change

1. Cycle Time Recovery

In cycle time existing condition of 177 seconds, the ideal cycle time control on 4-phase control is 80 – 130 seconds, with such condition needs cycle time recovery; after changing the cycle time, the new cycle time is 113 seconds. Based on the result of cycle time recovery analysis, there is an increasing of intersection service, which changes F to E, with the analysis result on Table-9.

Table-9.Result of Cycle Time Recovery Analysis

Performance Stage	Approach	Cycle Time (second)	Degree of Saturation (DS)	Delay (second/ pcu)	ITP
Cycle Time Recovery	K. SugionoSt. (N)	113	0.834	41.65	E
	P. AntasariSt. (E)		0.840		
	K. SugionoSt. (S)		0.819		
	P. AntasariSt. (W)		0.796		

On the stage of cycle time change, there is change on the service level but not too significant from the existing condition, F at first, changes to E, with Degree of Saturation value at 0.840 or ≤ 0.85.

2. Phase Simulation (4 Phases)

Phase simulation is done in 3 steps:
a. Controlling the phase on the foot of intersection on the north and south of KolonelSugionostreet.
b. Controlling the phase on the foot of intersection on the east and west of PangeranAntasaristreet.
c. Controlling the phase on the foot of intersection on the north – south intersection of KolonelSugiono street, dan the east – west of PangeranAntasaristreet.

On this stage of phase simulation, the analysis result of the intersection performance enhancement can be seen on Table-10.

Table-10.Phase Simulation is Done Using Intersection Performance Analysis Result.

Performance Level	Approach	CT (second)	Degree of Saturation (DS)	Delay (second/pcu)	ITP
Control of Foot of Intersection Phase of K.SugionoStreet North - South	Jl. K. Sugiono (N)	78	0.700	27.69	D
	Jl. P. Antasari (E)		0.711		
	Jl. K. Sugiono (S)		0.724		
	Jl. P. Antasari (W)		0.714		
Control of Foot of Intersection Phase of P.AntasariStreet East – West	Jl. K. Sugiono (N)	89	0.785	31.63	D
	Jl. P. Antasari (E)		0.763		
	Jl. K. Sugiono (S)		0.776		
	Jl. P. Antasari (W)		0.513		
K.Sugiono street North – South and P.Antsari Street East - West	Jl. K. Sugiono (N)	67	0.647	23.33	C
	Jl. P. Antasari (E)		0.663		
	Jl. K. Sugiono (S)		0.671		
	Jl. P. Antasari (W)		0.386		

Based on phase simulation result, there is change in intersection performance enhancement, which are: the first existing condition is F on the control of foot of intersection phase of the north – south of KolonelSugiono street, turns to D with the Degree of Saturation value of 0.724;on the control of foot of intersection phase of the east – west of PangeranAntasari street, turns to D with the Degree of Saturation value of 0.785;and on the control of foot of intersection phase of the north – south of KolonelSugiono street, and the east – west of PangeranAntasari street, turns to C with the Degree of Saturation value of 0.671. Of those three results, the best intersection performance is the control of foot of intersection phase of the north – south of KolonelSugiono street and the east – west of PangeranAntasari street, with the C-level of intersection service, and the Delay (D) value of 23.33, and the Degree of Saturation (DS) value of 0.671 or $\leq$ 0.85, meaning that the current on that intersection is smooth.

3. Phase Change

The phase change stage is done by changing from 4 phases to 3 phases, with the adjustments as follow:
1. Change of 3 phases (merging of direction current of east – west)
2. Change of 3 phases (merging of direction current ofnorth – south)

The analysis result is acquired from phase change, as seen on Table-11.

Table-11.Intersection Performance Analysis Result after Phase Change is Done

Performance Level	Approach	Cycle Time (Second)	Degreeof Saturation (DS)	Delay(second/pcu)	ITP
Change of 3 phases (merging of direction current of east – west)	K. SugionoSt. (N)	72	0.735	24.07	C
	P. AntasariSt. (E)		0.732		
	K. SugionoSt. (S)		0.732		
	P. AntasariSt. (W)		0.543		
Change of 3 phases (merging of direction current of east – west)	K. SugionoSt. (N)	64	0.691	21.52	C
	P. AntasariSt. (E)		0.691		
	K. SugionoSt. (S)		0.649		
	P. AntasariSt. (W)		0.684		

As seen on the phase change analysis, there are changes in intersection performance; on the change of 3 phases (merging of direction current of east – west), the existing condition F has changed to C; and on the change of 3 phases (merging of direction current of north – south), it has changed to C. it cannot be done in this analysis, considering the result of merging the traffic current which needs an access to make a U-turn, meanwhile there is no access to make a U-turn on the streets of KolonelSugiono street and PangeranAntasari street.

From several handling alternatives, the best chosen one is the phase control of foot of intersection of the north – south of KolonelSugiono Street and the east – west of PangeranAntasari Street, with the C-level of intersection service, with the delay (D) value of 23.33, and the degree of saturation value (DS) value of 0.671 or ≤ 0.85, which means that the current on that intersection is smooth. The cycle time diagram is seen on Figure-3:
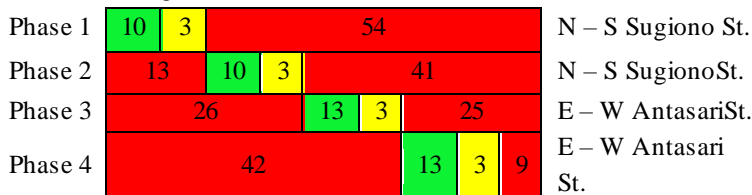
Fig.3: Phase Control Cycle Time Diagram of Kolonel Sugiono Street North – Southand Pangeran Antasari Street East – West.

V. CONCLUSION

There are many things to conclude based on the accomplished intersection handling scenario analysis, and to answer the problem statement, all at once; it is concluded that:

1. Based on the existing condition analysis, it is seen that the worst condition of Antasari intersection service level occurs in the noon with the F-level of service, the delay (D) value of 960 seconds/pcu, the degree of saturation value of 2,879 or ≥ 0.80, which shows the congestion on the intersection, and the cycle time of 177 seconds or ≥ 130 seconds meaning that the control of existing condition cycle time is not ideal.

2. From the accomplished control alternatives, the 4th alternative is the best for increasing the intersection level of service. In the 4th alternative, the phase on the foot of intersection of Kolonel Sugiono street north – south, and Pangeran Antasari street east – west, is adjusted and the intersection level of service has increased to C, with the delay (D) value of 23.33 seconds/pcu or ≤ 25 seconds/pcu, the degree of saturation (DS) value of 0,671 or ≤ 0.85, and the cycle time (CT) is 67 seconds or ≤ 80 seconds.

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Melatonin bioengineered: A New Possible Strategy for Treatment of Breast Cancer

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Abstract— *Breast cancer is an important public health problem, with an estimated 3.2 million new cases by the year 2050. Diet plays a key role in the etiology of breast cancer and breastfeeding is associated with a lower incidence of breast cancer. On the other hand, the improvement of the therapeutic properties of bioactive compounds through their incorporation into microcarriers is an important strategy in obtaining new therapies, since cyclical changes in concentration are eliminated; there is biological availability of the compound as well as the reduction in toxicity, number dose and suppression of adverse reactions. Studies using hormones such as melatonin extracted from human milk adsorbed onto polyethylene glycol (PEG) microspheres showed that the controlled release of this compound was able to reduce viability and induce apoptosis in MCF-7 cell lines. Colostrum differs from most of the secretions because it contains viable leukocytes during the first days of lactation with a quantity and activity comparable to blood leukocytes, and has several defense components such as antibodies and hormones, such as melatonin (MLT). This review details the influence of the soluble and cellular components present in human colostrum, such as the MLT hormone, as the modified release systems influence the action of MLT and the possible mechanisms involved that contribute to the hypothesis of reduction of breast cancer in women who breastfed.*

Keywords— *colostrum, melatonin, polyethylene glycol, breast cancer, bioengineering.*

I. INTRODUCTION

Breast cancer cases have increased worldwide, and are directly related with more life expectancy, exposure to risk factors, and habits. Breast cancer is a multifactorial disease with a higher incidence among women, leading to death [1]. Cancer and chronic inflammation are closely linked and the imbalance between reactive oxygen species and antioxidant enzymes favors the emergence of these diseases. Thus the control of the production of reactive species as well as the maintenance of oxidative balance are primordial for the control of tumor progression [2, 3].

Some factors such as healthy lifestyle and breastfeeding are related to the prevention of breast cancer [4]. Human colostrum differs from other secretions by containing large quantities of viable leukocytes comparable to those found in blood acting as anti-inflammatory mediators. It is believed that both soluble and cellular components interact with each other and may be important for antitumor immunity [5,6]. Breast milk is rich in soluble and cellular components, such as

phagocytes, secretory IgA immunoglobulin (SIgA), and hormones, especially melatonin (MLT) [5,7,8].

Melatonin, a hormone produced by the pineal gland, is involved in several physiological processes, including the functional regulation of breast milk. In milk it is related to the anti-inflammatory effects [9] and pro-oxidant and antioxidant effects of paramount importance in the oxidative stress balance as a protection mechanism [10].

Some studies have reported that the bioavailability and biofunctional function of melatonin may be potentiated when associated in modified release systems [11,12]. Among these systems, polyethylene glycol (PEG) microspheres have been considered an important vehicle for the administration of various drugs, natural products and hormones [13,14,15,16,17].

The administration of drugs adsorbed to carrier systems such as PEG microspheres has been an alternative treatment for various diseases [18], including breast cancer. These release systems are promising for the release of the hormone melatonin [11], preventing it from the degradation promoted by the metabolic enzymes increasing their bioavailability in the organism [19]. How much combined with the MLT has been demonstrated its ability to reduce cell viability and induce apoptosis in tumor cell lines from breast cancer [12,11].

The control of the process of carcinogenesis is closely related to the control of apoptosis, since the tumor cell is able to alter this system, favoring its proliferation and promotion [20]. Thus, cancer treatments are directed at inducing increased apoptosis of tumor cells [21, 22], which may be favored by the use of immunomodulatory agents such as MLT, for acting on immunocompetent cells and assisting in tumor eradication.

This review details the influence of the soluble and cellular components present in human colostrum, such as the MLT hormone, and how they may be responsible for mechanisms that reinforce the hypothesis that breastfeeding reduces the risk of breast cancer.

II. BREAST CANCER

Breast cancer is a public health problem, with around 59,700 new cases in Brazil in the year 2018 [23]. The worldwide incidence and mortality of this disease are highly related and it is estimated that by the year 2050 will appear about 3.2 million new cases of breast cancer in the world. Despite technological advances, there are still several mechanisms that must be elucidated in the eradication of this disease that affects the world population [24].

Breast cancer is considered a heterogeneous disease, both morphologically and clinically, and is due to a disordered proliferation of breast tissue cells. About 80% of the types of breast tumors originate in the ductal epithelium, known as invasive ductal carcinoma [25]. Invasive carcinomas are so called because they have high metastatic potential, since carcinomas in situ have low metastatic potential and may arise in both lobes and mammary ducts [26]. During carcinogenesis, genetic mutations are accumulating and the cell phenotype is changing through malignant lesions, evolving into invasive cancer [27].

The structure of the breast is composed of glandular tissues composed of the milk producing glands and the ducts through which milk produced and stromal tissues pass, which are fibrous and fibrous connective tissues. In addition to these tissues the breast is also composed of the tissue of the immune system and lymphatic system [28]. For normal development of breast tissue to occur, there is a need to balance cell proliferation and apoptosis. In tumor growth, there is a reduction in apoptosis and an increase in cell proliferation [27].

The balance between a protective cytotoxic response and a non-protective response can be regulated by the individual's overall immune status [29]. A major challenge for tumor research has been the identification of molecular and immunological changes associated with the different stages of tumor progression, and advances in these studies have been hampered by technical limitations to the pre-invasive stages of tumors [30].

The study with in vitro breast cancer cells began in 1973 from isolated cells from pleural effusion of a 69-year-old woman with metastatic disease [31]. MCF-7 cells are useful for in vitro breast cancer studies by having several particular ideal characteristics of the mammary epithelium, such as the ability to process estrogen in the form of estradiol via estrogen receptors in the cell cytoplasm. This cell line is positive for the estrogen receptor (ER) and for the progesterone receptor and negative for HER2. These cells are very well studied with the immense number of protocols defined which allows researchers to use this cell line for study pathogenesis and in the search for treatment of breast cancer through reliable means in vitro assays [32]. During the last decade, several work on the mechanisms related to the interaction between the cells of the immune system and tumor progression. The results indicate that an immune response to a tumor is determined by the different cell types, such as lymphocytes, NK cells, neutrophils and others, as well as by the interactions between hormones, proteins and receptors present on the cell surface [33].

On the other hand, tumor cells arise from a mutation in DNA (deoxyribonucleic acid) that can be caused by radiation, bacteria, fungi, viruses, chemicals, etc. Although the components of the immune system are present and active, cancer cells can progressively grow

and spread, thus, the body weakened by poor diet, genetic predisposition, advanced age and exposure is the perfect environment for the development of cancer. In addition the cancer cells are very similar to the own cells of the organism, which hampers even more the response of the immune system [28].

Among the mutations, the most important alterations that occur are self-sufficiency in signs of proliferation, insensitivity to growth inhibitory signals, evasion of apoptosis, unlimited replicative potential, sustained angiogenesis and tissue invasion and metastasis [20].

The carcinogenesis process is directly involved with the generation of reactive oxygen species. Oxidative stress participates in all stages of cancer development. At initiation, oxidative species damage DNA by introducing genetic mutations and structural alterations; in the promotion, there is an increase of the initiated cell population, which is proliferation with consequent decrease of apoptosis; already in progression participate in the development of irreversible cancer growth [34].

III. BREASTFEEDING AND THE IMPORTANCE OF BREAST CANCER PREVENTION

Breast cancer is the neoplasm most feared by women, since its occurrence causes great psychological, functional and social impact, acting negatively on issues related to self-image, social interaction and the perception of sexuality. It is considered of great importance in the health care of women, due to the high prevalence, morbidity and mortality [35].

The role of the immune system in cancer prevention is complex and partially understood. It is widely known that diet plays a fundamental role in the etiology of cancer [33] and that breastfeeding is associated with lower incidence of breast cancer. In this sense, studies have tried to elucidate the effects of lactation on breast cancer [36, 37]. There is evidence that human milk may confer long-term benefits and an increasing number of studies have indicated that breastfeeding provides protection against ovarian and breast cancer [38,39].

However, the effects of breastfeeding on the risk of breast cancer have been difficult to study because of the high correlation with parity [40, 41]. Reproductive factors may induce permanent changes in the epithelium of the mammary gland or in the surrounding stromal tissue [42,43]. Although the mechanisms have not been fully elucidated, the hypothesis of reducing the risk of breast cancer through breastfeeding seems to occur because of breast tissue differentiation or reduction in the number of ovulatory cycles [44].

Studies have revealed that the relative risk of having breast cancer reduces about 7,0% for each child

born and about 4,3% for every 12 months of breastfeeding. This suggests that breastfeeding duration mothers is crucial to ensure the immunity components acts against the breast cancer [37,45] There is still evidence that breastfeeding protects women who have had their children under 50 years of age [46]. Another study reported that women who breastfed several children had the lowest risk of developing breast cancer, and mothers who breastfed four or more children had a 60 percent reduction in breast cancer risk. The magnitude of the protective effect is directly related to the time of breastfeeding [47].

Lactating mammary glands are an integral part of the mucosal immune system, and the antibodies and cells present in the milk reflect the antigenic stimulation of the Mucosa-Associated Lymphoid Tissue (MALT) in both the intestine and the respiratory tract. The literature reports that antibodies and human milk cells have specificity for a variety of antigens from intestinal and respiratory pathogens [48].

Colostrum differs from most of the secretions by containing viable leukocytes (10^9 cells / ml) during the first days of lactation [49], with amount and activity comparable to blood leukocytes [5]. On the other hand, other defense components present in the secretion that may be associated with protective activity, such as lactoferrin, analogous complexes (receptors), fatty acids (lipids), mucins [50], cytokines and chemokines [51,52,53,54], antibodies such as IgA [55,56], lysozymes [52], probiotics [57], antioxidant factors [58], among other components produced by the maternal immune system, as well as several hormones such as to melatonin [59, 60, 15].

The concentrations of melatonin in human colostrum and mature milk are similar the concentration of this hormone in the bloodstream. Also, immunocompetent colostrum cells can start to produce melatonin after stimuli from injuries, such as those caused by bacteria or fungal metabolites. Studies have shown that lymphocytes and peritoneal macrophages from rats and human colostrum phagocytes produce melatonin in response to activation, and this production of melatonin in the site activates lymphocytes and macrophages to produce IL-12, IL-6, IFN-γ which increases the production of T lymphocytes, the presentation of antigens and the phagocytic activity of macrophages, thus increasing the local inflammatory aspect [61,62,63] and this synthesis of melatonin occurs by the same enzymatic pathway that occurs in human pinealocytes [64].

Immunocompetent breast cells remain highly permeable after childbirth, which makes this type of cell suitable for signaling pathways when collected in a non-invasive manner, suggesting that these cells play an

important role in the protection of the newborn in pathological conditions these cells will be the defense of the newborn, thus consolidating the importance of breastfeeding [62].

IV.   MELATONIN

Melatonin is synthesized by the pineal gland [65]. It plays an important role in circadian rhythm control, reproduction, sleep-wake, is directly linked to the regulation of several neuroendocrine axes, protection against cancer and action against free radicals, acting on cell protection [66, 67]. Studies have shown that melatonin may increase the action of innate and acquired immunity and stimulate mainly leukocytes, an immunomodulatory property, which represents an important mechanism of protection for several diseases [9, 68, 8], as well as showing remarkable functional versatility oncotic properties, antioxidants and antiaging [69].

The action of direct melatonin against free radicals has been increasingly studied and its indirect role as an antioxidant has been tested and the effect has been highly effective in reducing oxidative stress in the body when compared to the antioxidants better known as vitamins C and E. Melatonin and its metabolites have positive aspects that make them effective in fighting free radicals. They easily cross the blood-brain and placental barrier, in addition to all maternal organs which leads to greater protection of the placenta and the fetus. Another positive aspect of melatonin is that it can be produced in other compartments, external to the pineal gland [66], and it has been speculated that all cells can synthesize melatonin, mainly in their mitochondria and this local production has the function of protection against radicals free [70].

The production of melatonin by other kinds of cells and organs has been reported, such as the retina, thymus, brain, intestine, bone marrow, ovary, testis, placenta, skin and lymphocytes [71]. High concentrations of melatonin have been found in skin keratinocytes, suggesting that the production of melatonin outside the pineal gland is not only related to the light / dark circadian rhythm, but rather as an antioxidant and anti-inflammatory agent and as a mechanism of stress protection oxidative. This production of melatonin in response to oxidative stress occurs in all living beings, such as plants, unicellular beings, animals and man, and must have been the main function of melatonin in the primitive beings, since they did not have resources in the fight against free radicals.

The production of melatonin by cells of the immune system occurs by activation of pro-inflammatory agents such as cytokines, increases the phagocytic capacity of macrophages and lymphocytes and induces the synthesis of interleukin-2 (IL-2), which has autocrine action and paracrine [69].

Melatonin acts on inflammatory processes and allergic diseases by attenuating the activation of NF-κB, reducing the production of TNF-α and IL-6 and promoting the survival of mast cells via a series of enzyme kinase activation and inhibition processes [72].

Melatonin exerts antioxidant action, which decreases the formation of free radicals, reducing the number of lesions that may affect cellular DNA [73]. It exerts an antiproliferative effect on physiological dose dependent breast cancer MCF-7 (human breast adenocarcinoma cell line) cells, in addition to reducing the rates of invasive and metastatic properties of this cell type [74]. Studies have shown that melatonin decreased cell proliferation and increased expression of p53 and p21 proteins in MCF-7 cells, inhibiting proliferation and inducing apoptosis. The p53 protein is an important tumor suppressor gene and is involved in the regulation of the cell cycle [75]. Melatonin, via activation of the melatonin 1 receptor (MT1) [76], is associated with suppression of growth and development of breast cancer through regulation of growth factors, regulation of gene expression, inhibition of tumor cell invasion and metastasis and by regulation of mammary gland development [77].

V.   POLYETHYLENE GLYCOL (PEG) AND THERAPEUTIC APPLICATION IN BIOENGINEERING

Studies aimed at reducing adverse drug effects have been developed as novel therapeutic systems, known as modified release systems [78, 79, 80, 81, 82, 83]. The improvement of the therapeutic properties of bioactive compounds through their incorporation into microcarriers is an important strategy in obtaining new therapies, since cyclical changes in concentration are eliminated; there is biological availability of the compound as well as the reduction in toxicity, number of administered doses and suppression of adverse reactions [84].

PEG-drug conjugates and microemulsions-drug, are being studied as possible modified release systems for a variety of molecules and drugs [85, 86, 87, 88, 89, 90, 91, 92, 83]. This combination has many advantages such as prolonged residence in the organism, decreased degradation by metabolic enzymes and reduction or elimination of the immunogenicity of proteins [87].

Several studies have shown that the association of PEG microspheres with molecules, hormones or proteins increases the immunomodulatory capacity of both blood and colostrum phagocytes and suggests that the adsorption of these compounds to PEG microspheres has

immunostimulatory effects and can be considered a important material/vehicle, with potential for future therapeutic applications in infectious diseases or tumors [13, 15, 14, 17, 16, 93].

Studies using hormones such as melatonin and secretory IgA antibodies extracted from human milk adsorbed onto PEG microspheres showed that the controlled release of this compound was able to reduce viability and induce apoptosis in MCF-7 cell lines [11,12]. Other herbicidal and barium chloride studies, adsorbed to PEG microspheres on human blood mononuclear cells co-cultured with breast cancer cell lines (MCF-7), showed a pro-apoptotic effect in breast cancer cells MCF-7 human [94, 95]. Immunotherapy for tumor treatments based on cytotoxic properties of immunocompetent cells has also been the focus of many studies. Both T cells and phagocytic cells are considered effectors with antitumor activity [96]. The melatonin adsorbed to the PEG microsphere was able to increase the functional activity of colostrum phagocytes and that this modified hormone release system may represent an alternative in the treatment of diseases [17].

Here we hypothesize that melatonin adsorbed on PEG microsphere may be effective in the treatment of breast cancer. The possible interactions between components present in human milk and therapy of bioengineered melatonin as a strategy for the prevention and treatment of breast cancer are shown in figure 1.
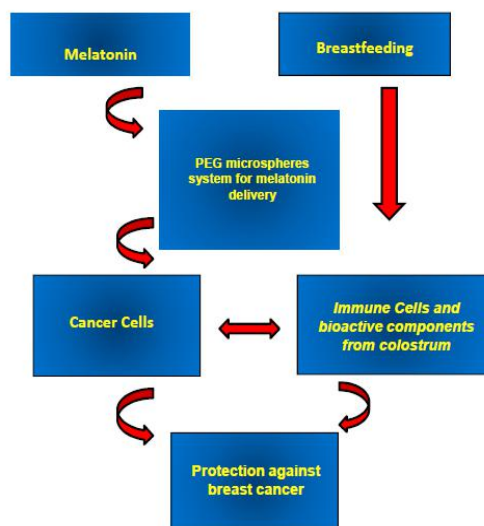
Fig.1: Hypothetical model of therapy with Melatonin bioengineered

Additionally the chronotherapy, the practice of drug administration according to the circadian rhythm, is intended to maximize efficacy and minimize toxicity in the body. This approach has proven advantageous in several diseases, such as cancer and asthma [97] and has been an alternative of treatments based on melatonin.

On the other hand, the expected response by chemotherapy, radiotherapy, hormone treatments, is the induction of apoptosis, since the balance between cell proliferation and apoptosis is determinant for its growth [98]. After initiation of chemotherapy, within 24 h there is a significant increase in apoptosis in breast tumors, associated with decreased proliferation. This response may occur differently in the various tumor types, and at the end of the chemotherapies there is an increase in the levels of the anti-apoptotic Bcl-2 protein, which favors the occurrence of chemoresistant residual cells, which may be important for tumor recurrences [99].].

The anti-apoptotic role in normal and pro-apoptotic cells in cancer cells has been reported in studies with melatonin, giving prominence to this hormone, since conventional cancer treatments can not do this discrimination between healthy cells and cancer cells, placing it in a prominent position in the search for effective treatment against various types of cancer, and especially against breast cancer [100].

VI. CONCLUSION

Major advances in cancer therapy have been occurring, and the study of the use of melatonin in cell culture or in vivo oncology has shown promise. The mechanisms of action of melatonin in reducing oxidative stress and the activation of apoptosis in cancer cells has put this hormone as a highlight in the adjuvant use of cancer treatment.

And considering that the breast tissue is in constant and direct contact with the soluble and cellular immune components in the milk, and the numerous immunological constituents of the breast milk, among these high concentrations of melatonin, macrophages, it is possible that interactions of these components, directly or modified release systems with factors present in tumor cells may be an alternative for tumor immunotherapy.

There is still much to study and develop to further increase the cure rates of cancer patients, as well as eradicate the occurrence of adverse reactions that both discomfort and incapacitate the patient, often leading to withdrawal of treatment. There is a need to improve the studies around melatonin as an immunomodulatory agent of colostrum phagocytes in the action against breast cancer cells, since these cells are present in large quantities, mainly in women who have breastfed, which can increase even more the chances of prevention against breast cancer.

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Groundwater quality:Study of the Nitrate(NO3-) concentration in the Urban Area of the Brazil/Bolivia Border

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Abstract— *Objective: To analyze the quality of groundwater potentially impacted by nitrate (NO3-), before and after the flooding of the Madeira River, in two urban areas of Rondônia on the Brazil / Bolivia border. Method: Data and water samples were collected according to Standard Methods for the Examination for Water and Wasterwater (APHA, 1998) together with the methodology proposed in the Water Sample Collection and Preservation Environmental Sanitation – CETESB. The place were georeferenced using the Global Positioning System (GPS). For nitrate measurement, the spectrophotometry method was used using the Spectrophotometer, brand Micronal B495, the chemical reagents used were made by Alfatecnoquímica and available in two vials called reagents 1 and 2 (nitrate reagent). Results: In the first large area of risk in 100% of samples, high levels of N nitrate (NO3-) were*
detected. > 10 mg / L. In the second area in 30% of the samples were detected NO3 content higher than 10mg / L. Conclusions: The population is consuming water with a high degree of nitrate contamination. It alerts itself to a public health issue.
Keywords— ***Groundwater quality, Nitrate, Contamination.***

I. INTRODUCTION

In the State of Rondônia, groundwater represents an important resource in human supply. Of the total water that the Water and Sewage Company of Rondônia (CAERD) produces, 35% originates from the underground spring. Groundwater, as it is a low-cost alternative, is accessible to all, especially the low-income population, both in daily supplementation and in the total

replacement of water provided by the public and private service (CAMPOS, 2003).

Another aspects that are highlighted are: Inefficiency of basic sanitation services and lack of sanitary sewage in the urban area. The inefficiency of these services forces the local population to build black and septic tanks for effluent deposition within the immediate vicinity of their land (MELO JUNIOR et al., 2006), which in practice, this process translates into contamination of groundwater.

According to Barbosa (2005), the lack of a sewage collection network leads the population to adopt the use of septic tanks or sinks. The inadequate fate of domestic and industrial sewage causes the degradation of the underground spring by the leaching of organic and inorganic contaminants. Most of these contaminants reach the shallow water table, and can also reach the deep or artesian water table.

Nitrate occurs naturally in groundwater, but its presence in high concentrations is a result of human activities, mainly to the use of in situ sanitation systems, the nitrogenous substances of organic waste are oxidized by chemical and biological reactions and the result is the presence of nitrate in soil. Nitrate is extremely soluble in water and can move easily and contaminate the aquifer at long range due to its persistence and mobility. It is observed the power of contamination present in this chemical agent, once present in the soil or directly in the water has very easy to contaminate the groundwater.

Nitrate (NO_3-) is a colorless, neutral, strong, oxidizing and water soluble ion, corresponding to the final ratio of biological stabilization of nitrogenous organic matter. It is the most common contaminant found in groundwater. Like Foster & Hirata (1993) cite, its concentration rarely exceeds 5 mg / L in non-polluted waters and concentrations above 10 mg / L represent a strong indication of contamination in the waters. In addition to the use of agricultural fertilizers and livestock, in situ sanitation systems, whether by septic tanks or rudimentary pits, are another important source of nitrate in groundwater. Due to the hazardous nature of this chemical agent, the lack of planning in the construction of each individual sanitation system (well x pit), allows the contact of the effluent from the well with the well water.

Baird; Cann (2011) corroborates the findings when they state that the inorganic contaminant of greatest concern in groundwater is the nitrate ion NO_3-, which normally occurs in aquifers in rural and suburban areas. Nitrate in groundwater originates mainly from four sources: fertilizer application with nitrogen, as well as inorganic and animal manure, in plantations; soil cultivation; sewage deposited in septic systems and atmospheric deposition.

The legislation on the quality of drinking water in Brazil, at Ordinance no. 518/2004 of the Ministry of Health and the World Health Organization is exhaustive: "Water containing concentrations greater than 10 mg / L of nitrogen (N) in the form of nitrate (NO_3-) is unfit for human consumption".

Concentrations above 3 mg/L of nitrogen in the form of NO_3- are indicative of contamination due to anthropogenic activities, also indicators of bacterial contamination and fertilizers. A safety alert for the health of people who are subjected to such a situation.

At concentrations above than 10mg/L NO_3 -N, may cause methemoglobinemia and cancer. Nitrate, in particular, can reach groundwater and watercourses, causing diseases by the consumption of contaminated water (infant cyanosis or methemoglobinemia and stomach cancer) and environmental damage, such as eutrophication. For Baird and Cann (2011), excess nitrate ion in drinking water is worrisome in causing newborns to blue baby syndrome; and in adults, according to research, may be responsible for causing stomach cancer, and increasing the likelihood of breast cancer in women (BAIRD, CANN, 2011).

Like previously stated, in high concentrations, nitrate is associated with methemoglobinemia or blue-baby syndrome, which makes it difficult to transport oxygen into the bloodstream of babies, which can lead to asphyxia. In adults, internal metabolic activity prevents the conversion of nitrate into nitrite, which is the agent responsible for this disease. It is now known that nitrites, under certain conditions, can be combined with secondary amines, forming nitrosamines, products which are considered carcinogenic, teratogenic and mutagenic according to experimental tests performed on animals. Some studies relate statistically to gastric cancers and cervical cancers with excessive nitrate intake (BRASIL, 2008).

II.   METHODOLOGY

Data and water samples were collected according to Standard Methods for the Examination for Water and Wasterwater (APHA, 1998) along with the methodology proposed in the Guide to Collection and Preservation of Water Sample of the Company of Environmental Sanitation Technology - CETESB.

The wells and water collection points were registered and some important variables such as age of the well, depth, hygiene conditions, cesspools, sewage, animals and others were registered.

The points of water collection for analysis were given in the urban area of two Amazonian municipalities, one state capital and another in the border area with Bolivia. 10 collections were made in each pre-defined area. The first area of risk of flooding and that appeared

with high concentration of nitrate and the second area far from the area propitious to flood. We will not puncture the exact places of water collection, so as not to stigmatize or stereotype the inhabitants of these places with higher nitrate concentration, according to the ethical principles of the research. These data are preliminary. Other elements that are being analyzed in the research: fluoride, chloride, nitrite, phosphate, sulfate and still can be extended to lithium, sodium, ammonium, potassium, calcium and magnesium. In addition, the wells and water collection points for analysis after flood and flood were the same as previously collected.

III.   RESULTS AND DISCUSSION

In the first large area of pre-flood / flood risk in 50% of samples, high levels of N nitrate (NO3-) were detected, above 10 mg / L, characteristic of waters with a high degree of impaction. Water not suitable for human consumption. 40% had a content> 3 mg / L, at 50%> 10 mg / L, the total contamination of the aquifer becomes evident. And after the flood / flood of the area the degree of contamination rose in a frightening way.

As shown in Table 1, high levels of N nitrate (NO3-) were detected in 100% of samples > 10 mg / L were detected 80% of the wells and collection points. PA57 calls attention with levels of 156.74, PA 51, with 70.08; PA54 at 67.36; PA59 at 63.27 and PA56 at 56.67. All characteristic of waters with high degree of impaction. The selected sites for water collection are urban areas of environmental risk for human health, a public health issue. Just to elucidate some points of reference, the surrounding graveyards, health units, streams that became an open pit, accumulation of houses in poor infrastructure conditions, the use of Amazonian well water and tubular wells without maintenance and near the black and septic septic tanks are conditioning and / or determinant for this scenario.

Table.1: NO3 concentration before and after flood (Situation I) Cadastral data of wells and water collection points and N-NO3 content (mg / L).

Amostral Point	Before	After
PA51	16,31	70,08
PA52	2,98	5,66
PA53	9,96	10,77
PA54	10,36	67,36
PA55	7,89	11,27
PA56	12,74	56,67
PA57	43,68	156,72
PA58	9,94	14,66
PA59	23,27	63,27
PA60	3,6	4,96

According to Table 2 in these points of water collection that did not have a direct influence by the flood / flood, the levels of nitrates did not undergo significant variations. In this area, 30% of the samples detected NO3 content higher than 10mg / L. Water not suitable for human consumption. In 70% of the samples, water content higher than 3 mg / L was detected, which characterizes water with a high degree of impaction, although it is not close to the results found in the areas of situation I, area affected by flooding.

Table.2: NO3 concentration before and after the Flood (Situation II) registration data from wells and water collection points and NO3-N concentration (mg / L)

Amostral Point	Before	After
PA21	5,54	**5,58**
PA22	5,56	**5,52**
PA23	1,27	**0,97**
PA24	**10,9**	**10,7**
PA25	2,45	**2,52**
PA26	**14,54**	**13,47**
PA27	**16,36**	**16,22**
PA28	4,5	**4,2**
PA29	2,77	**2,79**
PA30	3,27	**3,31**

Lima (2008), when investigating the groundwater of the aquifer Free Jaciparaná, in zone 3 of Porto Velho, before the event flooding of the Madeira River and consequently flooding of some urban areas of the city of Porto Velho, found it partially contaminated by nitrate.

In thirty of the ninety wells surveyed, that is, 33% of the water samples detected nitrate levels above or very close to the limit of 10 mg / L, the maximum value allowed in Brazil for water intended for human consumption, according to Administrative Rule #518 of March 25, 2004 from the Ministry of Health. In 68 wells, representing 68% of the samples, levels higher than 3 mg / L were identified, indicating changes in the chemical composition of the water by anthropogenic activities. The sampling points, the shallow wells, used in this study, 100% have depth up to 12 meters.

According to Lima (2008) this situation is identified with the concepts proposed by Hirata et al. (1997) on densely populated areas with an on-site sanitation system. This practice constitutes the main sources of nitrogen in the environment, due to the large number of pits. Campos (1999) em pesquisa em Mirante da Serra, também em Rondônia, found the predominance

of high levels of nitrate (NO3-) in the most densely populated areas. The low depth of the wells, the situation of sub-outcropping and predominance of latosols, extremely porous material; and, due to the high rainfall in the region, favors the leaching process. In addition to the precarious protection, the wells are susceptible to varying surface influences.

According to Varnier & Hirata (2002), even the pit being far from the well, around ten meters, commonly observed length, does not differentiate the degree of impaction in groundwater.

It is important to consider that, in case of presence of nitrate in the water, even in low concentrations, besides indicating that the contamination is old in the environment, it reveals the presence of organic matter associated with bacteria, viruses and parasites, alive or in some of the stages of decomposition. These agents cause several diseases, especially acute diarrhea and, in the form of nitrate, is a carcinogenic indicator (LIMA, 2008).

In part, this high contamination index was expected to be found in almost all of its totality, considering that these areas are used as effluent receptors, do not have a sewage collection network and the effluents produced by the population are released into the soil, streams and in septic and black septic tanks.

The studies by Alaburda & Nishihara (1998) are references regarding the population's health concern, especially the health of children and the elderly, because they are more susceptible to the development of methemoglobinemia due to exposure to water with a high concentration of nitrate and in adults the stomach cancers. Health impairments such as diarrheal diseases and gastroenteritis are commonly reported and recorded in the health care system of the counties surveyed.

IV.   FINAL CONSIDERATIONS

Therefore, it can be stated that the sites surveyed are largely contaminated with nitrate. The main constraints are as sources of contamination to the anthropic and multi-point action of the in situ sanitation system, type septic tank and black cesspits, exposure and precariousness of the wells, exposure of solid waste, sewage disposal of all nature. Allied to all these conditions the flooding / flooding in this case were determinant to aggravate the contamination of the water table. The population is consuming water with a high degree of nitrate contamination. It alerts itself to a public health issue.

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Numerical Simulation and Comparison of Carbide and HSS Tool Wear Rate while Drilling with Difficult to Cut Super Alloy Titanium Based on Archard Model

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Abstract— A Carbide and HSS tool wear rate simulation using Archard′s wear model is proposed, finite element modelling is done using commercial finite element software ABAQUS/explicit. ABAQUS interface was used to simulate the contact pressure. For measuring wear depth of tool's, drilling operation is performed experimentally then wear depth is measured on profilprojecter. Comparing the wear rate, based on Archad model. Result model shows that at 2000 rpm, 0.15 mm/rev feed rate and 45 mm drilling length Carbide tool is suited but at 3000 rpm, 0.20 mm/rev feed rate, 45 mm drilling length and 4000 rpm, 0.25 mm/rev feed rate, 55 mm drilling length HSS tool is suited because of lower wear rate than Carbide tool.

Keywords— Finite Element Analysis, Titanium Drilling, Archard′s Model, Wear Rate, Carbide and HSS Tool.

I.   INTRODUCTION

Titanium alloys are used extensively in aerospace, automobile and medical application because of combined high special strength (strength-to-weight ratio), fracture-resistant characteristics and exceptional resistance to corrosion. However, titanium alloys are usually considered as extremely difficult to cut material because of their low thermal conductivity and high chemical reactivity with cutting tool materials. Tool wear is major issue in dealing with titanium.

Being one of the new hole-machining methodologies, drilling is widely used machining process, which account for 40-60% of total material removal process. In the past, lot of experiments need to be conducted to obtain a series of related data during the drilling studies, which bring about huge raw material consumption. Finite Element simulation can not only save the raw material but also improves accuracy of result.

Furthermore, finite element analysis can also obtain the measured data which is difficult to obtain in experiment.

In this study, A 3D finite element model of drilling of titanium alloy with carbide and HSS tool is developed using ABAQUS. The FE model is based on Lagrangian formation with explicit integration method. The simulation are conducted under different rpm, feed rate and length of drilling in order to analyze and compare the wear rate of Carbide and HSS tool based on Archard′s model.

II.   WEAR MODEL

Tool wear is major issue in production process which can be minimized up to some extent by selection of correct tool at appropriate process parameter. For predicting wear rate Archard wear low is most commonly used which is expressed as [5]:

$$k_D = V / F_N . s \qquad (1)$$

Where k_D dimensional wear rate, V is the wear volume, F_N is the normal load, s is the sliding distance:

$$k_D = A . \Delta h / F_N . s \qquad (2)$$

V is replaced here by A, area and Δh is wear depth

$$k_D = \Delta h / (F_N/A) . s \qquad (3)$$

While F_N/A is local contact pressure expressed as P

$$k_D = \Delta h / P . s \qquad (4)$$

The process of wear rate calculation is begins by calculation of contact pressure between contact surfaces, the commercial ABAQUS analysis software is implemented to calculate the contact pressure. The wear height is calculated experimentally and then equation (4) is used to calculate wear rate. The flow chart of the finite element wear simulation procedure consisting of steps shown in figure1, the drilling parameter used for finite element simulation and experiment were in Table1.

Table.1: Process Parameter

Process Parameter	LEVEL 1	LEVEL 2	LEVEL 3
Spindle speed (rpm)	2000	3000	4000
Feed rate (mm/rev)	0.15	0.20	0.25
Length of drilling (mm)	35	45	55

III. FINITE ELEMENT MODEL

In this study a 3D models of drilling process is developed using a commercial finite element software ABQUS/Explicit. Due to the dynamic nature of the process, dynamic explicit element integration has been proposed for this study. Details of FE model are discussed as follows.

A twist drill bit with two cutting edges was adopted in drilling process. Geometric parameter of drilling tool were: the diameter is 3.1 mm, rake angle 20°, clearance angle 25°, helix angle 25° and tip angle 135°.The finite element model of work piece geometry dimension is 6.1 mm diameter and 55 mm length. The work piece and tool are set same as the actual working condition for both Ti-Carbide and Ti-HSS. Here work piece is created with deformable part interfacing with drill bit for FEA analysis. The coulomb friction model is used and constant friction coefficient 0.1 for Ti-Carbide and 0.15 for Ti-HSS is used. The tool is having rotational moment while the work piece is fixed in all direction, the encaster (U1=U2=U3=UR1=UR2 =UR3=0) loading condition is given. The overall FE model is shown in Figure 2.

3.1 Property Model

To model the thermo-visco plastic behavior of titanium alloy Ti6Al4V, the Johnson-Cook material law was used for material constitutive model of finite element simulation, which assumed a von misses type yield criterion and an isotropic strain hardening rule. This relationship given by following equation (5).

$$\sigma = [A + B(\varepsilon^n)][1 + C\ln\frac{\dot{\varepsilon}}{\dot{\varepsilon}_0}][1- \frac{T-T_{room}}{T_{melt}-T_{room}})^m]$$
(5)

where σ was the flow stress; ε is the plastic strain, $\dot{\varepsilon}$ is the strain rate (s-1), $\dot{\varepsilon}_0$ is the reference plastic strain rate (s-1), T is the temperature of work piece (℃), T_m is the melting temperature of the work piece (℃), T_{room} is the room temperature (℃). Coefficient A is the yield strength (MPa), B is the hardening modulus (MPa), C is the strain rate sensitivity coefficient, n is the hardening coefficient, m is the thermal softening coefficient.
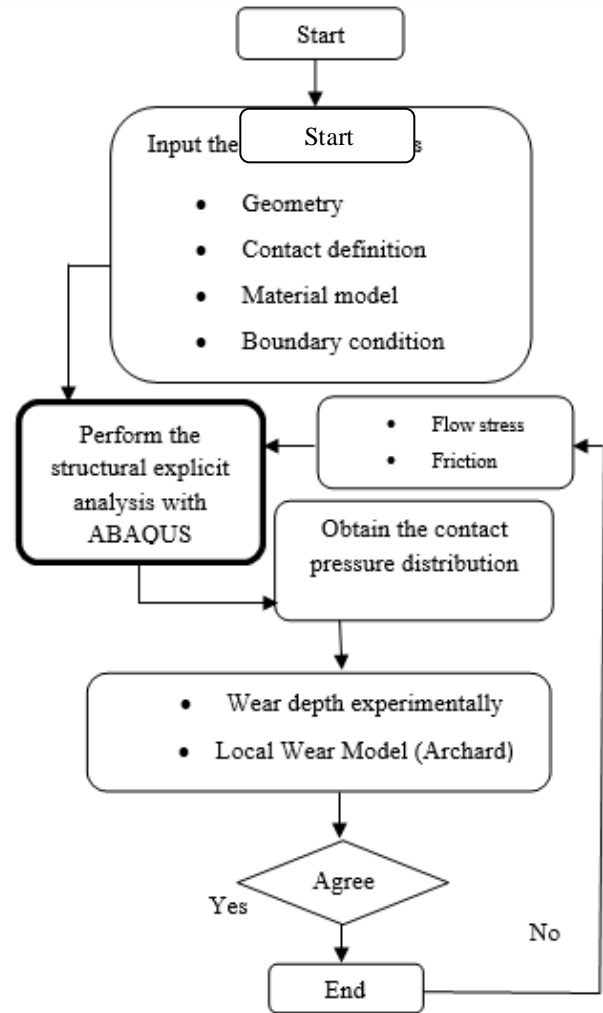
Fig.1: Flow Chart of Wear Rate Simulation.
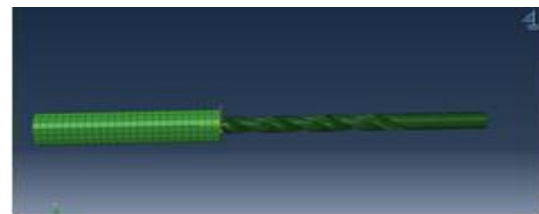
Fig.2: FEA Model.

As the plastic strain reached to its maximum value, damage is initiated. The equivalent plastic strain at the damage is calculated from the equation (6).

$$\varepsilon_D^{-pl} = \left[d_1 + d_{2exp} \left(d_3\frac{p}{q}\right)\right][1 + d_4\ln(\frac{\dot{\bar{\varepsilon}}^{pl}}{\dot{\varepsilon}_0})(1 + d_5\frac{T-T_{room}}{T_m-T_{room}})$$
(6)

Where d_1-d_5 are the failure parameters of Johnson-Cook damage model, *p* is the hydrostatic pressure, *q* is the Misses stress, $\dot{\varepsilon}_0$ is the reference strain rate, and $\dot{\bar{\varepsilon}}^{pl}$ is the strain at the time of failure [4].

Johnson-Cook constitutive material model and damage model parameter of Ti6Al4V are given in the

Table 2. The properties of the work piece and tool material used in this study are given in Table 3

Table.2: Johnson-Cook Constitutive Material Model and Damage Model Parameter of Ti6Al4V.

A (Mpa)	782.7
B (Mpa)	498.4
C	0.028
n	0.28
m	1
d_1	-0.09
d_2	0.25
d_3	-0.5
d_4	0.014
d_5	3.87

Table.3: Material Properties.

Material properties parameters	Ti6Al4V	Carbide	HSS
Density (kg/m³)	4420	1570	8140
Young modulus (Pascal)	122,000,000,000	669,000,000,000	207,000,000,000
Poisson ratio	0.31	0.26	0.27

IV. EXPERIMENTAL SET UP

A series of experiment was conducted to evaluate the wear depth of Carbide and HSS tool. The test was carried out on DECKEL MAHO-DMC 835V (continues speed up to 14000 rpm and 14kw spindle power) CNC machining center. After drilling operation is done the tool wear depth is measured using profile projector, by comparing the dimension of tool before and after drilling operation wear depth is measured. Figure 3 shows experimental setup of drilling.

(A)

(B)

Fig.3: Photograph of Experimental Setup (A) Profile Projector (B) Drilling Setup.

V. RESULT AND DISCUSSION

5.1 Contact Pressure

The FE model provides a result of contact pressure, the following figure shows the variation contact pressure with different level of process parameter for both Ti6Al4V-Carbide and Ti6Al4V-HSS obtained from simulation respectively,

As shown in figure 4, 5, 6 the result showed that while drilling at all process parameter level 1, level 2 and level 3 the maximum contact pressure is for Ti6Al4V-HSS that is 24375, 224968, 70635Mpa.

While drilling with Ti6Al4V-Carbide the graph showed that at initial drilling condition contact pressure is maximum but as process parameter increases the contact pressure decrease.
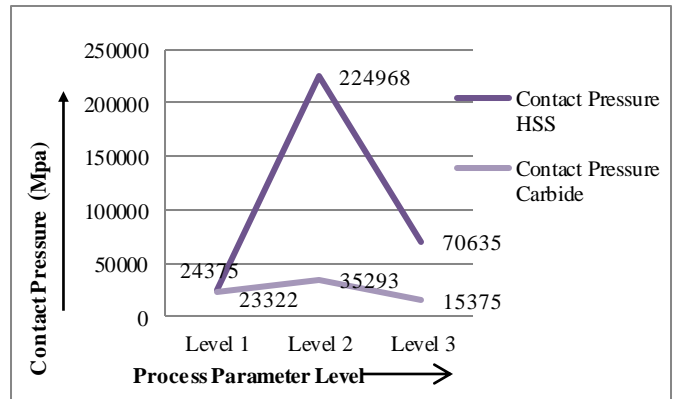
Graph 1 Contact Pressure vs. Process Parameter at different Levels.

The graph 1 showed that there is variation in contact pressure that is at level 1 for Ti6Al4V-HSS contact pressure is 24375 Mpa at level 2 there is large amount of increase in contact pressure up to 224968 Mpa and at level 3 the contact pressure is decreases up to 70635 Mpa.

(A)
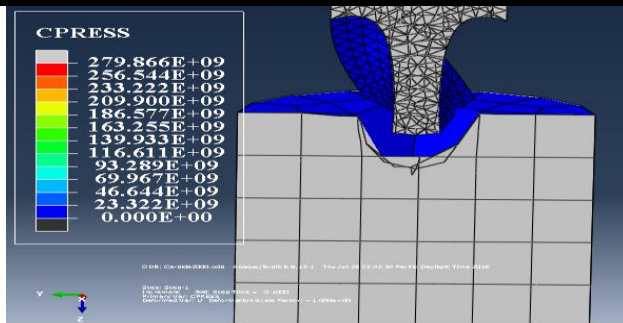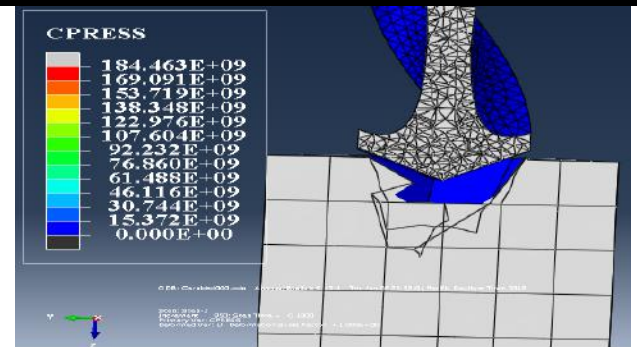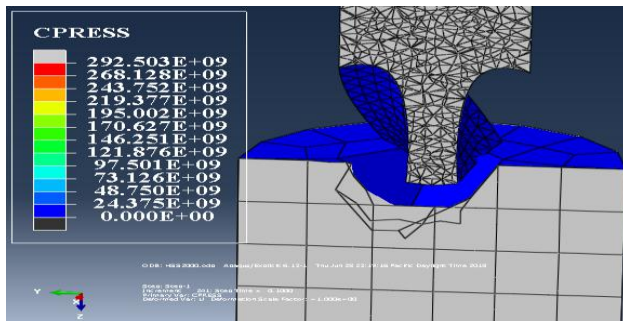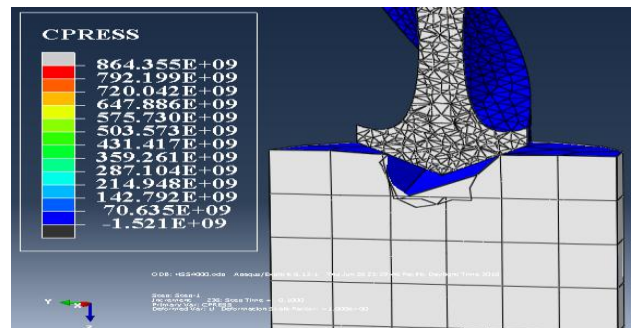
(B)

Fig. 4: Contact Pressure at Level 1 (A) Ti6Al4V-Carbide and (B) Ti6Al4V-HSS.

(A)

(B)

Fig. 5: Contact Pressure at Level 2 (A) Ti6Al4V-Carbide and (B) Ti6Al4V-HSS.

(A)

(B)

Fig. 6: Contact Pressure at Level 3 (A) Ti6Al4V-Carbide (B) Ti6Al4V-HSS.

5.2 Wear Rate

Wear rates of Carbide and HSS tool at different process parameters are calculated according to Archard wear model as shown in following Table 4:

Table.4: Wear Rate Comparisons.

Level	Wear Rate (mm^3/Nmm)	
	Ti6Al4V-Carbide	Ti6Al4V-HSS
1	1.317E-08	1.756E-08
2	7.630E-09	1.631E-09
3	1.885E-08	4.675E-09

Table shows the variation of tool wear rate with Archard model the comparison can be done between both Carbide and HSS tool. That is at level 1 the wear rate of HSS tool is greater than Carbide tool that is 1.756E-08 mm^3/Nmm and at level 2 and level 3 wear rate of Carbide tool is more than HSS up to 1.885E-08 mm^3/Nmm.
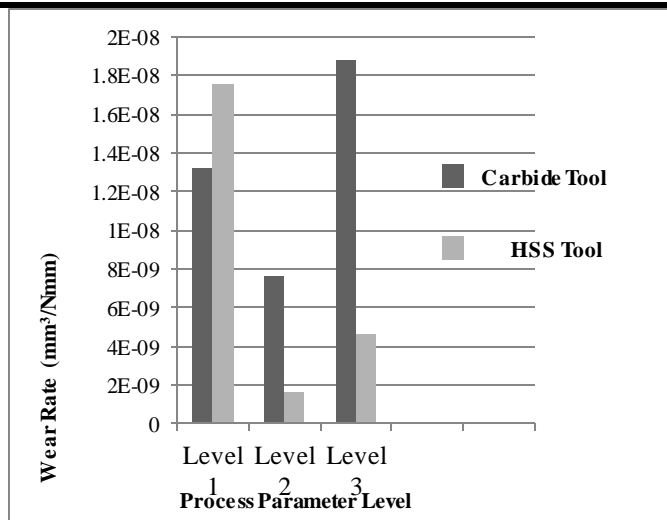
Graph 2 Wear Rate Comparisons Between Carbide and HSS.

From level 1 to level 2 wear rate of both tool is reduced but at level 3 wear rate of both tool is increased. The maximum wear rate that is 1.885E-08 of Carbide tool occur at 4000 rpm, 0.25 mm/rev feed rate and 55 mm drilling length.

VI. CONCLUSION

The conclusion can be drawn as follows:

(1) A three-dimensional finite element model of drilling process is developed for Ti6Al4V with two cutting tools carbide and HSS. Comparison of both tool wear rate is done based on Archard model.

(2) The contact pressure changes are compared for both tools. At selected level of process parameter, the contact pressure of HSS tool is more than Carbide tool. The maximum contact pressure is 224968 Mpa of HSS tool occur at 3000 Rpm, 0.25 feed rate and 45 mm drilling length.

(3) Also the wear depth of Carbide and HSS tool are calculated experimentally,

(4) Archard wear model showed that at initial rpm 2000, feed rate 0.15 mm/rev and drilling length 35mm Carbide tool is suited, but at 3000 rpm, 0.20 mm /rev feed rate, 45mm drilling length and 4000 rpm, 0.25 mm/rev feed rate, 55 mm drilling length HSS tool is suited because of lower wear rate than Carbide tool.

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Design and construction of a didactic standalone photovoltaic plant

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Abstract— This paper proposes the design and construction of a standalone didactic photovoltaic (PV) plant. The system components are available as a didactic kit to the students of the Federal Institute of Education, Science and Technology of Ceará (IFCE), Brazil. Thus, contributing to the teaching-learning process and providing a system to be used in future researches. In addition, the system was designed for supplying electricity to the lighting circuit of the Energy Processing Laboratory, located at IFCE Fortaleza Campus. The PV system developed during the work has an autonomy of 900 Ah and the total installed power of 840 Wp. Using a data capture system, a generation generated by the PV microgeneration was registered in operation up to 647 W.

Keywords— didactics, standalone photovoltaic plant, solar energy.

I. INTRODUCTION

The generation of electric energy from water resources still occupies the largest share of energy production in Brazil (68.1%) [1], according to data from the Brazilian Energy Research Company (EPE). With the water resource being the main source of electric energy in Brazil, atypical climatic periods of low rainfall lead to a considerable reduction in the hydroelectric water levels.

The water resource is limited and fundamental to the life of living beings. One of the most abundant resources on Earth is the solar resource. The results obtained by the SWERA Project [2] show that in Brazil, since it is an equatorial region, even in the southern states of the country, where the annual average is the lowest, the availability of solar energy is higher than in European countries, such as Germany, Spain and France, where the solar energy source has been widely explored.

An alternative to reduce the consumption of the electricity generated by hydroelectric plants would be to use the photovoltaic (PV) process, converting sunlight into electricity.

Considering that the study of this type of generation is very important for the sustainable development of the country, this work proposes to design and construction of a PV generation plant in a didactic way, with the equipment made available at the Federal Institute of Education, Science and Technology of Ceará (IFCE) Campus Fortaleza-Brazil, and easily accessible to undergraduate and master's students. The system supplies the lighting circuit of the Energy Processing Laboratory (LPE) located at IFCE.

II. LITERATURE REVIEW

A bibliographical review was developed, and it was verified that the use of PV plants as source of electric energy had already been proposed in the twentieth century by [3], where the author designed a solar plant allied to a wind farm. The use of PV energy to conduct desalination units, solving the problem of water shortage in places where there is no access to conventional electricity distribution is proposed by [4]. A PV plant, allied to wind power, for desalination by reverse osmosis of sea water was also proposed by [5]. Therefore, it is noted that the incentive to use this technology does not originate in the 21st century. In the case of hybrid systems with part of the generation using the PV process, the methodology for optimal sizing of stand-alone PV/wind-generator systems using genetic algorithms was suggested by [6].

With the popularity that autonomous PV systems were reaching, new ways to improve the design were investigated, as presented by [7]. The authors present a study and analysis of the sizing curves, revealing that the solar radiation data collected daily are better than the use of average monthly values. In the state of the art, researchers propose and apply algorithms for sizing PV systems. An algorithm for optimized sizing of each component of the system is proposed by [8].

One way of ensuring high performance was suggested by [9], introducing an advanced pitch converter in DC power conversion to improve efficiency over conventional impulse converters. A system for voltage control of the Pulse Width Modulation (PWM) inverter has also been implemented to maintain the sinusoidal output voltage with low harmonic distortion and variation of the output voltage for different types of load. In addition, the system has a solar tracking system, keeping the PV module better positioned. Due to the low efficiency of solar cells (around 16%), new technologies are emerging to improve the efficiency, as presented by [10]-[11], however, solar tracking is considered by [12] as the most appropriate technology to increase the efficiency of solar cells.

An analysis of the requirements for an autonomous PV system project is made by [13]. The proposed methodology aims mainly to assist in the choice and configuration of the load controller. Many advances in PV electricity generation can be observed [14].

The year 2017 was highlighted by [15] for having a greater number of publications related to renewable energies, showing that the interest for the subject is increasing. With this growing interest, it is necessary to encourage the study of the generation of electric energy from renewable energy sources by educational institutions. A system based on a microgrid wind-PV-battery, in laboratory scale for didactic use, is proposed by [16].

III. MATERIAL AND METHODS

PV off-grid systems, also called isolated or standalone systems, are usually used in locations that do not have access to conventional electrical power. With a wide application area, such as street lighting, power supply for communication systems, electric vehicle charging and aerospace systems, the PV standalone systems have become a low maintenance solution. To ensure greater autonomy in the power supply, these systems have a battery bank that stores the energy to be used at night or with lower solar irradiation. The off-grid system is generally composed of a set of PV modules, load controller, bank of batteries, and, depending on the application, a DC drive for alternating.

The criteria for the design of PV systems generally depend on the average values of solar irradiation and monthly or annual electricity consumption. In the annual average criteria, the PV generator capacity is determined from the generation capacity of the modules, calculated by the average solar irradiation over a year, and the consumption in the same period. While in the criteria of the critical month, also called the criteria of the worst month, the generation capacity of the modules in the month of lower generation must meet the average monthly consumption, guaranteeing the energy supply during the period where the

solar irradiance is lower [17]. In a PV off-grid system, where this is the only power source, the critical month method must be used to ensure year-round power supply.

The analysis of the installation site should be one of the first criteria to be evaluated. In this step a geographic analysis of the location where the PV modules will be installed is made. The climatic conditions and buildings or large vegetation in the surroundings must be observed, thus avoiding the appearance of shade during the hours of greater solar irradiation. The installation site is a factor of great relevance in urban PV microgeneration systems, where space is generally limited to the roofs of residences. In this case the space for installation is a determining factor to define the energy potential in that location. In order to provide support for the design of PV systems, the Reference Center for Solar and Wind Energy Sérgio Brito (CRESESB) provides an online platform, called SunData, which is used to calculate the average monthly solar irradiance in any place in the Brazilian territory [18]. The position of the Earth relative to the Sun varies according to the time of day and day of the year. Therefore, the geographical location of a PV plant is directly linked to the energy potential of the plant. To install the PV modules to obtain the best use of this potential annually, the PV modules must be positioned correctly.

Another point to be evaluated is the energy consumption that the PV system must supply. In a system that will supply all the energy consumed in a property, the average consumption verified in the energy bill will serve as the basis for the design of the PV system by the criteria of the annual average, while the highest consumption recorded will serve as the basis for the sizing by the criteria of the critical month. In other situations, in which there has never been an energy bill, or a system will be designed only for a specific circuit, such as lighting, for example, a survey of the loads to be supplied by the system must be done.

The system must be dimensioned to supply the demand for active energy (L) consumed daily. For the design of the autonomy it is necessary to consider the efficiency of the inverter and the bank of batteries, according to Equation 1:

$$L(Wh/dia) = \left(\frac{L_{CC}}{\eta_{bat}}\right) + \left(\frac{L_{CA}}{\eta_{bat}\eta_{inv}}\right) \qquad (1)$$

L_{cc} (Wh/day) is the amount of DC energy consumed daily in the critical month; L_{CA} (Wh/dia) is the amount of AC power consumed daily in the same month; η_{bat} (%) is the overall battery efficiency and η_{inv} (%) is the efficiency of the inverter. Suggested values are 85% for inverters and 86% for overall battery efficiency [19]. For [20], the type of battery that will be used is first defined. Then the discharge depth and the voltage of the battery bank are

defined. Once this is done, we can calculate the capacity of the battery bank for a given autonomy by Equation 2:

$$Capacity\ (Ah) = \frac{Consume(Wh/dia) \times Aut(days)}{V_{BB}\ (V) \times Prodes\ (pu)} \qquad (2)$$

$Aut(days)$ is the set autonomy for the PV system; V_{BB} (V) is the voltage of the battery bank; $Prodes\ (pu)$ is the depth of discharge of the battery at the end of the range (pu). With the necessary capacity to supply the determined autonomy, one can choose the batteries appropriate to the system. It should be emphasized that the battery must be of the stationary type and the disposal must be done in an appropriate way, so that the environmental impacts are minimized. Existing technologies and the environmental impacts caused by them are discussed in [21].

For sizing the inverter, it is necessary to establish the maximum power demand. According to CEPEL and CRESESB, if the power of the inverter is equal to or greater than the installed power, and in loads that demand peak power, electric motors during starting, it is necessary to be aware of this power and its duration to define the surge capacity that the inverter must withstand. The inverter input must be compatible with the battery bank configuration voltage for stand-alone PV systems and the output according to the load requirement.

Another factor that directly influences the PV generation is the shading, since each totally shaded cell stops producing energy. Thus, an analysis of the shading around the PV system is necessary. After calculating shading relative to objects in the surroundings and the total area available for free shading installation or partially shaded during some time of the year, modules that meet the power requirements generated for the available space must be chosen. The peak power (Wp) of the PV generator that guarantees the power supply needed to supply the load is defined by CEPEL and CRESESB (2014) by Equation 3:

$$P_m = \max_{i=1}^{12} \left(\frac{L_i}{HSP_i \times Red_1 \times Red_2} \right) \qquad (3)$$

P_m (Wp) is the peak power of the generation; L_i (Wh/dia) is the amount of energy consumed daily in month "i"; HSP_i (h/day) are the hours of full sun in the plane of the PV module in month "i"; Red_1 is the factor reducing the power of the PV modules in relation to their nominal value, including dirt, physical degradation, manufacturing tolerance for less, losses due to temperature. By default, $Red_1 = 0,75$; e Red_2 is the power derating factor due to losses in the system by conductors, controller, diodes. By default, $Red_2 = 0,9$. The hours of full sun (HSP) correspond to the number of hours at which the solar irradiation should remain at 1 kWh/m². Thus, the number of hours of full sun can be calculated by Equation 4:

$$HSP = \frac{Daily\ solar\ radiation\ (kWh/m^2)}{1\ (kW/m^2)} \qquad (4)$$

Knowing the peak power of the generation (P_m) and the unshaded area, we choose the PV modules that best meet the necessary peak power in the free zone, partially or completely, of shading throughout the year. The number of PV modules needed to meet the demand for electric power can be calculated by Equation 5:

$$N°_{mod} = \frac{P_m}{P_{mod}} \qquad (5)$$

P_{mod} is the peak power (Wp) of the chosen PV module. The ideal orientation for PV modules in fixed systems is to have the surfaces of the PV modules facing the Equator. That is, in facilities in the Southern Hemisphere, the surface of the PV module will be pointed to the geographical North and in installations in the Northern Hemisphere the surface of the PV module will be pointed to the geographical South [22]. For maximum energy generation annually, CEPEL and CRESESB (2014) suggest that the angle of inclination of the PV modules should be equal to the latitude of the installation site of the system. However, in places where the latitude is between -10° and 10°, a slope of at least 10° is used to facilitate the self-cleaning of the modules by rainwater. This minimum slope also makes it difficult to accumulate leaves on the surface of the modules.

The shape of the PV module (vertical or horizontal) can influence its efficiency. In some situations, such as mounting in snow-friendly environments, the horizontal mounting of the modules can reduce by half the effects of shading caused by snow accumulated on the bottom of the module. This reduction in the effects can be explained by the actuation of the bypass diodes contained in the module. In the horizontal assembly the shading affects two cell lines, whereas in the vertical assembly four cell lines are affected [23]. This is not the climatic reality of Brazil, however other elements can be accumulated in these places, such as leaves and dust. In Fig. 1 two installation modes are shown, and the accumulated dirt is represented by the gradual filling in the lower part of the PV modules. As an example of the module shown in Fig. 1, in extreme cases of dirt, a bypass diode is biased directly into the horizontal mount, while two bypass diodes are biased directly into the vertical mount, compromising every PV module.
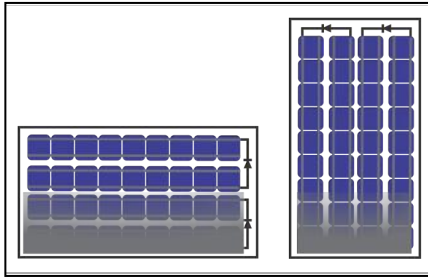
Fig. 1: PV module horizontal (left) and vertical (right)

The load controller must withstand the voltage and current levels provided by the PV system, so it is chosen based on the short-circuit current of the modules. For security reasons, Freitas [24] considers a current 25% greater than the short-circuit in the load controller design. Under these conditions the minimum current supported by the controller can be represented by Equation 6:

$$I_{Cont} \geq 1.25 \times I_{cc} \times Number\ of\ modules\ in\ parallel \quad (6)$$

I_{cc} is the short-circuit current of the PV module.

The input voltage of the load controller must also be observed in the sizing, so you must use modules compatible with the input voltage of the controller.

The correct dimensioning of the conductors, besides guaranteeing safety in the conduction of the generated electricity, reduces the losses caused by the voltage drop and, consequently, increases the efficiency of the system. Freitas [24] suggests the calculation of the section of conductors through Equation 7:

$$S = \frac{2 \times \rho \times l \times I_{max}}{V_n \times \Delta V_{adm}} \quad (7)$$

"S" is the conductor cross-section in mm², ρ is the resistivity of the conductor material (mm²/m); "l" is the length of the conductor (m); I_{max} is the maximum conductor current (A), V_n is the rated voltage of the system (V) e ΔV_{adm} is a dimensionless value between zero and one that corresponds to the percentage of the voltage drop admitted in the stretch.

IV. PROPOSED SYSTEM

The IFCE Campus Fortaleza, where the PV modules are installed, has its approximate geographical location at -3.74431095 Latitude and -38.53687271 Longitude, according to Google (2017). The installation site indicates a lower solar irradiation in the month of April, with monthly average of 4.53 kWh/m² per day. This value will be used for calculation in the sizing by the criterion of the critical month. The PV generation system will be used to supply power to the LPE lighting circuit, where the average daily consumption is shown in Table 1. The average of

electric energy spent will serve as the basis for calculating the battery bank that guarantees the autonomy of the system for the expected number of hours.

Table 1: Average daily consumption in LPE

Description	Amount	Unit power	
Led lamp	12	18.00 W	
Daily use (h)	8.00		
Total Daily Energy (Wh/day)			1,728

For the daily energy consumption, we can calculate the capacity of the bank of batteries necessary for the parameters of the Table 2:

Table 2: Parameters for calculating the battery bank

Total consumption (Wh/day)	1728,00
Autonomy (days)	1.00
Battery bank voltage (V):	12.00
Depth of discharge at end of range (pu)	0.25

The minimum autonomy for the storage system established by ANEEL REN 493 [25] is two days, however, due to the limitation of the equipment available in the IFCE for this project, the autonomy of only one day was considered. This autonomy can be expanded by acquiring another inverter model and a larger number of batteries, as will be seen later. Considering the efficiency of the inverter (0.85) and battery bank (0.86), the active energy (L) can be calculated:

$$L = \left(\frac{1728,00}{0.85 \times 0.86}\right) = 2,363.89\ Wh/dia$$

And the battery bank's ability for active power:

$$Capacity\ (Ah) = \frac{2363.89 \times 1.00}{12.00 \times 0.25} = 787.96\ Ah$$

Knowing the capacity of the bank of batteries for the determined autonomy, it is possible to arrange the arrangement of batteries in parallel and/or series to meet the calculated autonomy and desired bank voltage. The stationary batteries available at the IFCE have capacity of 150 Ah for each battery and the autonomy of the system is guaranteed by at least six batteries (Fig. 2).

Fig. 2: Stationary battery bank used

The inverter required to supply the installed power demand must have a power of at least 216 W. The inverter available at the IFCE is manufactured by Hayama and has power of up to 1000 W. The input for this inverter model is 12 V in direct current (DC). The output signal of the inverter is 220 Vac in a modified (square) wave with 60 Hz frequency (Fig. 3). Since the input of the inverter available on the IFCE is 12 V, serial connection to the available batteries could not be made, so all batteries were connected in parallel.

Fig. 3: Hayama Modified Wave Inverter 1000W

For this model of battery, you should not exceed the amount of six batteries in parallel, as indicated for [26], limiting the battery bank to a maximum of six batteries. Therefore, if there is a need to increase the autonomy of the system later, an inverter with an input of at least 24 V must be acquired, allowing the batteries to be connected in series. The waveform of the available inverter output is not sinusoidal, such as the wave pattern supplied by conventional distributors, but is enough for powering the laboratory lighting circuit.

One of the factors that must be considered is where the PV modules are installed. The site should be large enough to accommodate the number of PV modules required for the plant as well as free of shading. One of the alternatives to the installation space problem is addressed by [27], proposing the installation of the modules floating over water.

For this work, a site shading analysis was done to exemplify how this analysis is done, and to provide the best location for installation in case of plant expansion. For this,

the shadow projections at the winter solstice, equinox and summer solstice, generated by SketchUp software, are illustrated in Fig. 4.
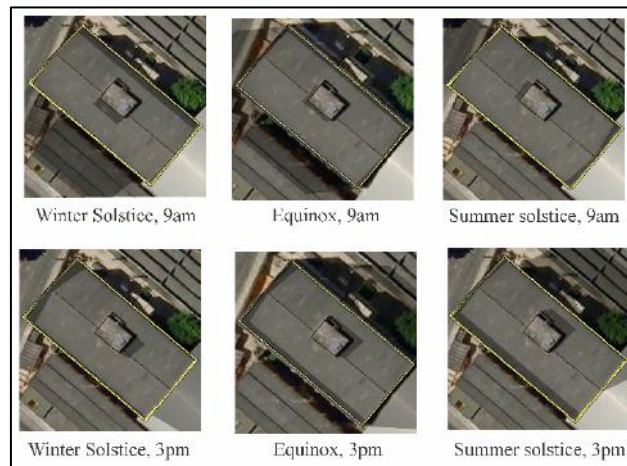
Fig. 4: Projection of the shadow at winter solstice, equinox and summer solstice

In the study of the installation area of the PV modules using the SketchUp software, the projection of the shadow (darkest area) on the roof during the whole year from 9 am to 3 pm is presented in Fig. 5.
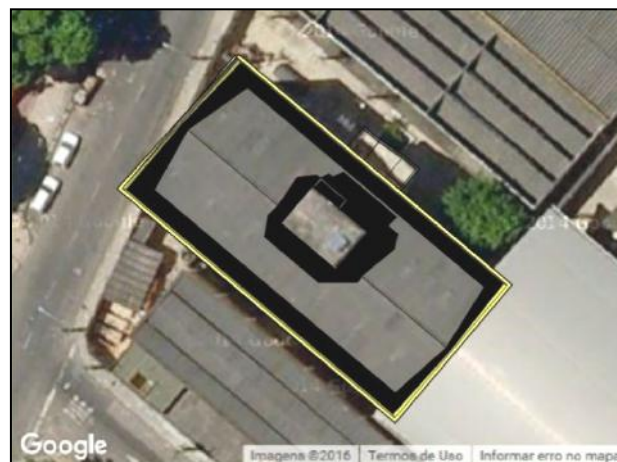
Fig. 5: Projection of roof shading throughout the year between 9 am and 3 pm

The interaction of the SketchUp software with Google Earth allows the drawing to be done over the image of the location, captured by satellite, and with the appropriate geographical orientation (north at the top of the figure and south at the bottom). The best place to install the PV modules is on the water tank (rectangle not shaded in the center of the figure) because it is at the highest point of the building and, therefore, does not present shading relative to the buildings in the surroundings.

After the projection of the shading throughout the year for the hours of greater solar irradiation, the project was exported from SketchUp to software AutoCAD (Fig. 6).
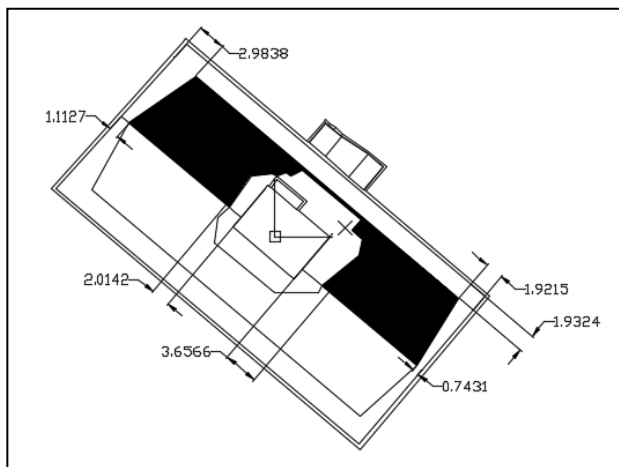
Fig. 6: Drawing in AutoCAD with highlight in the area available for installation without shading between 9 am and 3 pm (dimensions in meters)

In the case of a future expansion of the PV plant, the area for the installation of these new modules should be the part of the sloping roof oriented geographically more to the North. In Fig. 6, this area is highlighted (solid hatching), totaling approximately 216 m².

With a daily average of 4.53 kWh/m² per day at the place of installation, there are 4.53 hours of full sun available daily. The peak power required for the PV generator is then calculated through the parameters of Table 3.

Table 3: Parameters for calculating peak power of the PV generator

Energy consumed daily (Wh/day)	**1,728**
Hours of full sun (h/day)	4.53
Factor of reduction of the power of the modules (%)	0.75
Yield considering losses by conductors, controller, diodes etc.	0.90

$$P_m = \left(\frac{1728,00}{4,53 \times 0,75 \times 0,90}\right) = 565,12 \, Wp$$

The available PV modules are manufactured by Kyocera model KD140SX-UFBS. Considering that these modules are 140 Wp, it is necessary to calculate the number of modules:

$$N°_{mod} = \frac{565,12 \, Wp}{140 \, Wp} = 4,04 \, PV \, modules$$

Therefore, to meet the daily energy demand, it is necessary to use at least five modules. The six modules fixed on the water tank were used, according to Fig. 7.

Fig. 7: Six PV modules used

Since the input of the available inverter is 12 V, the operating voltages of the load controller and battery bank were also 12 V, making it necessary to arrange all PV modules in parallel. Therefore, the total short-circuit current of the PV array will be:

$$I_{curto-circuito} = 6 \times 8,68 = 52,08 \, A$$

For this PV array, a load controller is required which supports at least 52.08 A at its input. The load controller available from the IFCE for this project is the Schneider Electric C60. This model consists of a relatively simple controller with PWM control. Better results would be obtained with controllers that have MPPT control, as shown by [28]. Some available controller specifications are shown in Table 4.

Table 4: Schneider Electric - C60 Charge Controller Specifications

Supported Rated Current (A)	**60**
Maximum current peak (A)	85
System voltage (Vdc)	12 or 24
Maximum voltage of connected PV array (V)	55
Self consumption current (mA)	15
Ambient operating temperature (°C)	0 to 40

The configurations of this load controller are made through jumpers and potentiometers, as shown in Fig. 8.
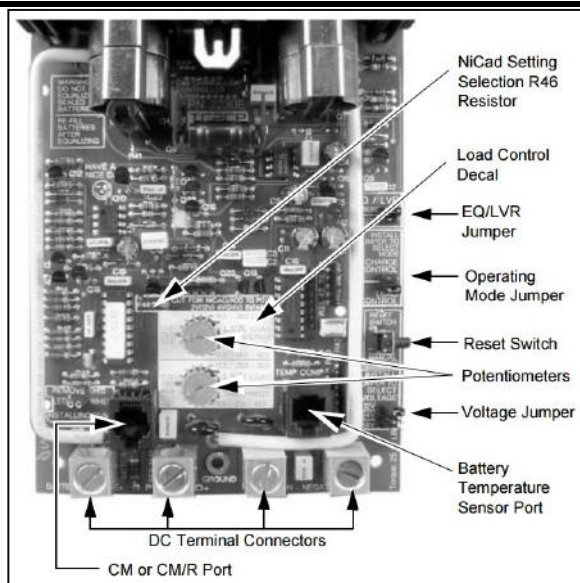
Fig. 8: Configuration Locations and Connections for the C60 Load Controller

The configuration of the jumpers was done as shown in Table 5.

Table 5: Selected load controller settings

Jumper	Selected setting
Operating Mode Jumper	Charge Control
Voltage Jumper	12 V
Automatic/Manual Battery Equalization (EQ) and Low Voltage Reconnect (LVR)	AUTO

The operation mode of the selected controller is the charge control of the battery bank, so the standby operation settings (BULK and FLOAT) have been adjusted according to the values given in the battery manual and the FLOAT is set to 13, 60 V and recharge regime (BULK) at 14.40 V. Due to the availability of the equipment, in this design the load controller supports a short circuit current up to 15% higher than the short circuit current of the PV array, calculated as 52.08 A, different from the 25% suggested by [24].

To facilitate the change of series/parallel configuration between the PV modules for future studies, the connection of the PV modules was made inside the electrical panel through the connection between the terminals (screws) corresponding to each module, organized in a printed circuit board. As the configuration for this project is made by connecting the six PV modules in series, a copper bus

was used for connection, as showed in Fig. 9. In the positive pole conductor of each PV module a polarized blocking diode was connected directly as safety measure for the case of shading of the PV module.
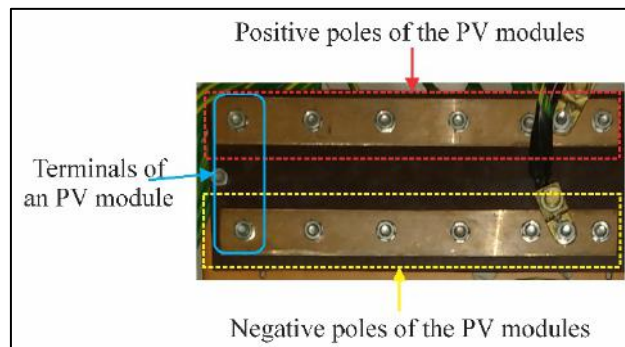
Fig. 9: PV modules connection bus on board developed

A photographic record of the assembled electrical panel, specifying each part, is shown in Fig. 10.
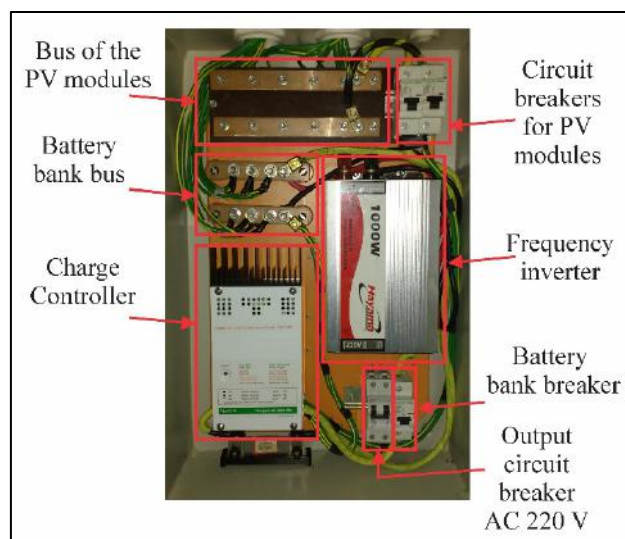
Fig. 10: Electrical panel developed

Because there were no red and black cables available for standardization of the positive and negative poles of the equipment, the conductors used were green and yellow. Microcontrollers have been applied to the monitoring of power generation systems, as can be seen in the projects proposed in [29]-[31]. For measurement, an IoT embedded system was constructed to measure voltage and current generated by the plant. Arduino Uno R3 measures the analog signals proportional to the voltage and current supplied by the PV modules and an Esp8266 to send the information collected by the internet. A voltage divider was made with resistors to measure the bus voltage of the PV panels and a shunt resistor was added between the bus of the PV modules and the load controller to measure the

current supplied by the PV modules. The Esp8266 is responsible for connecting to the Internet to capture the time of acquisition and send the data to a server through the MQTT protocol, which stores these in a ".txt" file whenever requested by a web page. In Fig. 11 the schematic of the measuring system is shown. The data acquisition system was in operation for a few days. Fig. 12 shows a chart of the data collected in one day every four seconds from 6 am to 6 pm (sunrise and sunset).

The results of these graphs enable the visibility of the electrical behavior of the system. One can observe, for example, moments in which there is a reduction in the power caused by the passage of clouds.
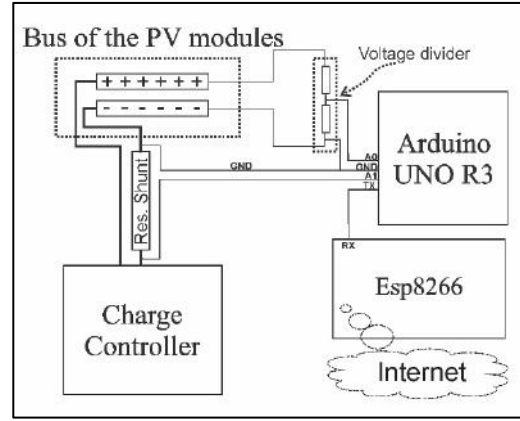
Fig. 11: Schematic of the measurement system
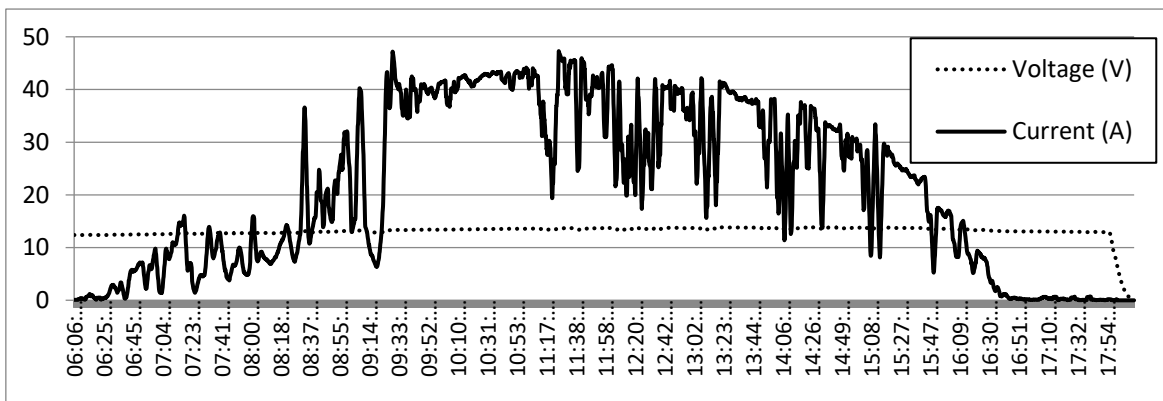
Fig. 12: Voltage graph of PV module bus and current supplied by it

Note that although the current is dramatically reduced by about 4:15 pm, the voltage remains at just over 12 V and decreases until zero at approximately 6 pm. At this

moment, the diodes are reverse polarized, not allowing current flow to the PV modules. The power supplied by the modules is shown in Fig. 13.
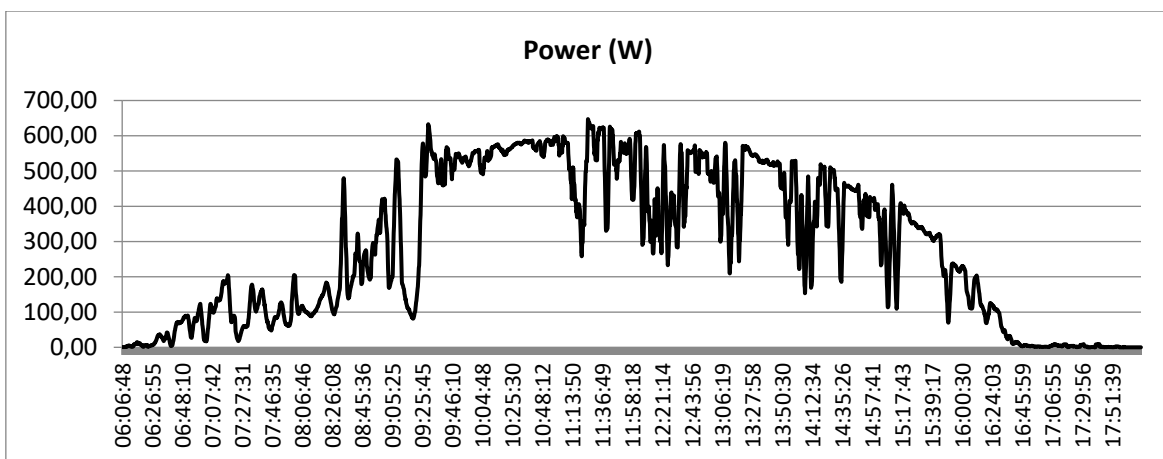
Fig. 13: Graph of the power provided by the PV modules

The cloud passage is characterized by drops in the power generated by the PV modules, as can be seen in Fig. 13. The highest recorded power was approximately 647 W.

V.   CONCLUSION

In this work a standalone didactic PV generation plant was designed and developed. The stages of the project were exposed, presenting factors that influence the generation of the system. Later, the knowledge gathered in this work was applied to design an autonomous PV plant designed to power the lighting circuit of the Energy Processing Laboratory at IFCE, Brazil. By means of a data acquisition system, generated power of up to 647 W was recorded. From the data collected by the acquisition system, the action of the blocking diode and cloud incidence was verified, factors that influence the generation of electricity by the system. An electrical panel has been designed in a way to facilitate access to each PV module separately, providing the different configuration of these PV for future work. This is because in addition to providing energy to the laboratory lighting circuit, the PV plant resulting from this work has the objective of helping students in a didactic way to facilitate the teaching-learning process of PV systems.

For a better analysis of the energy supplied by the PV generator and the behavior of the PV generator over the years, it is necessary to monitor the system for a longer period. Therefore, it is suggested as a theme for future work the development of a system for data acquisition capable of storing an adequate amount of information and transmit it in an accessible way to the user to consult the amount of energy generated among other information that may be relevant to some future study proposed.

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Factor Analysis and the Social Capital Index: A Study at the Brazil / Bolivia Border

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Abstract— Objective: *The study aimed to build the level of social capital by neighborhoods Guajará-Mirim border region between the State of Rondônia, Brazil and the Republic of Bolivia, which in recent years has been showing signs of social fragility due advance not virtuous practices. **Method:** This work made use of research in secondary bases as well as in primary bases. The tabulation of qualitative and quantitative data was performed in Excel (2010) and for their processing performance index construction purposes were calculated following the factorial analysis techniques presented by Hair et al. [19] Santana [20, 21]; and Choi [22]. For this, we made use of the statistical tool SPSS (Statistical Package for Social Sciences) for the construction of the* indices of social capital. The correlation analysis process was done in Excel. **results:** It was observed that the capital reached regular levels in Guajará-Mirim neighborhoods not observable, so correlations between the studied parameters, however, it needs to be further studied as factors such as the flooding of the Mamore river may have interfered in any way in the implementation process of the field survey to the residents of the city. It became clear that the municipality of Guajará-Mirim suffers from serious social problems and that most problems are correlated with the increase in alcoholic beverage market in the city and use drugs. However, was not observed as the institutional arrangements are dealing with this problem, that is, as

public bodies are relating to discuss actions for concrete solutions to this evil that plagues large portion of the population of Guajará-Mirim, mainly young teenagers residents of Guajá-Mamim. However, we hope to continue this work in order to better understand this mechanism of social network between the actors of this process in the region.

Keywords— Social Capital Index. Factor Analysis. Guajará-Mirim.

I. INTRODUCTION

This study aimed to discuss the capital in Guajará-Mirim border region between Rondônia and Bolivia, which in recent years has been showing signs of weakness due to the social advancement of non-virtuous practices.

Within an international perspective, the first great work in this direction was developed by Putnam [1] on the modern Italy.

Thus, using the regional Italian experience, Putnam [1] tried to analyze the new context of the country's political reform and its consequences, ascertaining how new institutions were created and how they evolved in their early 20s.

The fact of the Italian reform has made it possible to implement a single institutional model, ie a model replicated in different parts of that country, an extraordinary moment provided an opportunity to follow the evolution of these changes over time. So, as the institutional model theoretically remained constant simultaneously create regional governments with similar organizational structure, other external factors could be tested, such as the economic context and the political tradition. In addition, in order to illustrate the problem of this research, we prepared the following questions: What level of capital of the neighborhoods of Guajará-Mirim? Neighborhoods that have higher capital ratios have the lowest crime rates in the city? What future expected on a level of capital achieved by the municipality? It is enough to promote institutional change long awaited at the local level?

This is because, curiously note a rapid expansion process of this economic segment inversely proportional to local development. This research therefore seeks to analyze this aspect based on the theoretical perception of the capital, from the work of Putnam [1].

The spatial area corresponded to the urban area of Guajará-Mirim, more specifically 15 neighborhoods. Thus, this study aimed to build the level of social capital by neighborhoods Guajará-Mirim.

1.1. Problem Context

The social capital has a multidimensional nature. The narrower view defines it as a set of norms and social networks that affect the community's well-being in which are inscribed by facilitating cooperation among its members by reducing the cost of obtaining and processing information. [2]

According to Portes [3], the first contemporary analysis of social capital was produced by Pierre Bourdieu, which defined the concept as "the current resource unit or potentials that are connected by possession of a durable network of more or less institutionalized relations acquiescence or recognition "And Putnam [4]: "Social capital refers to features of social organization such as networks, norms and ties of trust to facilitate coordination and cooperation for mutual benefits. Capital Social increases the benefits of investment in physical and human capital. "

The social capital is therefore related to the ability of people to work together in groups and organizations that make up civil society. [5]

Therefore, the social capital has been identified as an integral component of economic and social development, which shapes the quantity and quality of social interactions of a society. Recognizing the potential of this concept, the World Bank has been using it to investigate and analyze how and in what form the social capital enables the poor to actively participate and benefit from the development process. [6]

For Evans [7] the most advanced societies show higher *social capital*, however, the potential of its construction in developing countries would be great and would be a challenge to be faced.

As Marteleto; Silva [2] There is evidence that social capital can be used to promote poverty reduction, development and social welfare, which would approach the interests of sociology and economics in this field.

It is understood that social capital is the process and empowerment tool of the citizen and that can change personal relationships and social exchanges to generate more networks of cooperation and solidarity. Thus, the rise of social capital ratios can have positive effects for their impact on democracy and socio-economic development [8].

To Arizpe [9] and according to D'Araújo [10] the social capital it is innovative concept in the analysis and development proposals, expresses the ability of a society to establish interpersonal bonds of trust and cooperation networks with the intention of produce collective goods. When trying to unravel the causes of the dynamic expansion of the capitalist production system in recent decades, favors the contribution of social and human capital for technological development, increased productivity and the very growth of the economy. According to Hutchinson and Vidal [11], all forms of capital can be understood independently, but are best understood when analyzed through their reciprocity and interdependence.

Rattner [12] reports further that while the human capital is the result of the actions of individuals in search of learning and improvement, social capital is based on the relationships between social actors that set each other mutual expectations and obligations, for in this way stimulate reliability in social relationships and streamline the flow of information, both internal and external. Contrary to human capital formation that encourages individualism, building social capital affects positively the cohesion of the family, community and society. Prevailing values that are contrary to the solidarity and cooperation help to expand the networks of corruption and crime in whatever level of society. [12] As for Fukuyama [5] the creation of social capital,

The basis for the construction of social capital is found in all societies, with their own particularities of each culture, and people end up using it, trying to achieve their goals as to satisfy their needs for economic, social and affective [13]. Corroborate this concept, authors such as Krishna; Uphoff [14]; Harpman; Grant; Thomas [15]; Ferrarezi [16].

II. METHODOLOGY

This research was structured based on the aspects of interdisciplinary research given the complexity surrounding the issue. The methodology for the development of work involved field research techniques where the researcher assumes the role of observer and explorer, directly collecting the data in place that have emerged or the phenomena [17]. According Prestes [18] field research developed mainly in the social sciences is characterized by the collection of data using techniques such as questionnaires, interviews, observations etc.

Therefore, this work made use of research in secondary bases as well as in primary bases. The tabulation of qualitative and quantitative data was performed in Excel (2010) and for their processing performance index construction purposes were calculated following the factorial analysis techniques presented by Hair et al. [19] Santana [20,21] and Cavalcante [22]. For this, we made use of the SPSS statistical tool (Statistical Package for Social sciences) v. 17 for the construction of the indices of social capital. The correlation analysis process was done in Excel.

III. ANALYTICAL MODEL

A factor analysis model can be presented in matrix form as in Dillon; Goldstein [23]:

$$X = \alpha F + \varepsilon \qquad (1)$$

Being,

X = is p-dimensional vector transpose of the observable variables, denoted by $x = (x_1, x_2, ..., x_p)$;

F = is the q-dimensional vector transposed unobservable variables or latent variables called common factors, denoted by $F = (f_1, f_2, ..., f_q)$, where $q < p$;

ε = is the transpose vector p-dimensional random variables or unique factors, denoted by $\varepsilon = (e_1, and_2, ..., and_p)$;

α = is the matrix (p, q) of unknown constants, called factor loads.

As Gama et al. [24]; Santana [20, 21], the factor analysis model assumes that specific factors are orthogonal to each other with all common factors. Usually, E (ε) = E (F) = 0 and Cov (ε, F) = 0.

According to the same authors, the initial structure used to determine the matrix of factor loadings generally can not provide a meaningful standard loads variable, so it is not definitive. The verification or not, this initial structure can be made by various methods of rotation of factors, as Dillon; Godstein [23]; Johnson; Wichern [25]. For the purpose of this research was used VARIMAX method of orthogonal rotation of factors.

The VARIMAX method is a method in which the factors of the reference axes are rotated about the origin until some other position is achieved. The goal is to redistribute the variance of the first factors to others and achieve a simpler factor standard and theoretically more significant [26]; [19]; [21]; [24]; [20].

As mentioned earlier, the choice of the factors was performed by the latent root technique. Thus, the matrix factor weights, which measures the correlation between the common variables observable factors and is determined by the correlation matrix as Dillon; Goldstein [23].

For the determination of Thesis Performance Indices was adopted factor scores matrix estimated by orthogonal rotation factor based process as indicated by Santana [20]. The factor score, by definition, each observation is located in the space of the common factors. For each factor f_j, ith the extracted factor score is defined by F_{ij}, expressed as follows [23]:

$$F_{IJ} = b_1 x_{i1} + b_2 x_{i2} + b_p x_{ip} \qquad (2)$$

Being that:

b_i = are the estimated regression coefficients for n common factor scores;

x_{ij} = are the n observations of p observed variables.

$i = 1, 2, ..., n$.

$j = 1, 2, ..., p$.

To get the equation that represents the Performance Index, Gamma *et al.* [24]; Santana [20] show evolutionary sequence of the formula from the above equation. Thus it appears that although the variable F_{ij} is not observable, it can be estimated by means of factor analysis techniques, using the matrix of observations

vector x of observed variables. In factorial notation, equation 2 becomes:

$$F_{(n,q)} = X_{(n,q)}b_{(p,q)} \quad (3)$$

In Equation 3, F is the matrix of regression estimate from n factorial scores and can be affected both the magnitude and the measurement units of the variables x. To circumvent such problems, it replaces the variable x by the standardized variable w, given by the ratio between the deviation around the mean and standard deviation of x, as follows:

$$\frac{x_i - \overline{x})}{S_x}$$

With these values, Equation 3 is modified making it possible to equation 4 below:

$$F_{(n,q)} = w_{(n,q)}\beta_{(p,q)} \quad (4)$$

Based on equation 4, the matrix of weights beta (β) with q standardized regression coefficients replaces b, since the variables are standardized on both sides of the equation. Pre-multiplying both sides of equation 4 for the value $\frac{1}{n}w'$, where n is the number of observations and w' is the transposed matrix W, allows to get the following equation.

$$\frac{1}{n}w'_{(p,n)}F_{(n,q)} = \frac{1}{n}w'_{(p,n)}w_{(n,p)}\beta_{(p,q)} = R_{(p,p)}\beta_{(p,q)} \quad (5)$$

The matrix $\frac{1}{n}w'w$, therefore constitutes the matrix of interrelated variables correlated or the correlation matrix of the observations of the matrix x, designated R. The matrix $\frac{1}{k}w'F$ it is the correlation between the factor scores and the factors themselves, denoted by Λ. Thus, rewriting the equation 5, it follows that:

$$\Lambda_{(p,q)} = R_{(p,p)}\beta_{(p,q)} \quad (6)$$

If the matrix **R** is nonsingular, you can pre-multiplying both sides of the equation by the inverse of R 6, obtaining:

$$\beta = R^{-1}\Lambda \quad (7)$$

Replacing the β vector in equation 4, you obtain the factor score associated with each observation, as follows:

$$F_{(n,q)} = w_{(n,p)}R^{-1}_{(p,p)}\Lambda_{(p,q)} \quad (8)$$

Thus, one arrives at the main performance index of formula (ID), where ID is defined as a linear combination of the factor scores, and the proportion of the variance explained by each factor in relation to the common variance. The mathematical expression shall be represented by the following formula:

$$ID_i = \sum_{j=1}^{q} \left(\frac{\lambda_j}{\sum_j \lambda_j} FP_{ij} \right) \quad (9)$$

At where,

$i = 1, 2, ..., n$.

λ = the variance explained by each factor;

$\sum \lambda$ = It is the sum total of the variance explained by the number of common factors. The factor score was standardized (FP) to obtain positive values of the original scores and allow prioritization of municipalities as the performance index values are situated between zero and one. The ranking formula that allows this can be seen by the following equation:

$$FP_i = \left(\frac{F_i - F_{min}}{F_{max} - F_{min}} \right)$$

It is clear, therefore, that **F min and F max** are the minimum and maximum values observed for the factor scores associated with institutional performance of Rondônia municipalities for the years 1980, 1990, 2000 and 2009. Therefore, with this formula is that It was structured performance indices adopted by this research.

3.1. Suitability Tests the Factor Method to Data Mass

As Gama *et al.* [24]; Santana [20], the two main tests aiming to assess the suitability of the method for mass concern, firstly, the sphericity test Bartlett, which has the property to assess the overall significance of the correlation matrix, i.e., forehead the null hypothesis that the correlation matrix is an identity matrix. The other is the Kaiser-Meyer-Olkin test (KMO), which is also widely used and is based on the assumption that the inverse correlation matrix approaches the diagonal matrix, in which case it looks for comparing the correlations between observed variables. Thus, the two methods were used for this research as adequacy measurement techniques of the method to the collected database.

According to Dillon; Goldstein [23]; Reis [26]; Mingoti [27]; Gama *et al.* [24]; Santana [20,21] mathematical formulas of these tests can be seen by the following equations:

$$KMO = \frac{\sum_i \sum_j r_{ij}^2}{\sum_i \sum_j r_{ij}^2 + \sum_i \sum_j a_{ij}^2} \quad (10)$$

Like this,

r_{ij} = Is the sample correlation coefficient between the variables x_i and x_j;

a_{ij} = Is the partial correlation coefficient between these variables that is both an estimate of the correlations between the factors, eliminating the effect of other variables.

According to Hair *et al.* [19] the a_{ij} shall take values close to zero, since it is assumed that the factors are orthogonal to each other. Thus, according to this author, this test values below 0.50 is unacceptable.

Bartlett's sphericity test tests the null hypothesis that the variables are independent, against the alternative

hypothesis that the variables are correlated. In other words, H₀: = R 1 or H₀: $\lambda_1 = \lambda_2 = \cdots = \lambda_P$, which allows reaching the following mathematical formula:

$$X^2 = -\left[n - 1 - \frac{1}{6}(2p + 5)\right].ln|R|_{ou}$$

$$X^2 = -\left[n - 1 - \frac{1}{6}(2p + 5)\right].\sum_{j=1}^{p} ln\lambda \qquad (11)$$

At where,

$|R|$ = Is the determinant of the correlation matrix of the sample;

λ = Is the variance explained by each factor;

n = Is the number of observations;

p = number of variables;

The statistical distribution is an asymptomatic x^2 with $[0,5\ p(p-1)]$ degrees of freedom. The Bartlett test is the most common method used to test the homogeneity of variance [28].

IV. RESULTS AND DISCUSSIONS

The level of representation by gender of respondents in the research questionnaire corresponds to 58% female and 42% male.

Most respondents (43.04%) reported having incomplete higher education level, followed by 21.52% with high school education and 18.99% with a college level (Chart 1).

As regards the age group of respondents it was observed that approximately 61% of the respondents said that they have between 18 and 30 years old, 24% between 31 and 45 years old, 10% between 46 and 60 years and above that corresponded to approximately 5 % (Chart 2). The corresponding data saved by Portes [3]; by Harpham, Grant and Thomas [15].

Chart 1: the respondents level of education
Source: Field Data.

Aripze [9] Cavalcante [22] Evans [7], Ocampo [13] Fortes [29] Purnam [4] corroborate the representation used in the search.
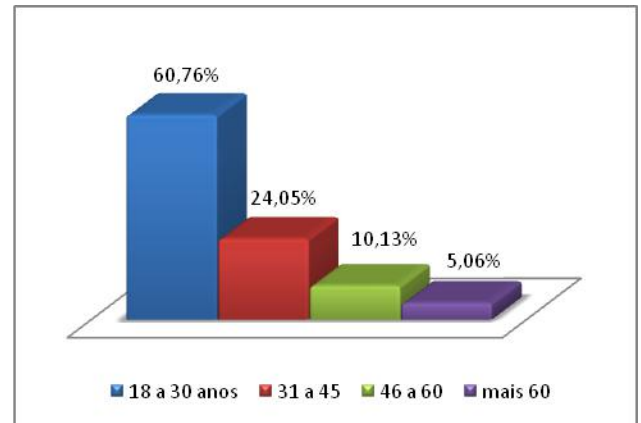
Chart 2: Age range of respondents
Source: Field Data.

With regard to income, about 20% said gain up to 1 minimum salary, 25% 1 to 2 minimum wages, 22% between 2 and 4 minimum wages, 24% between 4 and 8 times the minimum wages, 5% 8 to 16 minimum wages, and around 4% reported earning above that amount (Chart 3).
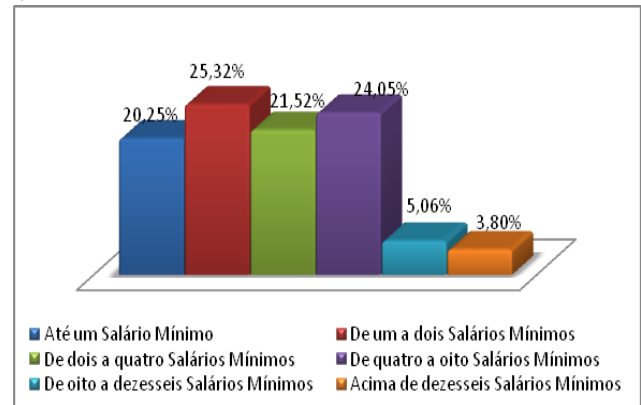
Chart 3: Average income of the respondents
Source: Field Data.

In Chart 4, it is observed that, on average, respondents stated not to participate in a group (10.13%), only one group (32.91%), two groups (18.99%), three groups (17 , 72%), four group (11.39%), five groups (6.33%) and six groups (2.53%).
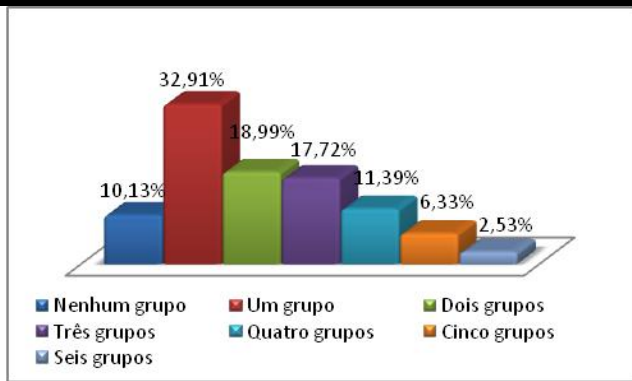
Chart 4: Quantity of group membership by respondents.
Source: Field Data.

It appears in Chart 5 that the religious group was the most frequent (34.18%), followed by family group (20.25%), school group and working group (both 8.86%) and cultural group (7.59%). The others had values below 4%.
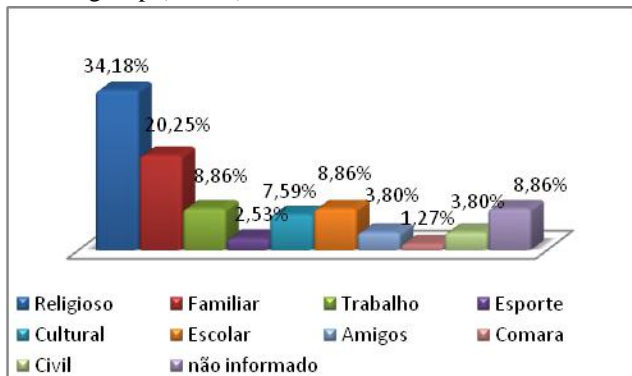
Chart 5: Types of groups considered most important.
Source: Field Data.

Charts 6-12 are part of the process of analyzing the levels of social capital by neighborhoods Guajará-Mirim. Thus, six parameters were observed to calculate the capital index that is shown in Chart 12. To calculate the statistical tool used was SPSS, v. 17 to the factorial processing of data. Thus, adopting a criterion range: 0.000 to 0.200 (very low); 0.201 to 0.400 (low); 0.401 to 0.600 (regular); 0.601 to 0.800 (good); 0.801 to 1.00 (excellent) analyzes were made for each of the above parameters. Works such as Hair *et al.* [19]; Gama *et al.* [24]; Santana [20]; Dillon; Goldstein [23]; Reis [26]; Mingoti [27]; They employ the same treatment, the same criteria of scale and the same parameters used in this research.

By Chart 6, it is observed that 80% of districts were considered good performance by the scale, 13% achieved regular results (Center and Triangle) and only 7% had results considered low, as was the case of the Planalto neighborhood.
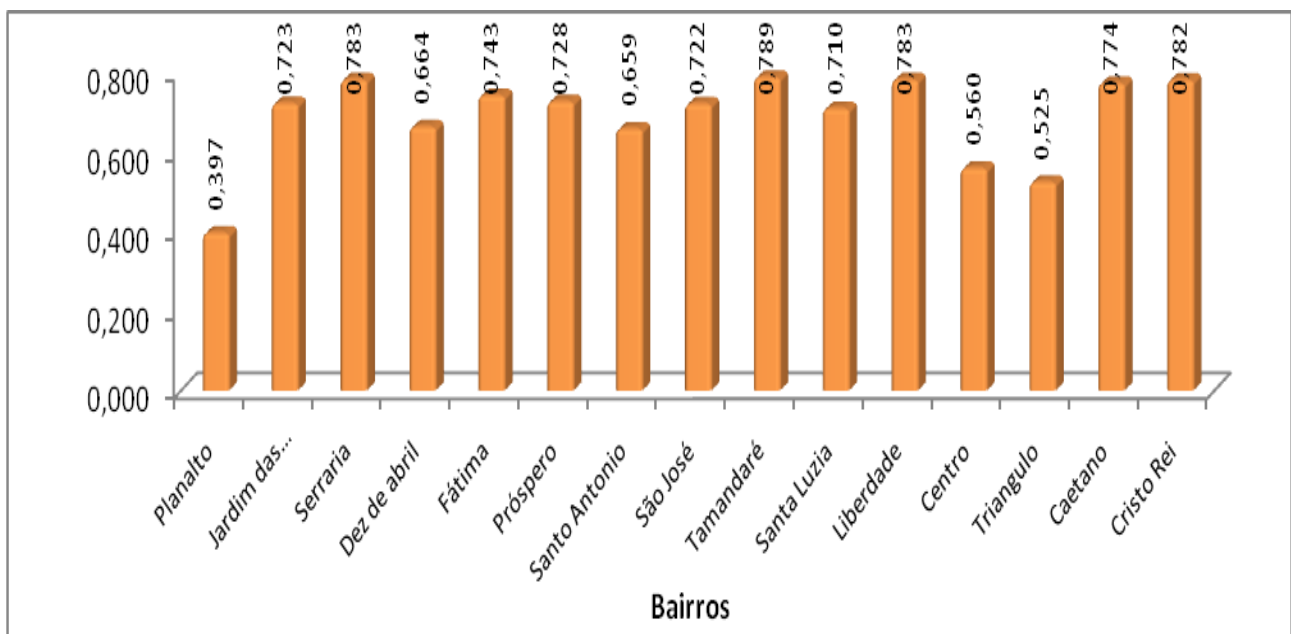
Chart 6: Groups Index and Networks neighborhoods Guajará-Mirim
Source: Field Data.

In Chart 7 it demonstrated that 100% of districts had regular results for the index of "trust and solidarity." In Chart 8, referring to the Collective and Cooperation Action Index, it was observed that 53% of districts showed very low and low results, 33% had regular performance and only 13% of them had considered performance "good" (Tamandaré and Liberty). The performances of the districts for the content of "information and communication" was "low" to 60% and "regular" 40% of them, as Graph 9.
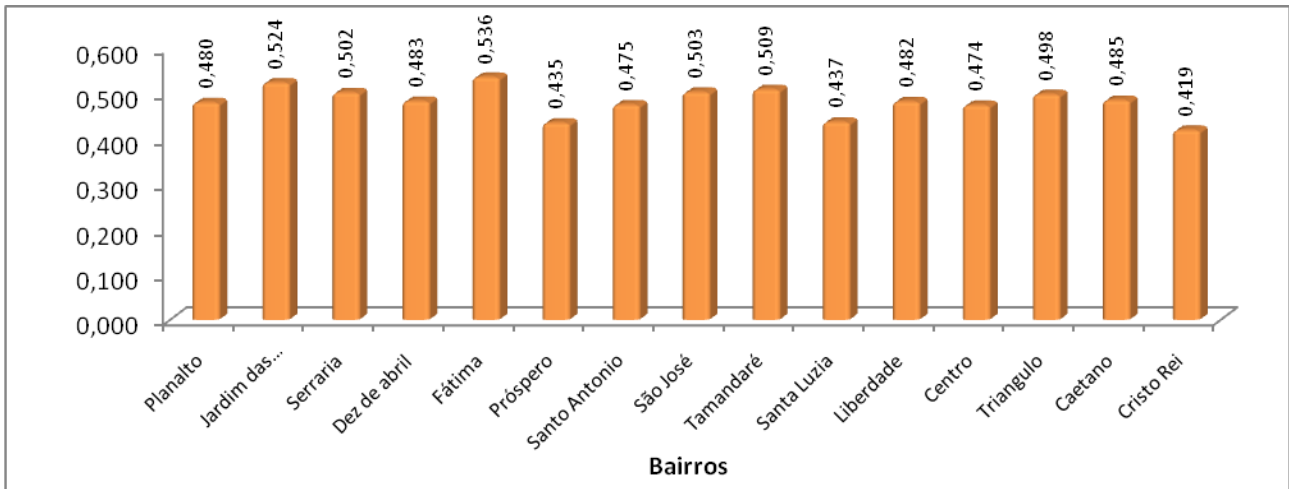
Chart 7: Confidence Index and solidarity by neighborhoods of Guajará-Mirim
Source: Field Data.
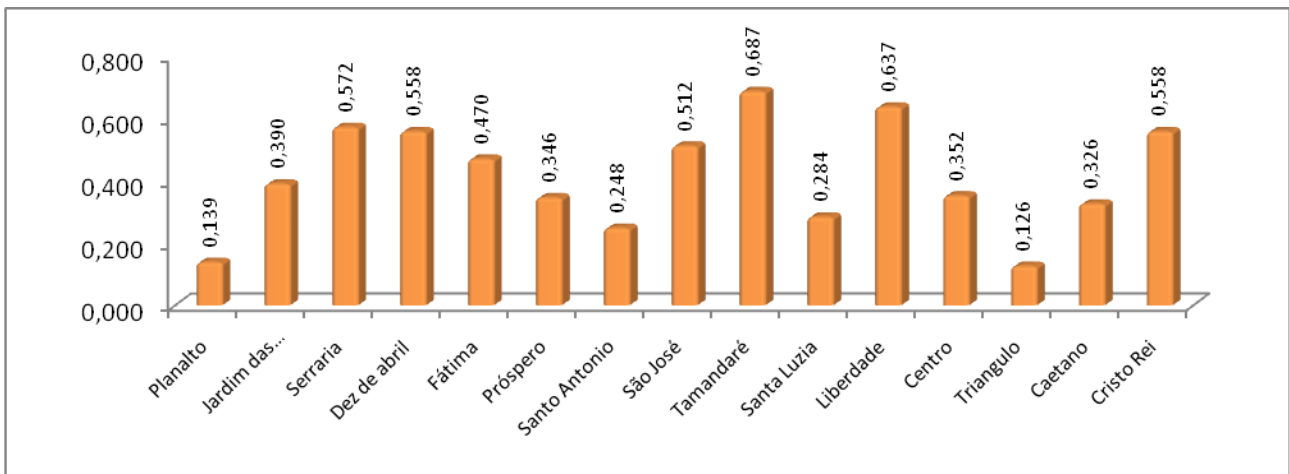
Chart 8: Collective Action and Cooperation index by districts Guajará-Mirim
Source: Field Data.
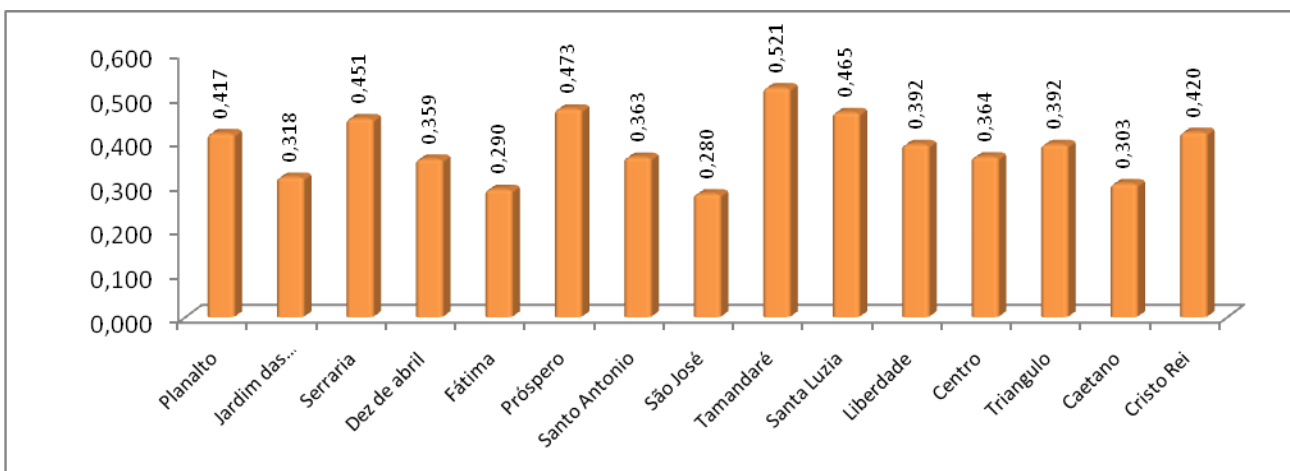
Chart 9: Information and Communication Index for neighborhoods Guajará-Mirim
Source: Field Data.

NO "cohesion index and social inclusion" presented performance "down to 7% of the Planalto neighborhoods, 80% of them from" regular performance "and only 13%

of" good "performance (Central districts and Ten April), as Chart 10.
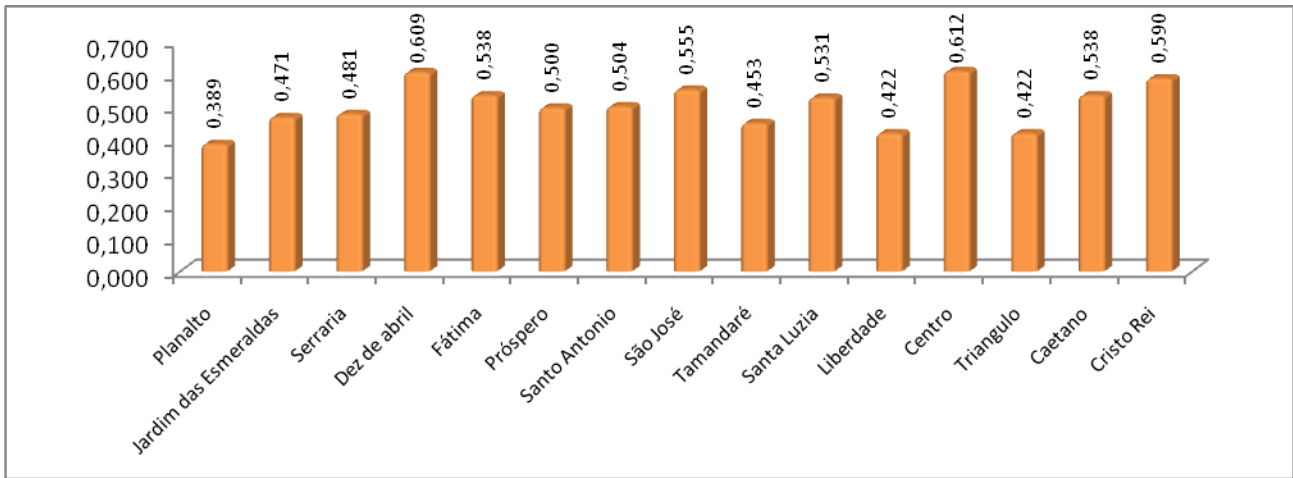
Chart 10: Cohesion and Social Inclusion Index for neighborhoods Guajará-Mirim
Source: Field Data.

With regard to the last parameter of capital (Chart 11), it was observed that 87% of districts had "regular" performance and only 13% showed results consistent with "good" performance (neighborhoods Christ the King and Center).

Already Chart 12 brings the result synthesis of capital by neighborhoods Guajará-Mirim as envisioned by this research.

Adopting the same analysis criteria based on the scale, it was observed that 100% of districts had capital of performances considered as "regular", that is below 0,600. Therefore, the level of social capital Guajará-Mirim reached the average, a value of 0.508, far, so what would be ideal, that is above 0,800.
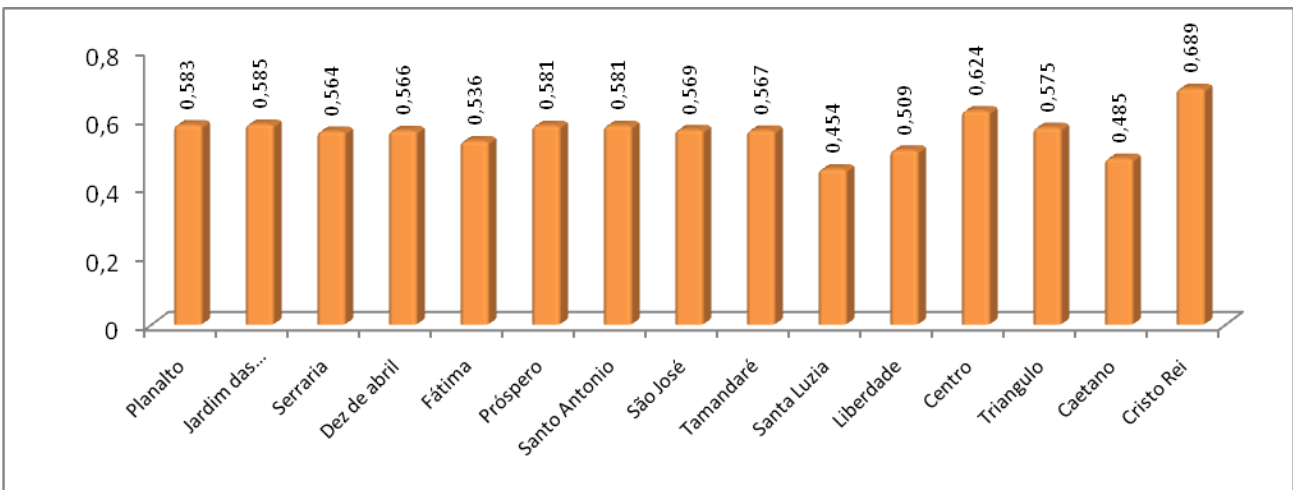
Chart 11: Empowerment Index by neighborhoods Guajará-Mirim
Source: Field Data.
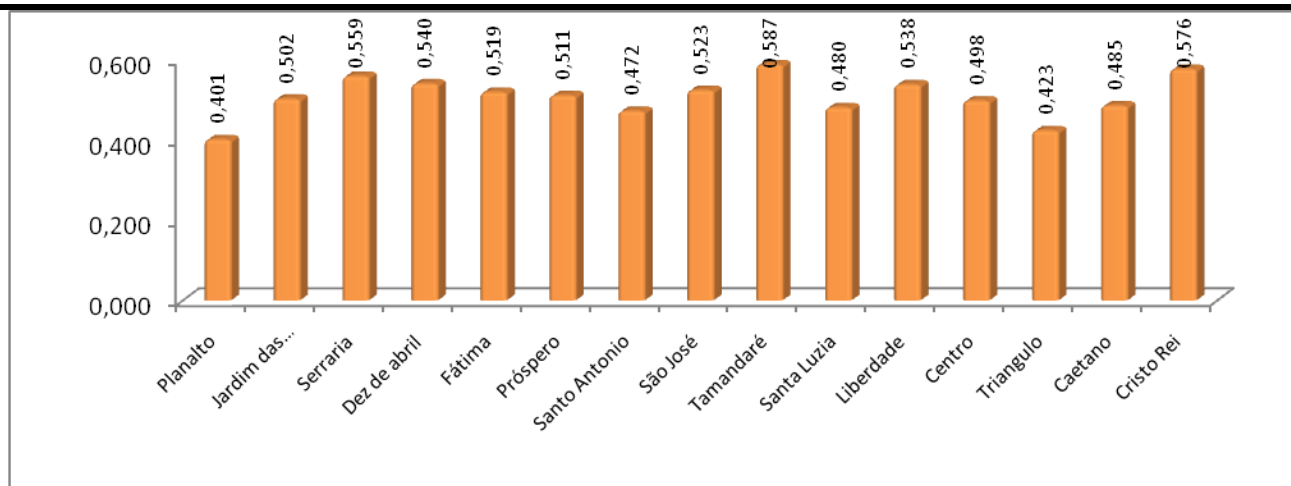
Chart 12: Social Capital Index by neighborhoods Guajará-Mirim
Source: Field Data.

The next step was to correlate the data in order to obtain information relevant to the object of this study. Therefore, the correlation was made procedure adopting the model Excel data analysis from the parameters shown in Table 1.

Adopting the same criterion of the performance scale presented above, however, according to the following descriptions (very weak, weak, regular, strong, very strong) results showed that the capital exerted no correlation with the parameters analyzed: Urban violence, beer consumption, marketing outlets, which may indicate the need for a deeper understanding on the subject of a possible renewal of this research, as the flood of the Mamoré River may have altered social behavior to the point of harming the questionnaires.

Table.1: adopted parameters for correlation: urban violence, beer consumption, marketing outlets and social capital.

NEIGHBORHOODS	URBAN VIOLENCE	BEER CONSUMPTION (LITERS)	MARKETING OUTLETS	SOCIAL CAPITAL BY NEIGHBORHOODS
Planalto	61	15,16	3	0,401
Jardim das Esmeraldas	162	15,18	12	0,502
Serraria	103	3,68	3	0,559
Dez de abril	149	48,69	10	0,540
Fátima	51	14,11	8	0,519
Próspero	43	10,41	6	0,511
Santo Antonio	15	1,33	3	0,472
São José	37	6,56	4	0,523
Tamandaré	122	21,9	8	0,587
Santa Luzia	88	31,84	13	0,480
Liberdade	77	4,72	7	0,538
Centro	125	25,62	8	0,498
Triangulo	68	5,34	5	0,423
Caetano	28	2,83	5	0,485
Cristo Rei	20	6,17	6	0,576

Source: Field Data.

Research such as Fukuyama [5] which deals with social values and creating prosperity; Fukuyama [30] which addresses the social capital development; Ferrarezi [16] assigns concepts and contributions of capital to public policies; Marteleto; Silva [2] with the approach of information for local development; Rattner [12] which is concerned with the construction of social capital as a priority, help to better understand the need to discuss and

build social capital ratio in order to analyze the correlations of the parameters, the possibility of highlighting the institutional arrangements, problems that afflict of the least favored population and the mechanisms of social network between the actors of the process in a certain location, or region.

The scaling of the index construction is guided in the work of Ocampo [13]; Portes [3]; Fukuyama [30]; Hutchinson and Vidal [11]; Krishna and Uphoff [14]; Santana [21].

V. FINAL CONSIDERATIONS

Therefore, it was observed that the social capital reached regular levels in the districts of Guajará-Mirim not observable, the correlations between the studied parameters, however, it needs to be detailed with other research methodologies and identification of more variables, since factors such as the flood of Mamoré River may have interfered in any way in the implementation process of the field survey to the residents of the city.

Moreover, it was evident that the municipality of Guajará-Mirim suffers from serious social problems and of the problems is correlated with the increase in alcoholic beverage market in the city and in possession of narcotics. However, was not observed as the institutional arrangements are dealing with this problem, that is, as public bodies are relating to discuss actions for concrete solutions to this vicissitude plaguing a portion of the population of Guajará-Mirim, especially young. However, it is expected to further research to understand this mechanism using other scientific tools to study the social network of interaction between the actors in this process in the region and its impact on regional development.

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Characterization of a Copper Powder for Heat Pipe Wick Applications

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Abstract— In powder metallurgy, it is necessary to know the powder's nature to understand how the processing of a powder occurs. In this paper, a characterization of a copper powder for heat pipe wick applications was experimentally done. The copper powder manufacturing method was atomization. This metallic powder was characterized by Scanning Electron Microscopy (SEM), X-Ray Fluorescence Spectrometry (ED-XRF), and Laser Diffraction Granulometry. As a result, the purity and the shape are compatible with the powder manufacturing method and great for wicks. Also, the copper powder has a unimodal distribution that is excellent for capillary structures.

Keywords— copper powder, characterization, heat pipe wick.

I. INTRODUCTION

In essence, powder metallurgy converts a metal powder with specific properties of size, shape, and packaging into a solid, precise, and high-performance form. In this way, powder metallurgy can be defined as the study of the processing of metallic powders, including the manufacture, characterization, and the conversion of metallic powders into useful products for engineering [1]. According to German [2], firstly is necessary to know the powder's nature to understand how the processing of a powder occurs. Usually, powder metallurgy works with particles larger than 1μm, but smaller than sand (25 μm to 200μm). The Scanning Electron Microscope (SEM) is one of the best available tools for observing the discrete characteristics of a metal powder, such as material, powder manufacturing method, particle size, and shape.

The particle size of a metal powder is one of the most import characteristics of powder metallurgy [3]. It is analyzed based on a geometric parameter (diameter, surface area, maximum dimension, volume, among others) and considering a spherical particle shape. There are several techniques of size measurement, such as microscopy, sieving, sedimentation, laser diffraction, and X-Ray [4].

The metal powder manufacturing can occur through various mechanical techniques (such as machining and grinding), electrolytic, chemical and atomization (gas, centrifugal or by liquid) [5].

The most common metal powder that is used in sintered capillary structures for application in heat pipes is copper powder, due to its high compatibility, high thermal conductivity, and ease of processing [6-8].

In this context, a characterization of a copper powder for heat pipe wicks was experimentally performed. The metallic powder was characterized by Scanning Electron Microscopy (SEM), X-Ray Fluorescence Spectrometry (ED-XRF), and Laser Diffraction Granulometry.

II. METHODOLOGY

The sintered capillary structure will be fabricated from an copper powder obtained by gas atomization. This kind of production is a relatively simple physical process. It consists of a pouring the molten metal through a hole that is struck by a gas beam (Nitrogen, Argon, or Helium). This procedure separates the molten metal into small droplets, which solidify forming the powder particles [7]. Subsequently, the particles undergo a process of annealing in reducing atmosphere to decompose oxidized surfaces. The purity of the obtained power is generally above 99%, and the particles are approximately spherical [8]. Figure 1 presents the metallic powder utilized.

Fig. 1: Copper Powder

A *Tescan*™ VEGA3 Scanning Electron Microscopy (SEM) from the Laboratory of Materials Characterization

of the Federal University of Technology - Paraná (LabCM/UTFPR) was used to observe the shape of the copper particles. As a result, a micrograph with a magnification of 500x was taken.

The chemical composition of the copper metal powder was determined by a *Shimadzu*™ EDX-7000 X-Ray Fluorescence Spectrometer from the Interdisciplinary Laboratory of Ceramic Materials of the Ponta Grossa State University (LIMAC/UEPG).

For the determination of the average particle size, the Laser Diffraction was applied. The technique consists of the scattering of light in a sample of powder dispersed in aqueous medium. A *Cilas*™ 920 Particle Size Analyzer for a range of 0.3μm and 400μm was used to measure the particle sizes by the *Fraunhofer* Diffraction Technique. The tests were done in the LIMAC/UEPG. In this particle size distribution analysis, alcohol was used as the dispersing agent under ultrasonic shaking for a period of 60 seconds.

III.   RESULTS AND DISCUSSION

The experimental results regarding the characterization of the copper powder for capillary structures are presented. From the Scanning Electron Microscopy (SEM), a micrograph of the copper particles with a magnification of 500x was obtained and is presented in Fig.2. The shape is approximately spherical.
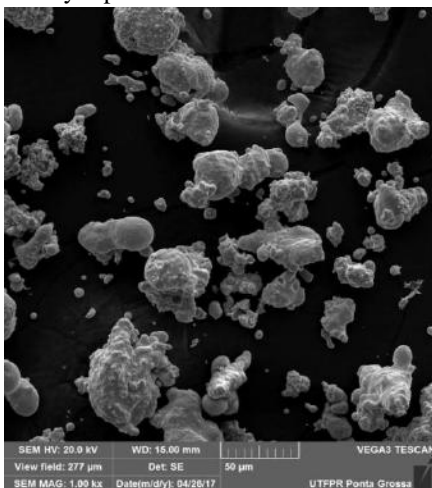
Fig. 2: SEM micrograph (500x).

The result of the X-Ray Fluorescence Spectrometry (ED-XRF) shows that the metallic powder is composed of 100% copper, so the purity is very high. According to the results of the SEM and the ED-XRF, the high purity and the shape are exactly as expect from the powder manufacturing method.

The distribution of the particle size obtained by the Laser Diffraction of the copper powder is presented in Fig. 3. In this graph, the X-axis shows the particle diameter [μm]. The Y-axis presents the relative [%] and the cumulative

[%] frequencies. The solid line represents the cumulative frequency for each particle size, defined with 30 size classes. The volume-based average particle diameter was 33μm.
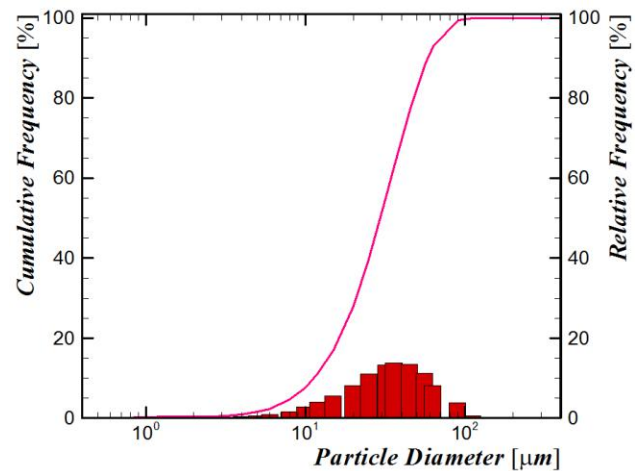
Fig. 3: Particle Size Distribution

According to the distribution, the copper powder behavior is unimodal, which means that there is a size with more frequency. The unimodal distribution is excellent for heat pipe wick applications [4].

IV.   CONCLUSION

This paper presented a characterization of a copper powder for heat pipe wick applications. As a result, the purity and the shape are compatible with the powder manufacturing method and great for wicks. Also, the copper powder has a unimodal distribution that is excellent for capillary structures.

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Job Satisfaction and Mental Suffering of Penitentiary Agents of the Female Prison of Porto Velho, Rondônia (Brazil)

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Abstract— *The study with the penitentiary agents that work in the female prison system of Porto Velho aimed to analyze the level of job satisfaction and the level of mental suffering of these workers. It is a descriptive and cross-sectional study. This study was performed with 34% of the penitentiary agents who carry out their activities at the Porto Velho Women's Penitentiary, Rondônia. For the data collection, three structured instruments were used: The Sociodemographic Questionnaire; the Self-Report-Questionnaire (SRQ-20), and the Occupational Stress Indicator (OSI), measured using a Likert scale. Satisfaction in the work had similar indexes to those found in the literature, presenting the highest proportion in the intermediate variables, that is, their higher frequencies are in the range of some dissatisfations, with 40%; and 35% with some satisfactions. The highest level of dissatisfaction is in the variable to the form by which changes and innovations are implemented, with 55%. The results showed that the prison staff had lower psychiatric disturbances (19.59%), in the following order of*

determination: decreased energy (23.33), depressed mood (23.33%), somatic symptom (21.25%), other symptoms of SRQ-20 20%) and depressive thoughts (10%), considered as indicators of evidence of mental suffering. From the data collected in this study, it is possible to indicate a possible association between work dissatisfaction and mental suffering.

Keywords— penitentiary agents, job satisfaction, mental suffering, worker's health.

I. INTRODUCTION

It has long been known that the work, when performed under certain conditions, can cause disease. The end of the seventeenth century marked the history of knowledge about diseases of the work, as in 1700 is published the classic De Morbis Artificum Diatriba, considered the first work on Workers' Diseases, the Italian physician Ramazzini (1633-1714) taken as a reference to the nineteenth century. Later, he was considered the Father of Occupational Medicine, using today his famous statement about the need for the headboard of any patient, ask him where he was working to see if the source of their livelihood was not the cause of his illness.

According to Brazil[1] (2007), the work can be considered an important action to promote or not the health of people. Health, in this case, is "a complete state of physical well being, mental and social and not merely the absence of disease." As Mendes [2] (2002), the work is able to favor or not health, therefore, may also be a risk factor.

The penitentiary activity, in general, requires great physical and mental effort and puts the professionals working in the area in complicated situations in order to protect society from offenders, stress generators and consequently likely to develop behavioral changes that differ from his personality structure, leading to the possible development of a psychological distress, reaching even to the development of a mental illness. The stress that is purchased daily by these professionals, creates a mental fatigue that can lead to consequences in the development of its functional activities, such as for life in society. Whereas these professionals deal with prisoners, who were theoretically removed from the social environment to change their behavior.

In the scenario of the Brazilian penitentiary system, we have the prison officers who are responsible for keeping out of the interaction of society, women convicted of various crimes such as murder, drug trafficking, among others.

Through the data collected in the interviews with the prison guards, one realizes that certain topics are more relevant than others that allows a better approximation of the implications of the activity in the health of these workers. It takes into account that the daily lives of agents in prison is conditioned by requirements imposed by the prison administration, difficulties in reconciling work life and life outside of work, and the lack of rise of perspective combined with professional devaluation. All these issues have the aggravation of being permeated by the phenomenon of violence, backdrop of all activity linked to security in prisons

These professionals are assigned the re-socializing function within prisons. However, living in a routine of tensions and insecurity must maintain order and discipline, which often necessitate the development of arbitrary actions due to the inefficiency of control mechanisms and the lack, often, of personal and material resources[3].

> "As Feitosa[3], the work of correctional officers in prisons in Brazil, according to the literature, itenjoys common aspects that despite all the advances in structure and prison work and theprogress of Human Rights can be quite unfavorable for these professionals who undergoidentity crisis when faced with a lack of human and material resources to meet theexpectations around your work. "

The company charges these professionals concrete actions for improvement, humanitarian policies, pedagogical actions. This same society condemns the system and marginalizes, disdains and devalues the activities of correctional officers, but are active viewers of the news of the crimes committed in society by putting in the hands of these servers, punishment, punishment and rehabilitation of this criminal.

> Feitosa[3] describes that "these professionals, unmotivated, disadvantaged by reality and neglect, are at high risk of acquiring somatic and psychosomatic diseases, as evidenced both studies who reported stress and work as those who defend the psychodynamics of work."

The prison guard is knowing that their role is to oversee, maintain discipline, promote the safety of the units and preserve the custody of the prisoner, but the conditions in which they now faced in prisons do not let you action alternatives and re-socializing functionboth defended by public policies seems is a very distant future.

The correctional officers are in charge of searching workers prisoners, cells, visitors, inmates conduct, conduct internal monitoring of Unity and discipline meal of prisoners. By having direct contact with internal and being seen by them as the one responsible for the maintenance of their confinement, these workers are often exposed to various stressful circumstances such as intimidation, assaults and threats, the possibility of riots in which, among others they run the risk of being killed or become hostages[4].

Not even there is a plan for the occupation in practice comes close to such a purpose, as quoted Feitosa[3], "the agent himself is confused with the paradox of his craft

between re-socializing agent, humanizing and disciplinary agent, constraining party."

Lima *et al* [5], show that the overall general condition of capitalism also reproduced in the particular context of the prison system workers. As an example, according to Lima *et al*[5]. There are the poor the prison system infrastructure conditions that affect all who are in that hostile environment, including not only the prisoners but also professionals and so the prison guards, causing damage to the health thereof; the correctional officer is the professional responsible for track and monitor the inmates in the prison unit, providing services in the security sector; are professionals who are continually exposed to risk situations, as well as intimidation, assaults, threats, killings and riots in which, among others, are at risk of being hostages as they have direct contact with inmates and are seen by them as being responsible by keeping them in prison; traumatic events, such as attacks, bring psychopathological consequences, such as post-traumatic stress, and also the reconstruction of troubled thoughts that are factors of cause and maintenance of mental disorders; the activities performed by correctional officers added to poor working conditions and the indifference of society to this group influence their physical and psychic health status; Besides the situations of risk exposure that impair the physical and mental health of the prison guard, the desktop still hidden dangers related to infection by infectious diseases, since proliferation of epidemics and contagious diseases are favored by the environment place which is characterized in overcrowded cells, instability and health hazards. the activities performed by correctional officers added to poor working conditions and the indifference of society to this group influence their physical and psychic health status; Besides the situations of risk exposure that impair the physical and mental health of the prison guard, the desktop still hidden dangers related to infection by infectious diseases, since proliferation of epidemics and contagious diseases are favored by the environment place which is characterized in overcrowded cells, instability and health hazards. the activities performed by correctional officers added to poor working conditions and the indifference of society to this group influence their physical and psychic health status; Besides the situations of risk exposure that impair the physical and mental health of the prison guard, the desktop still hidden dangers related to infection by infectious diseases, since proliferation of epidemics and contagious diseases are favored by the environment place which is characterized in overcrowded cells, instability and health hazards.

Given that the prison officer have direct contact with inmates are just susceptible to contamination by various diseases, the most common being tuberculosis, hepatitis and HIV / AIDS; still about mental health, it is known that emotional distress of these workers may join the morbid conditions, such as metabolic syndrome, it has been detected a higher frequency of this condition among patients undergoing major psychological demands in professional practice; the deleterious nature, health, work in prisons influences, including sleep quality of its workers and there is a relationship between stress, sleep disturbances, decreased resilience, decreased work capacity and occurrence of incidents; the health situation presented reflects the working conditions of staff whose exercise activities as an escort; discipline and safety of prisoners, review and inspection of the entry and exit of people and vehicles in prisons, checking and magazine and daily conference of the prison population, in a repetitive, unhealthy and overloaded routine, making even sometimes roles are not his, how to judge the need for health care to the request of the prisoner showing the face of the State's failure to assign to the agent responsible for establishing the appropriate approach every time.

The agent is still in the midst of a hierarchy of duality, setting up a paradox that on the one hand, obey the orders of their superiors and, on the other, requires the convicts. Importantly, in addition to the psychological pressure suffered on the environment seen as threatening to the detriment of violence by prisoners, the agents are also under pressure from their superiors; demands of work imposed by higher imply less freedom of decision and less job control, causing professionals to become more tense and raise your stress level; all these factors only have to contribute to the illness of the group[5].

In short, "the activities developed by correctional officers are exhausting both physically and emotionally, so studies investigating aspects related to the health of these professionals are needed"[5].

Prison officials show changes in their behavior throughout his professional career. It was intended with this study, to investigate the mental suffering of the penitentiary agents is associated with dissatisfaction at work and, for this, a survey was conducted with agents that act on the Women's Penitentiary in Porto Velho from the following issues: a) What the job satisfaction level of prison officers of the female prison in Porto Velho, in Rondonia, western Amazonia?; b) What is the level of mental suffering of these workers?. With a view to the presented problem, we conducted a study involving 34% of all prison staff working in women's prison in Porto Velho, Rondônia, Brazil.

II. METHOD

We used a quantitative approach to a type characterized as epidemiological study, the model is transversal, which consists of a cut in the flow history of the event, wherein the display is observed simultaneously.

2.1. Instruments and Procedures

For this study, the following guiding instruments were used:

In the first step we applied the sociodemographic questionnaire divided into three blocks, with closed questions, in order to identify the socio-demographic profile of the penitentiary agents.

Block I - was conducted Profile survey of prison staff working in women's prison in the city of Porto Velho, seeking to identify the following variables: name (optional), your age, marital status, children numbers, time working in the prison system, level of education, working hours.

Block II - training or specialization, ie, what training they had to work in the prison and these trainings were enough, and yet, if they have higher level and what your expertise.

Block III - Survey of the conceptions of the agents about their work as a security guard in women's prison unit.

Second stage application of satisfaction scale work of OSI - *Occupational Stress Indicator* , for prison staff working in women's prison, Instrument organized by Cooper[6], translated and validated for Portuguese by Swan, Moraes and Cooper (cited in Martinez[7]) - Portuguese version of the scale job satisfaction, available in Couto[8] .

Third step application of a detection instrument for non - psychotic psychological distress, the "*Self-Report-Questionnaire*" (SRQ-20). This instrument adapted by Borges; Argolo[9], for use in studies of Psychiatric Morbidity in Primary Health Care Facilities in developing countries, coordinated by the World Health Organization.

The instrument called by SRQ is derived from four instruments existing psychiatric research. The original version consists of 24 items, the first 20 items for "screening" of non - psychotic disorders and the last 4 items for detection of psychotic disorders. As an instrument is intended for the detection of symptoms, it is well suited for the study population. It is a self administered instrument, containing a range of answers YES / NO. The Portuguese version adopted the first 20 items to non - psychotic morbidity, which used in Brazil the SRQ-20 in primary health care services in Porto Alegre.

2.2. Local Study and Number of Sampling

The survey was conducted at the Presidio Women's City of Porto Velho, capital of Rondonia State, which includes on its staff a total of 59 (fifty nine) penitentiary agents, and 34% participated in the study.

2.3. Criteria for Inclusion and Exclusion

Inclusion criteria: the research with the participation of twenty (20) prison officers working in women's prison unit in the city of Porto Velho.

Excluded from the search, prison officers who refused to participate.

2.4. Ethical aspects

The project was submitted and approved by the Ethics Committee of Research Institution of Higher Education - IES meeting the requirements of Resolution 196/96/CNS/MS procedures needed to perform the search. It was guaranteed to the participants the confidentiality of their identity at all stages of this research. All the subjects of the research signed the Term of Free and Informed Consent - TCLE.

2.5. Data analysis

In order to get important data for this study divided the sociodemographic questionnaire in three parts:

Block I - Profile Survey of active agents in prison female prison unit.

Block II - Training or expertise of prison officers.

Block III - Conceptions of prison officers on their work in women's prison unit.

2.6. Satisfaction at Work

The instrumental satisfaction with aspects of the work has 22 variables. Each analysis is categorized into satisfaction with the options: I - a) delighted b) very pleased, II - Intermediate: a) some satisfaction; III - Dissatisfaction: a) huge dissatisfaction and b) a lot of dissatisfaction.

Job satisfaction was assessed by adding the results of the variables presented, the degree of satisfaction or dissatisfaction as measured by the scale being assigned 6 for great satisfaction, 5 for many satisfactions, 4 for some satisfactions, 3 for some discontents, 2 for many dissatisfactions, 1 to massive dissatisfaction.

For the tabulation of the data we used the Microsoft Excel 2007 program, and the same process carried out to associate the design variables of the prison guard about his work in the prison unit with job satisfaction and mental suffering.

2.7. Mental Suffering

The mental distress was assessed using 20 variables, the response scale constituted from *yes* or *no*.

The categorization was made by five factors being addressed in the factor analysis 1 - decreased energy consisting up to six variables: (feels tired all the time, tires easily, finds it difficult to make decisions, is difficult to accomplish with satisfaction activities of daily life, have difficulty to think clearly, have difficulties in -your service work is painful, cause you suffering.

Then, the variables are the factor analysis 2 - somatic symptoms, consisting of four variables as follows: (headache is often have unpleasant sensation in the stomach, have poor digestion, lack of appetite).

As the variables of factor analysis 3 - of depressed mood, appear three variables, as follows: (feels nervous (a), tense (a) or worried (a), has lately felt sad, been crying more than usual).

And in the factor analysis 4 of depressive thoughts - is made up of four variables, as follows: (have lost interest in things, is unable to play a useful role in your life, a useless person feels, worthless, have no idea end life).

Finally the factor 5 organized by other symptoms of the SRQ-20, having three variables: (sleeps badly, startles easily, have hand tremors).

The mental distress was assessed by the sum of the variables presented in the SRQ-20, considering how 7 cutoff or more affirmative answers of 20 questions submitted for classification of the prison officers on suspicion of minor psychic disturbance, hence with possible mental suffering. The officers who responded less than 7 affirmative questions were categorized as not suspected of mental suffering or without mental suffering.

2.8. Work Limitations

This work was carried out only with the female because it is a women's prison and only female officers have direct contact with the women's prisioner. The questionnaire was administered every other day in order to reach the different shifts and always at night so as not to hinder the work of the agents, as the night the women's prisioner are in their cells and during the day they leave to study, go to the doctor, doing laundry, finally, the agents would not have enough time for a satisfactory data collection was made. So, we tried to always schedule an evening appointment with the agents, in which they had availability to answer the questionnaire with ease. Thus, questionnaires were completed in five different shifts, each consisting of five female agents, visits to the women's prison for the collection of data was authorized by the Director of Prisons.

III. RESULTS AND DISCUSSION

3.1. Sociodemographic Profile

Block I - Survey of the profile of penitentiary agents working in the female prison unit. Block I questionnaires show that the predominance of age was higher in the age group of 20 to 29 years, with 55% of respondents; followed by 40% in the range of 30 to 39 years; 5% aged 40 to 49 years. There were no interviewees between the ages of 50 and 59, or over 59 years of age. As for marital status, 45% of penitentiary agents are married or living in marital status, 45% are single, and 10% are separated, divorced or widowed. Regarding the number of sons, 45% of the agents have only one son, 35% have no sons, 15% have 2 sons and 5% have 3 sons. Regarding the length of time in the prison system, 45% work from 1 to 3 years in the system, 30% work from 4 to 6 years, 20% less than 1 year and 5% from 7 to 10 years. As for the educational level, 35% of the agents have complete secondary education; 30% incomplete upper level, 30% have completed upper level, and 5% have specialized courses. Of the agents with higher education 50% did not report the course they completed, 20% graduated in law, 15% graduated in Portuguese; 5% in biomedicine; 5% in accounting sciences and pedagogy. As for the working hours 60% have a workload of 40 hours a week, 35% more than 40 hours and 5% work 20 hours a week. Of the extra activities besides work in the female penitentiary, 75% do not dedicate hours of work to other activities,

15% dedicate from 1 to 5 hours a week; 5% dedicate from 6 to 10 hours and 5% dedicate from 16 to 20 hours.

Block II - Training or expertise of prison officers. Concerning the training or expertise, 55% of agents said they received training to work in the prison unit and 45% say they have not received training. Of the 55% who received training, only 85% had this training in the training course, 5% annually and 10% did not answer. Of agents who have received training 65% do not consider sufficient training to support their practice of service, 25% consider enough time to support their practice of service and 10% did not answer this question.

Block III - Conceptions of prison officers on their work in women's prison unit. The agents who participated in the survey 75% said they do not feel good when working with people who are deprived of their liberty, and 25% said yes. When asked if their work was important for the proper functioning of the prison, the agents were unanimous in answering yes, 100%, demonstrating that know the importance of their work to society. When asked if their work suits your professional expectations, 75% of agents said no and 25% yes. Asked if the prison's direction provided some psychological support for the penitentiary agents, 75% said no, only 25% said yes.

The study showed 55% with a mean age 20-29 years, and 45% of prison officers work less than four years in the profession. This result is due to the fact that it occurred a recent public tender, and all emergency penitentiary agents, who were the majority in the system, have been laid off, many of them were already in the system for over 10 years. So today, the women's prison in Porto Velho has an effective "young" in the prison system, result of the last public tender for state penitentiary agents. To be considered young professional, 35% do not have children, while 45% of agents have only one child.

Of the 20 officers who participated in the study, 30% have a university degree and 5% have graduate - expertise, 45% is acting between 1 to 3 years in prison units, and 60% have a weekly load of 40 hours. Of the individuals surveyed, 45% say they have not received enough training to work in prisons, however 55%, feels prepared to work in the prison system.

Vasconcelos[10], Fernandes *et al* [4] and Lopes[11] are some of the references to studies that address the working conditions of prison staff in Brazil.

To Vasconcelos[10], "the prison institution, immersed in the dilemma between being the same exhaustive disciplinary apparatus and 'transformation tool for individuals, has demonstrated, through the ages, which way tends to choose. The very perpetuation of their character, inherently repressive, dispel any belief in achieving adequate resocializer purposes degraded social environment the prison guards use "institution and the experience" to be able to perform their activities, a situation which ultimately exacerbate the fear and

increase violence "forming a vicious cycle that is installed in a brutal and merciless universe."

Fernandes *et al* [4], in cross-sectional epidemiological study of working conditions and health of correctional officers, via sample of 311 workers in prisons in the metropolitan area of Salvador - Bahia observed that it was the group with high education, stating that various agents had higher levels. To explain this finding, presented the hypothesis that individuals with higher education have provisionally entered the penitentiary activity, however, the high level of unemployment, would have remained in employment, mainly because of advantages offered by the public sector. The average working time as a prison guard found by the authors was 10.3 years.

Fernandes *et al*[4] draws attention to the characteristics of prison labor, highlighting the need to deal with individuals who constantly question his authority. This is a situation that requires adequate training, so that agents do not use features such as violence or else give in the face of threats and attempted corruption of detainees.

Foucault[12] in a work entitled watch and punish, shows that prison labor is the most appropriate way for the transformation of the individual, for the time being we are stuck, have an occupation, and in time will lose their violent personality, and becoming a be quieter, more docile.

Paraguassu Chaves[13] in his research "Work and Occupational Diseases" had already identified the profile of vulnerable groups of workers, susceptible and receptive, in a situation of imminent risk of suffering and illness in Rondônia. In their study traced demographic profile of workers in the public security system, health, education and others. Paraguassu-Chaves[14] with his research entitled "GIS of occupational diseases in Rondônia in the last decade" traces the profile of the service provider framework in the public security system. This author has identified the predominance of the age group 20 to 29 years old, single marital status to a greater extent, with more than 50% with only child. And also states that the need for admission to public service by public tender, the younger population has sought at all costs a job opening on what is possible, including in the services considered highly dangerous and unsanitary.

Of Paraguassu-Chaves agreement[15] on "Social Inclusion in Border Region", the level of education tends to increase over time because of the requirements for holding public office, regardless of higher education. The most diverse backgrounds professionals are seeking employment, not caring if it is within their area of training. Excessive workload has been one of the conditions to occupational stress. Because it is penitentiary agents "female", these in addition to the labor professional practice also perform household chores, overloading them.

To Paraguassu-Chaves[13] training or expertise is not enough necessary to ensure satisfaction and work efficiency. The training must be systematic and application feasible on a daily of prison officers. The inefficiency of the counseling service directly affects the prison officers. Dealing with persons deprived of their liberty lead to unpleasant feeling. The very lack of a professional projection, a career in the prison system, an expectation of a future, leads to personal and professional frustration. Silva[16] brings the law relating to labor law, as one of the professional development principles.

3.2. Satisfaction at Work

How do you feel about your work? The set of variables according to the satisfaction scale in the work of OSI - Occupational Stress Indicator, is who guides the construction of the level of job satisfaction.

Communication and form of information flow in the company in which you work: of the 20 interviewed prison officials, 40.0% claim to have some dissatisfactions and 35.0% claim to have some satisfactions.

His relationship with others in the company where you work: Many options satisfactions and dissatisfactions Some have the same percentage with 30.0%.

The feeling you have as to how their efforts are evaluated: 45.0% have some dissatisfactions and 30.0% have some satisfactions.

The content of the work it does: 35.0% of prison officers are with some satisfactions and 30.0% with many satisfactions.

The degree to which you feel motivated by their work: 35.0% have some satisfactions and dissatisfactions Some 30.0%. personal opportunities in your current career: 45.0% of agents have some dissatisfactions and 25.0% Some satisfactions.

The level of security in your current job: 40.0% claim to have many grievances and 25.0% have some dissatisfaction.

The extent to which you identify with the external image or performance of your company: 45.0% of respondents answered that they have some grievances and 40.0% having some satisfactions.

The supervisory style that his superiors use: 40.0% of prison officials said they have some satisfactions, 20.0% which has many satisfactions and 20% having some dissatisfaction.

The way in which change and innovation are implemented: 55.0% have some dissatisfaction and 30% have some satisfactions.

The way in which innovations and changes are implemented: 55.0% have some satisfactions and 20% that has some dissatisfaction.

The degree to which you feel you can grow and develop in their work: 60.0% of the interviewed agents have some satisfactions and 15.0% have some dissatisfaction.

The way in which conflicts are resolved: 30.0% of respondents answered that they have some satisfactions and the same percentage some dissatisfactions.

The opportunities that their work offers towards achieving their aspirations and ambitions: 45.0% of workers said they have some satisfactions and 25% having many dissatisfactions.

Their degree of participation in important decisions: 25.0% of the surveyed said they have some satisfactions and dissatisfactions some 25.0%.

The degree to which the organization absorbs the potential you think you have: 35.0% claim to have some satisfactions and dissatisfactions some 30%.

The degree of flexibility and freedom that you have judges in their work: 45.0% said they have some satisfactions and 20% having many satisfactions.

The psychological climate that prevails in the company you work: 45.0% of agents claim to have some dissatisfactions and satisfactions some 20%.

His salary in relation to their experience and the responsibility that has: 30.0% of respondents claim to have many grievances and 30.0% Huge dissatisfaction.

The organizational structure of the company you work: 35.0% of respondents claim to have some dissatisfaction and 30% Many dissatisfactions.

The amount of work you have to solve: 40.0% said they have some satisfactions and 30% Many satisfactions.

The degree to which you judge to be developing their potential in the company where you work: 35.0% claim to have some dissatisfactions and 30.0% with some satisfactions.

Table.1: Satisfaction Scale OSI Labor - Occupational Stress Indicator

HOW DO YOU FEEL ABOUT YOUR WORK?	ES	%	MS	%	SS	%	SD	%	MD	%	HD	%
Communication and form of information flow in the company where you work.	3	15	0	0	7	35	8	40	1	5	1	5
His relationship with others in the company where he works.	3	15	6	30	3	15	6	30	2	10	0	0
The feeling you have as to how their efforts are evaluated.	0	0	3	15	6	30	9	45	1	5	1	5
The content of the work you do.	2	10	6	30	7	35	5	25	0	0	0	0
The degree to which you feel motivated by their work.	1	5	2	10	7	35	6	30	4	20	0	0
personal opportunities in your current career.	1	5	2	10	5	25	9	45	2	10	1	5
The level of security in your current job.	0	0	0	0	0	0	5	25	8	40	7	35
The extent to which you identify with the external image or performance of your company.	1	5	0	0	8	40	9	45	1	5	1	5
The supervisory style that his superiors use.	1	5	4	20	8	40	4	20	2	10	1	5
The way in which change and innovation are implemented.	0	0	0	0	6	30	11	55	3	15	0	0
The type of task and the work in which you are charged.	2	10	2	10	11	55	4	20	1	5	0	0
The degree to which you feel you can grow and develop in their work.	1	5	2	10	12	60	3	15	1	5	1	5
The way in which conflicts are resolved.	2	10	2	10	6	30	6	30	3	15	1	5
The opportunities that their work offers towards achieving their aspirations and ambitions.	1	5	0	0	9	45	2	10	5	25	3	15
Their degree of participation in important decisions.	1	5	2	10	5	25	5	25	4	20	3	15
The degree to which the organization absorbs the potential that you think have.	1	5	3	15	7	35	6	30	2	10	1	5
The degree of flexibility and freedom you think you have in your work.	2	10	4	20	9	45	2	10	3	15	0	0
The psychological climate that prevails in the company you work.	0	0	2	10	4	20	9	45	2	10	3	15
His salary in relation to their experience and the responsibility you have.	0	0	0	0	3	15	5	25	6	30	6	30
The organizational structure of the company you work for.	1	5	1	5	5	25	7	35	6	30	0	0

The amount of work you have to solve.	0	0	6	**30**	8	**40**	4	**20**	1	5	1	5
The degree to which you judge to be developing their potential in the company where he works.	1	5	4	**20**	6	**30**	7	**35**	1	5	1	5

Legend: **ES = enormous satisfaction (6 weight); Many satisfactions MS = (weight 5); Some satisfactions SS = (w 4); Some dissatisfaction SD = (w 3); MD = Many dissatisfactions (weight 2); Huge dissatisfaction HD = (w 1)**

Martinez[7] states that the distribution of data in a central value is natural, most employees has intermediate levels of satisfaction, the lowest percentages are distributed in levels of greater satisfaction and less dissatisfaction; this assertion of the author can be supported in this work.

Studies Arvey *et. al*[17] about the job satisfaction determinants have analyzed variables related to organizational culture as generic factors.

Job satisfaction, facing the raised discussions, can be characterized as a multifactorial variable. And the most studied according to surveys, are the nature of work, working conditions, and the climate in which it is performed. According to statistics from Social Security mental disorders occupy the third position among the causes for granting social security benefits. The survey data points to the lines of business that have more cases of expulsion for mental disorders: oil extraction, real estate, air transport, collection, treatment and distribution of water and manufacture of textile products, leading to the conclusion that, depending on the occupation, the risks increase. Weds still frequent victims of assaults in the workplace;

Herzberg[18] and Locke[19] claim that the individual must meet needs or answer values to feel satisfied at work.

On the discussions presented, it can be said that even after decades of research, there is no consensus in the literature about the job satisfaction components.

Much has been said about health and job satisfaction, but satisfaction at work cannot be isolated from the life of the individual as a whole. According to Rodrigues[20] "Employees who have an unsatisfactory family life have work as the sole or greatest means for the satisfaction of many of their needs, especially social." Thus, the work assumes enormous dimensions in man's life.

Martinez[7] describes that job satisfaction has been placed by theorists such as influencing process in occupational health, highlighting how researchers Henne; Locke[21], which identify dissatisfaction at work as an unpleasant psychological state, triggering of significant conflicts for the individual to exercise a job that would prefer to avoid, can this emotional state cause him to have health problems.

In a study presented by Rock[22] with system analysts in São Paulo, on the relationship between health and work, it was found that job satisfaction appeared also negatively associated with medical consultation demand and as the negative interference reduction factor work in family and personal life.

A survey by Martinez[7] on the relationship between job satisfaction and health of workers, held with 224 administrative employees of a managed care company in health and pension plans in São Paulo, found that job satisfaction is related to each aspects of the mental health of the study, and this is independent of socio-demographic variable.

Rebougas, *et. al*[23], in a study on satisfaction and the impact of work on 133 professionals from four mental health services in Rio de Janeiro, concluded that 62.4% of study subjects reported moderate levels of satisfaction, whereas, moreover, the greater the education of the respondents, the lower the satisfaction. Research Almeida Filho & Rouquayrol[24] they point out that the cross-sectional studies have certain limitation by the inability to established causal relationship between job satisfaction and mental health, because this exhibition and event are analyzed at the same time cut. However, this type of study provides an assessment of relations through measures of association, whose objective is to evaluate the coincidence of a given disease or health-related event in the presence of a condition attributed hypothetically as a risk factor.

Epidemiological studies, despite its advantages, also have some disadvantages, both transverse and longitudinal, because it does not explain the dynamics of the identified correlations. A quantitative research provides qualitative data describing characteristics of a population or sample, and also establishes associations, risks and probabilities between variables. However, depending on their reductive character, just not including the investigation of the processes and dynamics of the observed relationships, which restricts the analysis of social and / or subjective aspects. Thus, epidemiological research in addition to using epidemiological techniques need to be used for theoretical support of other sciences such as anthropology, sociology, psychology, immunology, biostatistics, clinical and other[24, 19].

Establish the relationship between health and job satisfaction is no easy task, because not always can prove to the satisfaction produces health, and health produces satisfaction or if both are the result of some other factor, and thus, a relationship not yet been set the epidemiological point of view[21].

The well - being, in terms of psychological burden, comes not only the absence of its operation, but rather, a free running, dialectically articulated with the job content, expressed, in turn, the job itself[25].

Paraguassu-Chaves[13] to report their findings analyzes on certain paradoxes between the variables made in the scale of job satisfaction of the OSI - Occupational Stress Indicator. In his study the author presents a new proposal using factor analysis beyond the OSI scale. The salary aspect regarding your experience and the responsibility that has been the variable "A lot of dissatisfaction" with 85%; The amount of work you have to solve; The level of security in your current job; The way in which conflicts are resolved; Their degree of participation in important decisions were the most important variables in "Some dissatisfaction" with 40%.

It is important in this dynamic analyze what are the possible destinations for the suffering, which can be transformed into pleasure and creativity or result in frustration and illness[26]. Work can be a source of pleasure, to allow the application of intelligence and also when it recognizes the importance of this for the labor organization. The work is thus perceived as health, because the relationship of that become mediators of the subject and the construction of their identity achievements[27]. When the worker's activity is recognized and valued by the organization, the work becomes structuring the identity of the individual. But when this same activity is not significant for the subject, to the organization or to society, it can be a source of suffering[28].

3.3. Mental Suffering

Data on mental suffering will be presented according to the classification of Iacoponi & Mari[29], a sequential manner, Factor 1, power reduction; Factor 2, somatic symptoms; Factor 3, depressed mood; Factor 4, depressive thoughts and Factor 5, other symptoms of the SRQ-20.

Table 2 made by the factor 1 - Power reduction, has a higher frequency in the variable "are difficulties in carrying out their daily activities with satisfaction" with 30%; then 25% of the variables "Do you feel tired (a) all the time", "If tired easily" and "find it difficult to make decisions." The variables "has difficulties in service (your job is painful, cause you distress) with 15% and" It's difficult to think clearly with 5% were the lowest frequencies. Mean Decrease Power Factor was 23:33%.

Table.2: Frequency on the Factor 1 - Energy Reduction.

QUESTIONS	(YES)	%	(NO)	%
Do you feel tired (a) all the time?	5	25	15	75
Do you get tired easily?	5	25	15	75

Finds it difficult to make decisions?	5	25	15	75
Finds it difficult to perform with satisfaction your daily activities?	6	30	14	70
Has trouble thinking clearly?	3	15	17	85
It has difficulties in service (your job is painful, cause you suffering?)	4	20	16	80

In factor 2 (Table 3) the frequency of somatic symptoms, had its highest rate variable "has headaches often" 25%; Then the variable "has unpleasant sensations in the stomach" and "have poor digestion" of 20%; there was no manifestation regarding the variable "has no appetite." The average factor was Somatic Symptom 21.25%.

Table.3: Frequency on the Factor 2 - Somatic Symptom

QUESTIONS	(YES)	%	(NO)	%
Do you have headaches often?	5	25	15	75
It has unpleasant sensations in the stomach?	6	30	14	70
You have indigestion?	4	20	16	80
Lack of appetite?	2	10	18	90

The factor 3 (table 4), the frequency of depressed mood, as often was the variable "Do you feel nervous tension or upset" at 40%, followed by the variable "It has recently felt sad" with 20% and less frequently with the variable "has been crying more usual, with 10%. The average factor Depressed Mood was 23.33%.

Table.4: Frequency on the Factor 3 - Depressed Mood

QUESTIONS	(YES)	%	(NO)	%
Do you feel nervous (a) tense (a) or worried (a)?	8	40	12	60
You have felt sad lately?	4	20	16	80
She has been crying more than usual?	2	10	18	90

In factor 4 (Table 5), with respect to the depressing thought, the variables "has lost interest in things", "he is unable to play a useful role in your life" and "You feel a useless person, useless "and" Any idea to end the life "predominate with 10%. The average factor depressing thoughts was 10%.

Table.5: Frequency on the Factor 4 - Depressive Thoughts

QUESTIONS	(YES)	%	(NO)	%
He has lost interest in things?	2	10	18	90
It is unable to play a useful role	2	10	18	90

in your life?				
You feel a useless person, useless?	2	10	18	90
Any idea of ending life?	2	10	18	90

In other symptoms of SQR-20 had more often the variables, "scares up easily" 20% "Sleep evil" with 15%, followed by the variable "has hand tremors" with 5%. The average factor Other Symptoms of SRQ-20 was 20%.

Table.6: Frequency relative to Factor 5 - Other Symptoms of SRQ-20.

QUESTIONS	(YES)	%	(NO)	%
Sleep badly?	5	25	16	80
Startles easily?	5	25	15	75
You have hand tremors?	2	10	18	90

The female prison system inmates agents of Porto Velho, Rondonia are presented 19:59% with minor mental disorders, in the following order of determination: power decrease (23:33), depressed mood (23:33%), somatic symptom (21:25%), other symptoms of SRQ-20 (20%) and depressive thoughts (10%).

The results of the studies Fernandes et al[4] showed that 30.7% of prison guards had minor psychological disorders (now called mental disorders), reviews the application of self-reporting-Questionnaire , SRQ-20 percent considered high compared with those obtained studies in other professional categories . Studies by Fernandes et al[4] was developed with correctional officers (male), unlike research in the female prison in Porto Velho.

The authors found a positive association between psychological distress (common mental disorders) and various working conditions, among which, working for more than nine years in the prison system, excessive working hours, inadequate environment from the psychological point of view, insufficient infrastructure, lack of time for leisure and not sports.

According to Dejours[28] contrary to what one imagines, the exploitation of suffering the organization of work does not create specific mental illness, so there is work psychoses. The biggest critics of psychiatric nosology to date, failed to demonstrate the existence of a mental illness arising from work.

The Gomes study[30] found that most identified health problems were ill feeling intense be generalized; anxiety, tension, nervousness, irritability, depression, anxiety and exhaustion; sleep disorders; digestive problems; breathing and voice problems. Cunha in a study[31] found that the most frequent health problems are the uncomfortable feeling in the stomach, indigestion, gastritis (30.0%) and headache (17.4%).

Tartaglini & Safran[32], show that police officers and inmates as submitted professionals to a high risk for the disease reported as debilitating stress. These authors found prevalence of anxiety, behavioral disorders and higher alcohol abuse among inmates agents than the general population. Reported among these workers, a prevalence of emotional disorders of 18.6%, alcohol abuse, 4.5% and 7.9% anxiety disorders.

Goldberg et al[33] in a study conducted in France, with all categories of prison workers, observed prevalence of 24% of depressive symptoms, 24.6% of anxiety disorders and 41.8% of sleep disorders. In Fernandes study et al[4] The prevalence of minor psychological disorder found (30.7%) was higher than those found by Araujo et al[34] 20.1% Borges[35] 19.0% Fernandes[36] 19 to 24%, Pitta[37] 20.8%, in particular school teachers samples of Salvador teaching, metallurgical, processing of data workers and hospitals, respectively.

In the research of Santana; Cruz38, the most prominent symptom was Depressive-Anxious Humor, since the most pointed question was "he is nervous all the time and worried about the masculine gender (n = 120) (88.2%) and the feminine gender (n = 80) (100%). It is a psycho-emotional symptom whose characteristic is supposed to be intrinsic to work, because the work routine of prison staff needs constant attention and vigilance, generating tension and worry.

This assumption is consistent with the concept of anxiety defined by Castillo et al[39] "Anxiety is a vague, unpleasant feeling of fear, apprehension, characterized by tension or discomfort or derived from danger anticipation of something unknown or strange.

The ansiogenia is also noted in the work Dos Santos et al[40], to get results, as the exposure of Prison Guards to situations that cause high anxiety.

Studies conducted in Spain with correctional officers by Ghaddar et al[41] and France with prison workers by Goldberg et al[33] also observed the existence of anxiety symptoms.

The research Tartaglini and Safran[32] regarding mood, reported a prevalence of disorder in 18.6% of the Prison Guards, inferring that this incidence is higher than in the general population. For the term psychopathology *Depression* is a generic form which means pathological sadness designating the change of mood in both its inhibition and in his exaltation. The Humor is part of affectivity and the change can become a pathological state. It is taken as the person 's mood and defined as "affective tone of the subject"[42] .

For Santana; Cruz38's Symptoms Depressive Mood, Somatic Symptoms and Decrease in Vital Energy in the issue of "feeling tired all the time" women had higher incidence rates than men accounting for the greater part.

What is the reason? We dare suppose to be a question of attribution to the dynamics of power that can represent oppression of the feminine gender in a Penitentiary Institution, constituting a possible remnant of masculinism. Or the possibility of women being more sensitive to issues related to affectivity. Which would give us a better direction where we begin the movement of change: paying attention to what sensitivity can teach us.

There was representation in high SRQ-20 in relation to the short time profession. This similarity is characterized by those with less than three years of work, given that in their daily practice still have close relationship with the inmates. Already with long, they are usually in other positions, in administrative or higher positions, moving away from functional practices and exposure to situations of great psychological demands to which professionals with little time are subject[38]. This demand suggests a *burnout* as described by Pereira[43] "a typical suffering of occupations where relational and affective aspects of the subject are required at work."

Paraguassu Chaves[13] used the same instrument "Self-Reporting Questionnaire-, SRQ-20*",* and found similar indicators and contradictory to that found in this study. The study was conducted on a group of women who work as prison officers in Porto Velho. About 50% of respondents in Paraguassu-Chaves[13] search are the same prisoners agents who participated in this research. On energy reduction in load (factor 1) found the highest prevalence in the variable "find it difficult to make decisions," with 45% and "find it difficult to perform with satisfaction their daily activities" with 30%, similar to the survey of the prison officers the women's prison in Porto Velho. In factor 2 the frequency of somatic symptoms, had its highest rate variable "has headaches often" with 45%; "It unpleasant sensations in the stomach" is 30% higher than the present study. In factor 3 of depressed mood, most often it got the "Do you feel nervous or tense worried" variable with 40%. In the fourth factor that refers to the depressing thought, the variables "has lost interest in things," he was predominant with 25% followed by "Any idea end life" of 20%. In other symptoms of the SRQ-20 had more often the variables, "Sleep evil" with 25%.

IV. CONCLUSIONS

The study showed a mean age category 20-29 years, and 45% is less than four years in the profession. This result is due to the fact that it occurred a recent public tender, and all emergency penitentiary agents, who were the majority in the system, have been laid off, many of them were already in the system for over 10 years. So today, the women's prison in Porto Velho has an effective "young"

in the prison system, result of the last tender for Agents State Penitentiary.

Of the 20 officers who participated in the study, 30% have a university degree and 5% have graduate - expertise, 45% is acting between 1 to 3 years in prison units, and 60% have a weekly load of 40 hours. Of the individuals surveyed, 45% say they have not received enough training to work in prisons, however 55%, feels prepared to work in the prison system.

The data presented show that 40% of the women have some dissatisfaction, followed by some 35% fulfilled. They are delighted 15% of respondents; 5% with many dissatisfactions, and 5% with huge dissatisfaction.

The aspect in which the agents show more satisfaction refers to the extent to which they feel they can grow and develop in their work with 60%, and most dissatisfaction index refers to the way in which changes and innovations are implemented with 55%.

The female prison system inmates agents of Porto Velho, Rondonia are presented 19:59% with minor mental disorders, in the following order of determination: power decrease (23:33), depressed mood (23:33%), somatic symptom (21:25%), other symptoms of the SRQ-20 (20%) and depressive thoughts (10%), considered as evidence of mental distress indicators. And if added together, the total number of agents that are with huge dissatisfaction with the ones with a lot of dissatisfaction, we arrive at a worrying picture. This suggests a possible association between job dissatisfaction and mental suffering.

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Analysis of Heat Transfer in the Material during Pulsed Laser-Metal Interaction by Using Kinetic Theory

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Abstract— *Nowadays technological developments, the use of lasers in production is increasing and plays an important role due to low cost and high accuracy. The heat transfer, over the course of laser-metal interplay, has a great importance in metal forming. In this study, different types of materials were investigated in order to designate the temperature distributions inside material and on the material surface versus the thermodynamic properties of the material used and then the temperature distributions obtained from the analysis were compared each other.*

In addition, the heat transfer is occurring during the interaction of the laser power of 1.10^{10} W/m² and 5.10^{10} W/m² with laser power intensity in two main groups using different materials these are steel, nickel, tantalum and titanium, and numerical results are obtained using the finite-difference method. In the first step, a solution is obtained by electron kinetic theory according to the basic heat transfer. In the second step, since heat convection is formed after material has reached the melting point. Using electron kinetic theory model for convection solutions have been obtained. Moreover, the temperature distribution that occurs during the laser metal interaction was studied by variation of the time chart and the material depth. As a result of the study, material's surface at the correct temperature of liquid phase change material and increased depth in the direction perpendicular to the electro-kinetic theory approach is further demonstrated by the decrease in the first manner and then remains constant in exponential phase change temperature. In addition to this the analysis results, the substrate temperature increases, the change in phase in the material becomes smaller and smaller.

Keywords— *Kinetic Theory, Pulsed Laser-Metal, laser.*

I. INTRODUCTION

A laser is a device electromagnetic stimulated emission of radiation that continues to happen for a while instantly optical amplification of light emission. The term "laser" with stimulated emission of radiation "has emerged as an acronym for light amplification [1]. In today's developing technology, because of the delicate processing quality of the laser material, laser has many uses such as engineering, industrial processing [2], medicine, scientific research [3], electronic and communication field [4]. The basic principle of laser devices is the output photon energy from the light source by passing it through a medium, of electrons from atoms very and available beams are very different motion in a single direction is to obtain a new beam [5]. The process describing the laser machining necessitate a knowledge of physical properties of the material and the machining ambient, such as heat capacity, thermal diffusivity, gases and pressure in the processing environment [6]. In the laser machining ——process, various phenomena that occur when the electromagnetic radiation that comes out on the surface of a material come into the form of scattering, absorption and transmission. The absorption of radiation leads to various effects in materials, such as evaporation, possible plasma formation, molten layer formation, etc., which constitute the pressures of laser material processing techniques [7].

Laser metal interacts with the free electrons in the transmission band to the surface of the photons that hit the surface of the material. As a result, electrons with increasing kinetic energy collide with excited cage molecules at higher energies. The higher vibrational energy of the molecules leads to higher temperatures. These interactions result in phonon-phonon confusion as to provide thermal equilibrium. All of these events give the definition of the heat transfer mechanism [8].

In the literature, there are many various studies that help to distribute the temperature due to laser material interaction in solids and model it using Fourier equation. Koc at al. 1995, investigated the phenomena of heat transfer occurring for the laser processing power of 1.10^{10} W/m²

and 5.10^{10} W/m^2. At the same time heat conduction and convection were evaluated electron kinetic theory, in addition to this different types of materials analysed in order to determine the temperature distraction [9] Yilbas at al. 2006, analysed and developed the electron kinetic theory formulation for laser ultra-short pulse heating by estimating the comparatively low cage temperatures. Consequently, the developed formula is the analogous with found for improved formulation hyperbolic heating model [6]. Mansoor et al. 2015, The effect on the laser short-pulse temperature was investigated for an aluminium thin film and the energy transfer was calculated using the Boltzmann equation in the film. When they calculate the time-dependent change in equilibrium temperature, the laser pulse intensity in the subsystem continues. However, the equilibrium temperature is different for the electron and lattice subsystems associated with the phonon [10]. Koc et al. 2004, examining the 3-D laser heating model on four different materials (tantalum, iron, titanium, nickel) using the electron kinetic theory approach. For these materials the temperature distribution depends on the time. According to this information the surface temperature of the material is calculated and analysed. As a result of the study, He found the temperature rises up to the point of melting at the material origin and by the reason of to heat transfer by conduction. When heating for these materials, the temperature distribution is reduced in the x direction [11]. Shuja and Yilbas at al. 2013, investigated and simulated laser which is induced melting of coated carbon steel which is kept constant at 7.5 mm and is contained with alumina, boron, tungsten carbide. As a consequence of this, surface temperature raised during the first heating phase of the laser pulse, However the temperature of cooling cycle is precipitous drop [12]. They studied laser metal interactions and focuses on process of development for flexible applications. In addition to this, investigated new approaches with laser metal interaction which is flexible tool for transparent electrodes of metal or synthesis of nanomaterials [1].

II. MATHEMATICAL MODELLING OF HEAT TRANSFER

Heat transfer analysis is required to examine the temperature distribution during the laser metal interaction. Fourier's equations of conductivity used in heat transfer processes are insufficient during high-power laser-metal interaction. For this reason, there is a need for kinetic theory to study the heat transfer phenomenon during laser-material interaction more accurately [11].

This model can be explained as follows. Electromagnetic radiation applied from the outside is absorbed by free electrons in the transmission line of metals. These electrons, rise in energy, collide with atoms and leave some of their energy in atoms. Because of this mutual effect, the phonon energies of the atoms increase and cause the phonon energies to soar by forcing them to vibrate around the atoms around them. Some acceptances have been made to facilitate the resolution of the problem [9] [13].

- It is assumed that dissipation of energy due to thermionic emission do not occur.
- Local equilibrium,is presumed at material t = 0 uniform temperature.
- It is accepted that the plasma has a continuous regime, the absence of nucleation and liquid metal flushing, the neglect of the physical change of the laser beam due to the laser optical system and plasma.
- It is supposed that electrons will not be affected by temperature changes of the mean free path [14].

According to kinetic theory, it is necessary to show regard to the free electron model in the quantum field in order to study the conduction of the heat. Electrons that move freely within the surface at a certain speed are called free electrons. Within a volume confined to a particular surface, electrons can change their energy according to the law of dispersion of the fume. The electrons are placed in the molecular cage and have phonon energy according to their vibrational motion [15]. When considering the lattice vibration, the displacement of an atom at the "s" point in the lattice is given by the following expression [9].

$$A_g . e^{i(gs - \omega_g t)}$$

Where; motion's amplitude is A_g. At the T temperature, the approximate coupling energy related to this vibration mode is given by the Planck formula [9] [14]. The energy of the lattice vibration contingent upon the phonon number (n) and frequency (ω). If the number of phonons (n) in the T temperature and in the thermal equilibrium is written depending on the Planck distribution;

$$\langle n \rangle = \frac{1}{e^{\hbar\omega / k_B T} - 1}$$

or;

$$\langle n \rangle + \frac{1}{2} = \frac{1}{2} \text{ctnh.} \frac{\hbar\omega}{2k_B T}$$

Where; $\langle \ \rangle$: indicates the average of the thermal balance

     k_B : Boltzman canstant.

     $\langle n \rangle$: The average number of photons in thermal equilibrium

$$N_{n+1} / N_n = e^{\hbar\omega / \tau}$$

$$\tau = k_B . T$$

It is written in the form. In this case, the ratio of "nth" to the total number of oscillations in the quantum state;

$$\frac{N_n}{\sum\limits_{s=o}^{\infty} N_s} = \frac{e^{-n\hbar\omega/\tau}}{\sum\limits_{s=o}^{\infty} e^{-s\hbar\omega/\tau}}$$

If the regulation of the mean excitation quantum number of the oscillation is made and x = exp (-ℏωτ), the following takes the form;

$$\sum_s s.e^s = x\frac{d}{dx}\sum_s x^s = \frac{x}{(1-x)^2}$$

In the classic sense, each oscillation is considered to have " $<n>\hbar\omega \approx k_BT$ " energy. The average energy of an oscillation at frequency ω is $<h> \hbar\omega$. The average energy for one atom vibration;

$$<E> = h.\,\omega g\,/\,[exp\,(h.\omega g/k.T\text{-}1)]$$

C_v is Heat capacity of the oscillations which is written in the form.

$$C_v = \left(\frac{dE}{dT}\right)_v = N.k_B.\left(\frac{\hbar.\omega}{\tau}\right)^2.\frac{e^{\hbar\omega/\tau}}{\left(e^{-\hbar\omega/\tau}-1\right)^2}$$

Equation 3N is written for three-dimensional N atom oscillations. Because each atom has three degrees of freedom. N atomic energy in a single direction due to tremble vibrations;

$$E_x = N_x.k_B.T$$

3N equation can be identified as the phonon energy. For the most part, in a homogeneous material, thermal conductivity factor is described by assuming that heat conduction is continuous and the thermal conductivity factor in the single direction is given by the following relation [16] [17].

$$K = \frac{N.\bar{V}_x.k_B.\lambda}{6}$$

In this analysis, mathematical explanations of electrons moving in the material and reflected back from the surface are strong. This situation can be removed from the surface by imaginary mirror placed on the surface. The expected arrival of an electron at x distance without collision is exp (x/λ) for x≪λ. The probability of collision at the end of an electron dx interval is dx/λ. According to the figure 1, the possibility of collision last for II, III, I ways of the electrons at dx distance is as follows.

a) Electron flow   b) Mirror Acceptance
Fig.1: Direction of movement of electrons in relation to energy transport

The probability of total collisions of electrons in the surface section along the medium might be written as follows [8] [13].

$$\int\limits_{-\infty}^{\infty} \exp\left[-\frac{|x-s|}{\lambda}\right].\frac{ds}{\lambda}.\frac{dx}{\lambda}$$

Where the distance of the "x" atoms and "λ" is the electron free path [18]. The lower limit of the integral (-∞) in this equation shows the electrons returning from the surface into the material.

Electron movement is described in figure 1. Electron phonon collision result, the net energy transfer from electrons to phonons is written as follows.

$$\Delta E_{x,t} = \int_{-\infty}^{\infty} \exp\left[-\frac{|x-s|}{\lambda}\right] \cdot \frac{ds}{\lambda} \cdot \frac{dx}{\lambda}_{.f.} \left(E_{s,t} - E_{x,t}\right)$$

The Es,t and Ex,t sequences in this form are the energies of electrons and atoms at one point, respectively. The parameter f is the percentage of energy that the electron gives to the atom during the atomic collision and $f = 10^{-4}$ is taken [19] [20]. The change in the passage of heat from a homogeneous medium which is a formula of distance x is written by the following equation.

$$\frac{dI}{dx} = -\delta.I(x)$$

Absorption coefficient is denoted by δ. The negative sign here states a decrease in beam intensity thanks to absorption of the positive magnitude [21]. If we integrate this equation;

$$I = I_o.\exp(-.x)$$

Here; Io is the maximum intensity of the incoming laser beam. Because of this reason, using the afore function for the high level intensity of the incoming laser beam, the energy absorbed during dt time domain dx might be given as:

$$\Delta E_{x,t} \Big|_{abs} = I_o.\delta.e^{-\delta.x}.A.dt.dx$$

The overall energy augment in metal during dt time at dt [22];

$$N.A.(E_{x,t+dt} - E_{x,t}).dx = \Delta E_{x,t} + \Delta E_{x,t} \Big|_{abs}$$

For this reason, the total energy transfer equation is [23]:

$$N.A.(E_{x,t+dt} - E_{x,t}).dx = I_o.\delta.\exp(-\delta.x).A.dt.dx$$

$$+ \int_{-\infty}^{\infty} \frac{N.\overline{V}_x}{6.\lambda^2} . \exp\left(-\frac{|x-s|}{\lambda}\right).f.\left(E_{s,t} - E_{x,t}\right).ds.A.dt.dx$$

The "V" in this form refers to the electron velocity. If the energy transfer in electron atomic collision is written in terms of electron and atomic temperatures, the formula is arranged as follows [24]:

$$\frac{dT(x,t)}{dt} = \frac{I_o.\delta}{\rho.Cp}\exp(-\delta.x) - \frac{K.f}{2.\lambda^2.\rho.Cp}T(x,t)$$

$$+ \frac{K.f}{4.\lambda^3.\rho.Cp}\left[\int_0^{\infty}\exp\left(-\frac{|x+s|}{\lambda}\right)T(s,t).ds\right.$$

$$+\int_0^x\exp\left(-\frac{|x-s|}{\lambda}\right)T(s,t).ds + \int_x^{\infty}\exp\left(-\frac{|x-s|}{\lambda l}\right)T(s,t).ds\Bigg]$$

III.   MATHEMATIC MODEL OF HEAT CONVECTION WITH KINETIC THEORY APPROACH

If an atom moving outward from the surface is in the vapour phase, the applied counter forces slow down the atom. If the atom's initial kinetic energy allows escape, the atom is vaporized [25]. The escape will be equal to the latent heat of evaporation. The initial minimum value required for escape Vx [26]:

$$\frac{1}{2}m.V_x^{\ 2} = U_o$$

The velocity distribution of the molecules according to Maxwell law is written as follows:

$$f(V_x).dV_x = \left[\frac{m}{2.\pi.k_B.T}\right]^{1/2}.\exp\left[\frac{-m.V_x^{\ 2}}{2.k_B.T}\right].dV_x$$

Hence, the number of molecules separating the surface during time dt is:

$$N.\ f(Vx).dVx.Vx.dt$$

Here N is the number of molecules on the surface of the unit volume. All these atoms with velocities greater than Vmin will be able to move away from the surface. G is the unit field, and the unit is the number of atoms evaporating is written as follows:

$$G = N.\int_{V_{min}}^{\infty} f(x).V_X.dV_X$$

$$G = N.\left[\frac{m}{2.\pi.k_B.T}\right]^{1/2}.\frac{1}{m}.\int_{\frac{1}{2}mV^2}^{\infty}\exp\left[\frac{-m.V_x^{\ 2}}{2.k_B.T}\right].\frac{d(mV_x^{\ 2})}{2}$$

$$G = N.\left[\frac{k_B.T}{2.\pi.m}\right]^{1/2}\exp\left[-\frac{U_0}{k_B.T}\right].$$

Where using this formula $V_0 = \frac{1}{2}.m.V^2$, Vs is velocity of the evaporation of surface and can be written as:

$$\frac{G}{N} = V_s = \left[\frac{k_B.T}{2.\pi.m}\right]^{1/2}\exp\left[-\frac{U_0}{k_B.T}\right].$$

There is no restriction to prevent molecules from escaping inside the cage. However, there will be a gap in the cage area behind the unreleased molecules. This space is filled by the free energy and other free molecules. The molecules released in the cage immediately form a new equilibrium position. In this way, the molecule is absorbed by a void of metal and can be moved at the lattice level. The average velocity of moving free molecules in the cage is much lower than the thermal velocities Vth [8] [11]. The Vf rate of the free molecules is approximately;

$$V_f = V_{th}.\exp\left[-\frac{U}{k_B.T}\right].$$

Here U is the energy essential to obtain the free molecule. This is important to take into account the energy delivered by free molecules and holes. The number of free molecules in any unit volume (N_f) in the T temperature;

$$N_f = N_0.\exp\left[-\frac{U_1}{k_B.T}\right].$$

The amount of the voids contained in a unit volume [11];

$$N_h = N_0 . \exp\left[-\frac{U_2}{k_B . T} \right].$$

Here U2 is the activation energy. In this case, N_0 is the number of cage places in the unit cell. As a consequence,

$$N_f = N_h$$

But this acceptance is not exactly true.

$$N_{bm} + N_h = N_0 ..$$

The number of conjugated molecule shown in N_{bm}. If μ is the average free path for a molecule that collides with alternative molecules, there is a possibility of a collision at dx is [6]:

$$1 - \exp\left[-\frac{dx}{\mu} \right] = \frac{dx}{\mu}$$

The possibility of collision in a space P_h;

$$P_h = \frac{N_h}{N_{bm} + N_{fm} + N_h} = \frac{N_h}{N_0 + N_{fm}} = \frac{\exp\left[-\frac{U_2}{k_B . T} \right]}{1 + \exp\left[-\frac{U_1}{k_B . T} \right]}$$

The probability of collision with a free molecule is P_m;

$$P_m = \frac{N_{fm}}{N_{bm} + N_{fm} + N_h} = \frac{N_{fm}}{N_0 + N_{fm}} = \frac{\exp\left[-\frac{U_1}{k_B . T} \right]}{1 + \exp\left[-\frac{U_1}{k_B . T} \right]}$$

The probability of collision with a compound molecule is P_{bm};

$$P_{bm} = \frac{1 - \exp\left[-\frac{U_2}{k_B . T} \right]}{1 + \exp\left[-\frac{U_1}{k_B . T} \right]}$$

There are two types of energy carriers that transport molecules. These are free molecules and holes. If the number of free molecules that collide with a space is equal to the number of moving molecules that are separated from the cage by any period at the time dt. This expression describes the results of the transmission energy from any dx cross section due to the escaping mobile molecules of the appropriate number for the free molecule hole collision operation [27] In the elastic collision process, the re-captured molecule will transfer some energy. Transfer energy [24] [28] ;

$$U(s) + 3.k_B . \phi(s,t)$$

Here; ϕ (s, t) is the lattice temperature in the s position at time t. The amount of energy that escaped molecules will take with it

$$U(x) + 3.k_B . \phi(x,t)$$

The energy balance in dx results amount of energy.

$$U(s) - U(x) + 3.k_B . \left[\phi(s,t) - \phi(x,t) \right]$$

Where U (s) is the activation energy in the free position of the molecule s and is usually a function of the temperature. But

since the surface is surrounded by molecules with a small amount, there is a decrease in the surface Vo. The number of free molecules separated from ds to dx in the time dt after a collision, where the molecules held in the eye are transferred from the energy ds section to the dx section;

$$N_{sx}. A. \bar{U}_{sx}. dt. \frac{ds}{\mu}$$

Here; Usx is the relative velocity of the free molecules from s to x. The probability of collision of these molecules first in the dx section;

$$N_{sx}. A. \bar{U}_{sx}. dt. \frac{ds}{\mu}. \frac{dx}{\mu}. \exp\left(-\frac{|x-s|}{\mu}\right)$$

The number of collisions with the free molecules is:

$$N_{sx}. A. \bar{U}_{sx}. dt. \frac{ds}{\mu}. \frac{dx}{\mu}. \exp\left(-\frac{|x-s|}{\mu}\right). P_{fm}$$

The number of the collisions with escaping molecules is [11]:

$$N_{sx}. A. \bar{U}_{sx}. dt. \frac{ds}{\mu}. \frac{dx}{\mu}. \exp\left(-\frac{|x-s|}{\mu}\right). P_{bm}$$

The number of collision with the holes is:

$$N_{sx}. A. \bar{U}_{sx}. dt. \frac{ds}{\mu}. \frac{dx}{\mu}. \exp\left(-\frac{|x-s|}{\mu}\right). P_{h}$$

The amount of energy that the molecule transfers during the collision with a vacancy is;

$$U(s) - U(x) + 3.k_B.\left[\phi(s,t) - \phi(x,t) \right]$$

The amount of the energy transferred by the molecule during the collision with a bound molecule is:

$$\frac{1}{2}.g.k_B.\left[\phi(s,t) - \phi(x,t) \right]$$

Herewith, the energy which is transferred to the cross section dx from all the fields in ds is:

$$\frac{\Delta E}{A.dx.dt} = \int_{-\infty}^{\infty} \frac{N_{sx}}{2.\mu^2}. \bar{U}_{sx}.h.k_B.P_{fm}.\exp\left(-\frac{|x-s|}{\mu}\right)\left[\phi(s,t) - \phi(x,t) \right]ds$$

$$+ \int_{-\infty}^{\infty} \frac{N_{sx}}{2.\mu^2}. \bar{U}_{sx}.g.k_B.P_{bm}.\exp\left(-\frac{|x-s|}{\mu}\right)\left[\phi(s,t) - \phi(x,t) \right]ds$$

$$+ \int_{-\infty}^{\infty} \frac{N_{sx}}{2.\mu^2}. \bar{U}_{sx}.P_{h}.\exp\left(-\frac{|x-s|}{\mu}\right)\left[U(s) - U(x) + 3.k_B.\left[\phi(s,t) - \phi(x,t) \right] \right]ds$$

Thus, taking into account the transmission equation involving convection effects, the transmission and convection equation for the kinetic theory that gives the temperature distribution is written as follows [8] [29]

$$\frac{dT(x,t)}{dt} = \frac{I_o.\delta}{\rho.Cp}\exp(-\delta.x) - \frac{K.f}{2.\lambda^2.\rho.Cp}T(x,t)$$

$$+ \frac{K.f}{4.\lambda^3.\rho.Cp}\left[\int_0^{\infty}\exp\left(-\frac{|x+s|}{\lambda}\right)T(s,t).ds\right]$$

$$\left. + \int_0^x \exp\left(-\frac{|x-s|}{\lambda}\right) T(s,t).ds \quad + \int_x^\infty \exp\left(-\frac{|x-s|}{\lambda}\right) T(s,t).ds \right]$$

$$-\frac{P_{fm}.h.K^m}{2.\mu^2\rho.Cp}.T(x.t) + \frac{P_{fm}.h.K^m}{4.\mu^3.\rho.Cp}. \left[\int_0^\infty \exp\left(-\frac{|x+s|}{\mu}\right) T(s,t).ds \right.$$

$$\left. + \int_0^x \exp\left(-\frac{|x-s|}{\mu}\right) T(s,t).ds \quad + \int_x^\infty \exp\left(-\frac{|x-s|}{\mu}\right) T(s,t).ds \right]$$

$$-\frac{P_{bm}.g.K^m}{2.\mu^2.\rho.Cp}.T(x.t) + \frac{P_{bm}.g.K^m}{4.\mu^3.\rho.Cp}. \left[\int_0^\infty \exp\left(-\frac{|x+s|}{\mu}\right) T(s,t).ds \right.$$

$$\left. + \int_0^x \exp\left(-\frac{|x-s|}{\mu}\right) T(s,t).ds \quad + \int_x^\infty \exp\left(-\frac{|x-s|}{\mu}\right) T(s,t).ds \right]$$

$$-\frac{P_h..K^m}{2.\mu^2.\rho.Cp}.T(x.t) + \frac{P_h..K^m}{4.\mu^3.\rho.Cp}. \left[\int_0^\infty \exp\left(-\frac{|x+s|}{\mu}\right) T(s,t).ds \right.$$

$$\left. + \int_0^x \exp\left(-\frac{|x-s|}{\mu}\right) T(s,t).ds \quad + \int_x^\infty \exp\left(-\frac{|x-s|}{\mu}\right) T(s,t).ds \right]$$

$$-\frac{3}{2}.\frac{P_h.K^m}{\mu^2.\rho.Cp}.T(x.t) + \frac{3}{4}.\frac{P_h.K^m}{\mu^3.\rho.Cp}. \left[\int_0^\infty \exp\left(-\frac{|x+s|}{\mu}\right) T(s,t).ds \right.$$

$$\left. + \int_0^x \exp\left(-\frac{|x-s|}{\mu}\right) T(s,t).ds \quad + \int_x^\infty \exp\left(-\frac{|x-s|}{\mu}\right) T(s,t).ds \right]$$

Mathematical Modelling of Pulse Heating

The output of the beam from the solid lasers peaks in a few millimetres. The series of these peaks rise and eventually result in a fall. In the pulsed heating process, β and ζ are chosen appropriately. These two exponential functional analytical equations are used and parameters give rise time. I_1 is the maximum amplitude determined.

$$I_0 = I_1.\left[\exp(-\beta t) - \exp(-\zeta t)\right]$$

In order to see the effect of the impulse in the temperature distributions, the impulse N is modified to remain equal to the total power density and is shown in Figure 2.
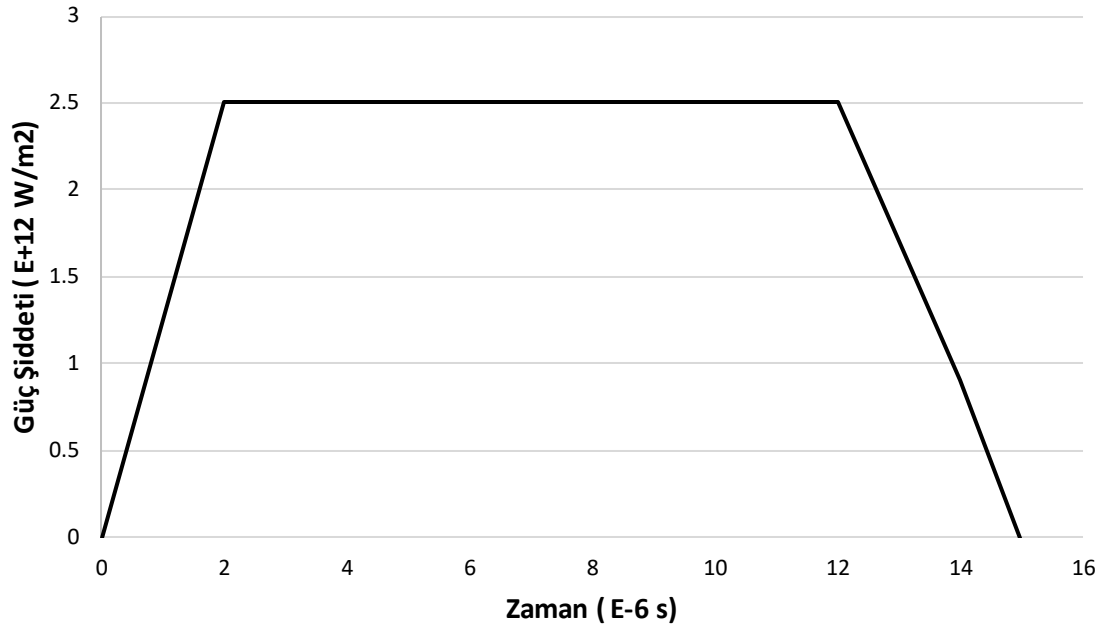
Fig.2: The change in power density of the pulsed laser over time.

Pulse Heating Analysed and Numerical Solution

During the laser-material interaction, the distribution of temperature in the material was analysed in one dimension depending on the time. In this study, the analysis of the temperature distributions during the interaction of the laser power of 1.10^{10} W/m^2 and 5.10^{10} W/m^2 with the laser power intensity of Steel, Nickel, Tantalum and Titanium materials was made according to kinetic theory.

The temperature variations at the material surface during the interaction of steel, nickel tantalum and titanium materials, respectively, with laser intensities of power densities of 1.10^{10} W/m^2 and 5.10^{10} W/m^2, found according to the electro kinetic theory approach which is given in Figures 3 and 4.

Times of melting temperature of materials;

	1.10^{10} W/m^2 Power Intensity	5.10^{10} W/m^2 Power Intensity
Steel	0.014 μsn,	0.0028 μsn,
Nickel	0.0174 μsn,	0.0035 μsn,
Tantalum	0.0224 μsn	0.00448 μsn
Titanium	0.0149 μsn	0.00298 μsn
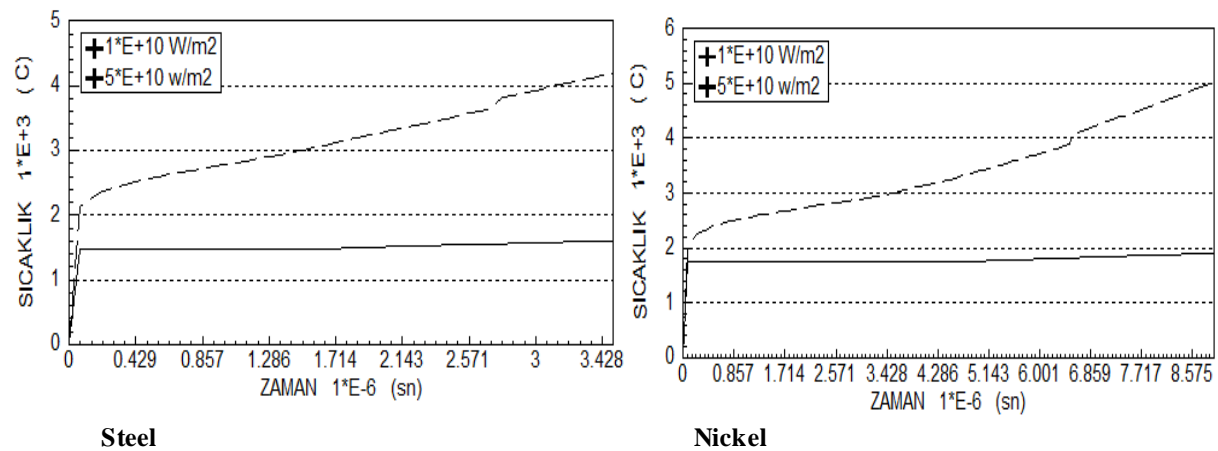
Steel   Nickel

Fig.3: Time-dependent variation of the temperature distribution of the steel and nickel material surface during the interaction with the laser beam at the power densities of 1.10^{10} W/m^2 and 5.10^{10} W/m^2, respectively, by electrokinetic theory approach.
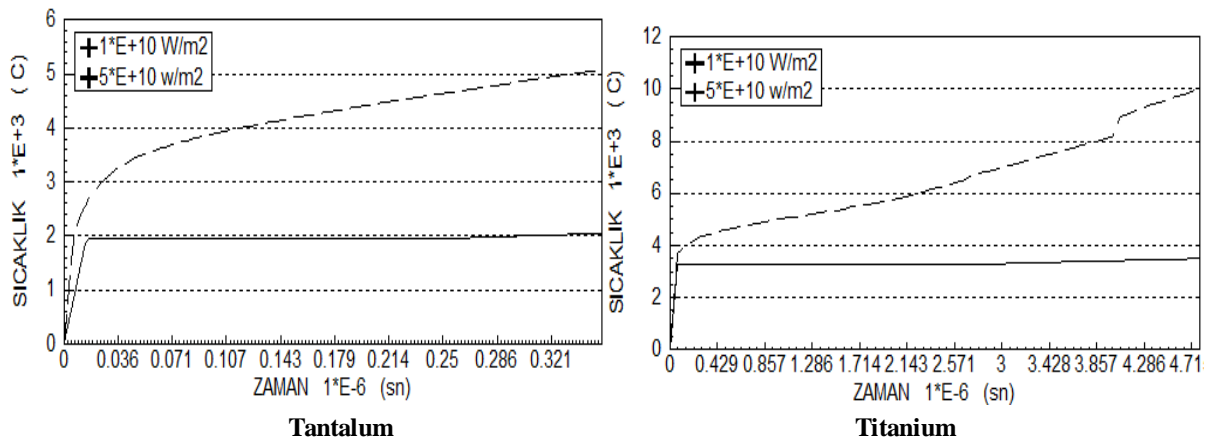
Tantalum   **Titanium**

Fig.4: Time-dependent variation of the temperature distribution of the tantalum and titanium material surface during the interaction with the laser beam at the power densities of 1.10^{10} W/m² and 5.10^{10} W/m², respectively, by electro kinetic theory approach.

As can be seen from these figures, at a power density of 1.10^{10} W/m², the temperature of the material surface step-up rapidly until the melting temperature, then the temperature proceeds constant until the phase change is completed at the melting temperature. At a power density of 5.10^{10} W/m², the temperature increases slowly until it reaches the melting temperature, then increases slowly after reaching the melting temperature. The reason for this is that in high power density phase change occurs in a shorter period.
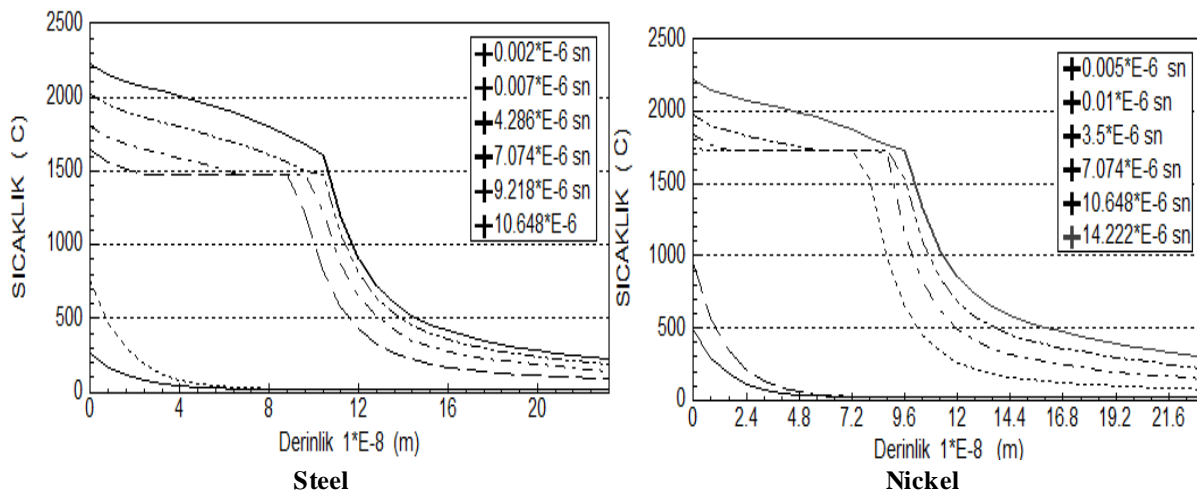
Steel   **Nickel**

Fig.5: Variation of the temperature distributions in the material according to material depth found by the electro kinetic theory approach during interaction with the laser beam at the power density of 1.10^{10} W/m² the steel and nickel.
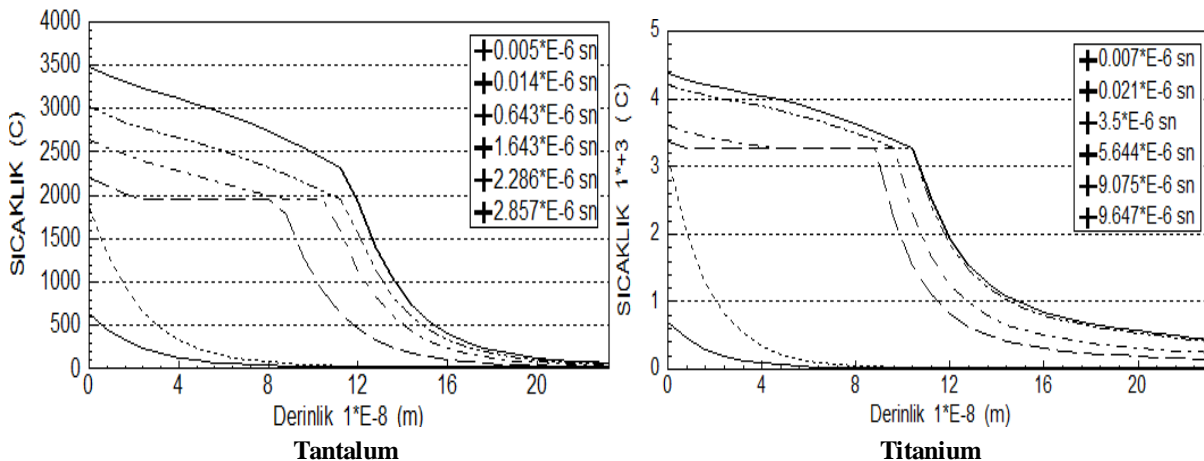
Tantalum   **Titanium**

Fig.6: Variation of the temperature distributions in the material according to material depth found by the electro kinetic theory approach during interaction with the laser beam at the power density of 1.10^{10} W/m² the tantalum and titanium.

Figures 5 and 6 show the temperature distributions of the material depth at various times according to the electro kinetic theory approach of the interaction of steel, nickel, tantalum and titanium materials with the power density of 1.10^{10} W/m² power density, 5.10^{10} W/m² power density, respectively, in figures 7 and 8.
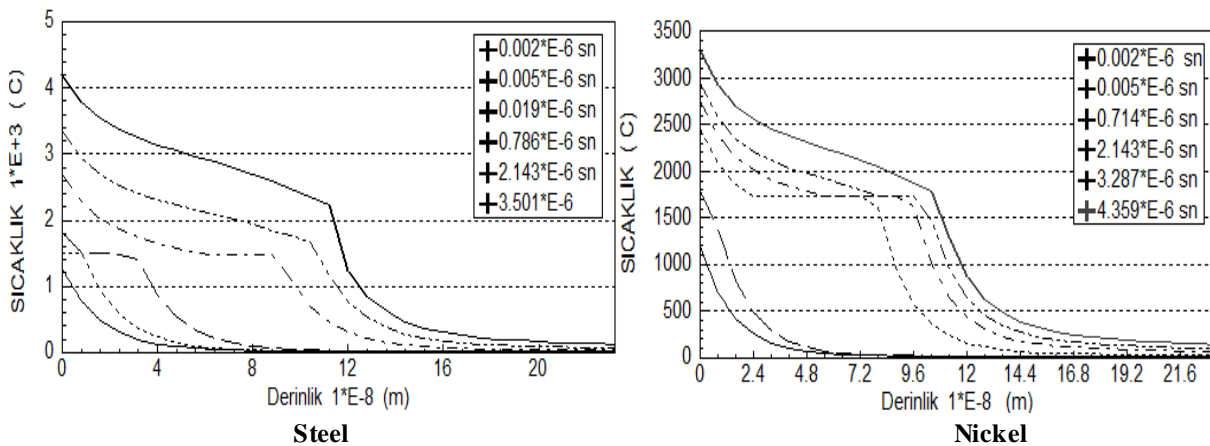
Steel   **Nickel**

Fig.7: Variation of the temperature distributions in the material according to material depth found by the electro kinetic theory approach during interaction with the laser beam at the power density of 5.10^{10} W/m² the steel and nickel.
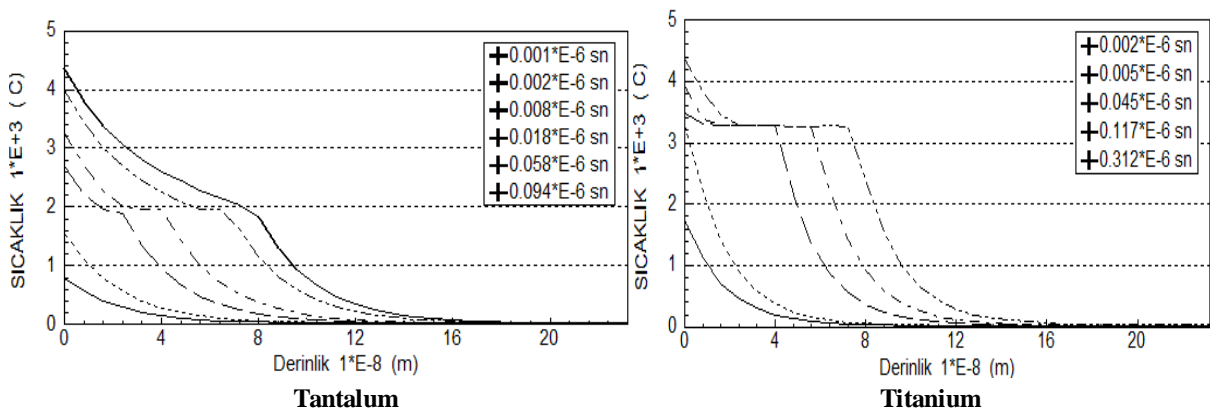
Tantalum   **Titanium**

Fig.8: Variation of the temperature distributions in the material according to material depth found by the electro kinetic theory approach during interaction with the laser beam at the power density of 5.10^{10} W/m² the tantalum and titanium.

As shown, material is coming reduction occurs at the correct temperature to the depth from the surface temperature distribution in the liquid phase at least one exponential by showing decreased and remained stable at the phase change temperature, then showed a rapid decline in exponential solid phase then continues as asymptotically. Phase change material in the surface temperature increases, the temperature remains constant, decreases gradually in the liquid layer.

IV.   CONCLUSION

When the surface of the material upon temperature increase take into account, the results of analysis made by electro kinetic theory approach can be considered in three regions. The solid phase found in the first zone. Although it appears linear graph very slight increase in temperature continues until the melting point of the parabolic. The energy density at low temperatures of the liquid phase of the second, first remains constant and then increases gradually. In this case the energy of the electrons and the kinetic energy increases

pausing of atoms that is defined and explained by the increase in potential energy is converted into latent heat needed to phase changes. However, when high concentrations of the phase change material in contact with the laser beam is formed within a shorter time.

When analysed as a time-dependent increase in surface temperature; heat transfer coefficient and absorption coefficient of the small increase in surface temperature of the material was determined to be faster than large ones. In contrast, materials with large heat transfer coefficient, the surface temperature increase becomes slow and material temperature increases towards depth is more rapid.

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Comparison of Step Response Characteristics of Simple Fractional Order Systems and Second Order Systems

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Abstract--_The step response characteristics of first and second order systems are well known. On the other hand, the step response of fractional order systems (FOSs) with 2-term fractional denominator is like those of first and second order systems. But there are important differences between the two types of characteristics. Considering the step response, the behavior of simple FOS with a denominator polynomial having unity term and the other involves fractional power is investigated in this paper comparatively with 1st and 2nd order systems. The results bring light for the design of fractional order control systems (FOCSs)._

Keywords— *Fractional order, control system, step response, time constant, rise time, overshoot.*

I. INTRODUCTION

With increasing technology and high-speed computers, new numerical methods for modelling and solving physical systems have been presented. FOSs have founded many applications not only in this respect, but they also constitute more realistic models for physical phoneme. Therefore, plenty of literature has appeared for analyzing and designing these systems in the last two decades [1-5]. Especially, fractional order proportional integral derivative (FOPID) controllers have appeared extensively in control system design [6-8].

As some examples on very recent literature, [9] presents a FO positive position feedback compensator and it is compared to the standard integer-order one for active vibration Control of a rectangular free-edged carbon fiber composite plate. In [10], FO control of dissimilar redundant actuating system is used in large passenger aircraft; two dissimilar actuators used for position control surface are modelled by fractional orders and three FO controllers are used to improve transient response of the system. In [11], it is aimed to solve the stability problem for some FO nonautonomous systems by linear state feedback control

and adaptive control; a new property for Caputo fractional derivative is used to derive some sufficient conditions for the global asymptotical stabilization.

Considering sophisticated and rather special applications [12-17], there are a huge number of publications about FOSs; so only very few of them are referred in this paper. On the other hand, a compact publication investigating the step response characteristics of even simple FOSs, namely rise time, settling time, delay time, overshoot, oscillation period, damping time constant of oscillations, and some others which do not exhibit similarity with those of integer order systems [18] is not yet present. The purpose of this paper is to draw attention to the differences between the step response characteristics of simple FOSs and 1st and 2nd order systems and thus to supply some lights for FOCSs' designers.

For the mentioned purpose, time domain characteristics of first and second order systems are reviewed in Section 2. In Section 3, the step response characteristics of o a FOS with 2-term denominator are presented depending on the fractional power. Section 4 discusses and lists the differences between 2nd order and fractional order characteristics. Section 5 covers the conclusions.

II. REVIEW OF FIRST AND SECOND INTEGER ORDER SYSTEMS

It is well known that the simple first order transfer function

$$H_1(s) = \frac{1}{p_1 s + 1} \qquad (1a)$$

has a step response

$$y_1(t) = 1 - e^{-t/p_1} \qquad (1b)$$

monotonically increasing from 0 to 1 with a time constant $\tau = p_1$ [18]. The dc gain is assumed to be 1 which is not important for relative time domain characteristics.

For the second order transfer function,

$$H_2(s) = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2} \qquad (2a)$$

is the standard form where ω_n is undamped natural frequency and $\xi \geq 0$ is the damping ratio [18].

Overdamped step response

$$y(t) = 1 - \frac{1}{\tau_2 - \tau_1}\left(\tau_2 e^{-\frac{t}{\tau_2}} - \tau_1 e^{-\frac{t}{\tau_1}}\right), \qquad (2b)$$

occurs for for $\xi > 1$, where two time constants are $\tau_1 = 1/\omega_n\left(\xi + \sqrt{\xi^2 - 1}\right)$ and $\tau_2 = 1/\omega_n\left(\xi - \sqrt{\xi^2 - 1}\right)$ so that it increases monotonically from 0 to its final value 1. For $\xi = 1$, the response is similar in shape to the overdamped case, but the variation is described by

$$y(t) = 1 - e^{-\omega_n t}(\omega_n + 1) \qquad (2c)$$

which is known as critically damped case.

Underdamped response occurs for $0 < \xi < 1$. The response

$$y(t) = 1 - \frac{e^{-\xi\omega_n t}}{\sqrt{1-\xi^2}}\sin\left(\sqrt{1-\xi^2}\omega_n t + \sin^{-1}\sqrt{1-\xi^2}\right) (2d)$$

is stable and approaches to the reference value 1 with damped oscillations with frequency $\sqrt{1-\xi^2}\omega_n$ and damping time constant $1/\xi\omega_n$. The special case of oscillatory response occurs for $\xi = 0$, the system is undamped, and the step response is

$$y(t) = 1 - \cos\omega_n t \qquad (2e)$$

which represents sustained oscillations with frequency ω_n and undamped oscillation period $T_n = 2\pi/\omega_n$.

All the step responses considered so far stars from 0 at time $t = 0$ and approaches to 1 monotonically or oscillatory manner as $Lim\ t \to \infty$ (except the undamped case $\xi = 0$). The following time domain characteristics are defined for these responses:

Time constant τ: Time required for the response to reach $1 - (1/e)$ of its final value.

Rise time T_r: Time required for the response to reach from 10 % to 90 % of its final value.

Settling time Ts: Time required for the response to stay around its final value with an error less than 2 %.

Oscillation period T_o: Period of oscillations for underdamped case.

Peak time T_{max}: The time the response reaches its maximum value.

Peak value y_{max}: Maximum value of the response; y(T_{max}).

Overshoot y_{osh}: $y_{max} - 1$; How much the response exceeds the final reference 1.

Percent overshoot POSH: It is defined by $(y_{osh}/y_{ref})100$.

Reduction Ratio: RR: Ratio of successive overshoots. From Eq. (1b), it is straightforward to show that

$$\tau = p_1, \qquad (3a)$$
$$T_r = ln9\,p_1 = 2.197225\,p_1, \qquad (3b)$$
$$T_s = ln50\,p_1 = 3.912023\,p_1. \qquad (3c)$$

In summary for a first order system; i) The step response increases exponentially to its steady state value without any oscillations, ii) Rise time and settling time are some multiples of time constant $\tau = p_1$.

From Eq. (2b), the over damped response of a second order systems has

$$\tau: e^{-\tau\omega_n\xi}\sinh\left[\tau\omega_n\sqrt{\xi^2-1} + \cosh^{-1}\xi\right]$$
$$= e^{-1}\sqrt{\xi^2-1}, \qquad (4a)$$
$$T_r = t_2 - t_1, where \qquad (4b)$$
$$e^{-t_1\omega_n\xi}\sinh\left[t_1\omega_n\sqrt{\xi^2-1} + \cosh^{-1}\xi\right] = 0.9\sqrt{\xi^2-1},$$
$$e^{-t_2\omega_n\xi}\sinh\left[t_2\omega_n\sqrt{\xi^2-1} + \cosh^{-1}\xi\right] = 0.1\sqrt{\xi^2-1}$$
$$T_s: e^{-T_S\omega_n\xi}\sinh\left[T_S\omega_n\sqrt{\xi^2-1} + \cosh^{-1}\xi\right]$$
$$= 0.02\sqrt{\xi^2-1}. \qquad (4c)$$

From Eq. (2c), the critically damped response of a second order systems has

$$\tau = [1 + \ln(1 + \omega_n)]/\omega_n, \qquad (5a)$$
$$T_r = ln9/\omega_n, T_s = \ln[50(1 + \omega_n)]/\omega_n, \qquad (5b, c)$$
$$T_s = \frac{1}{\xi\omega_n}ln\frac{50}{\sqrt{1-\xi^2}} = \frac{\tau_e}{2\xi^2}ln\frac{50}{\sqrt{1-\xi^2}}. \qquad (5d)$$

From Eq. (2d), the under damped response of a second order systems has

$$\tau: e^{-\tau\omega_n\xi}\sin\left[\tau\omega_n\sqrt{1-\xi^2} + \sin^{-1}\sqrt{1-\xi^2}\right]$$
$$= e^{-1}\sqrt{1-\xi^2}, \qquad (6a)$$
$$T_r = t_2 - t_1, where \qquad (6b)$$
$$e^{-t_1\omega_n\xi}\sin\left[t_1\omega_n\sqrt{1-\xi^2} + \sin^{-1}\sqrt{1-\xi^2}\right]$$
$$= 0.9\sqrt{1-\xi^2}, e^{-t_2\omega_n\xi}\sin\left[t_2\omega_n\sqrt{1-\xi^2}\right.$$
$$\left. + \sin^{-1}\sqrt{1-\xi^2}\right] = 0.1\sqrt{1-\xi^2},$$
$$T_s \cong \frac{1}{\xi\omega_n}ln\frac{50}{\sqrt{1-\xi^2}}, T_o = \frac{2\pi}{\sqrt{1-\xi^2}\omega_n}, \qquad (6c, d)$$
$$T_{max} = \frac{\pi}{\omega_n\sqrt{1-\xi^2}}, \quad y_{max} = 1 + \frac{e^{\frac{-\xi\pi}{\sqrt{1-\xi^2}}}}{\sqrt{1-\xi^2}}, \qquad (6e, f)$$
$$y_{osh} = \frac{e^{\frac{-\xi\pi}{\sqrt{1-\xi^2}}}}{\sqrt{1-\xi^2}}, \quad POSH = \frac{100e^{\frac{-\xi\pi}{\sqrt{1-\xi^2}}}}{\sqrt{1-\xi^2}}, \qquad (6g, h)$$
$$RR = e^{\frac{-2\xi\pi}{\sqrt{1-\xi^2}}}. \qquad (6i)$$

For the succeeding peaks, Eqs. (6e-i), should be modified by using $(2k - 1)\pi$ instead of π where k represents the

peak numbers; for the first peak $k = 1$ and Eqs. (6e-i) are valid.

From Eq. (2e), the un-damped response of a second order systems has

$$\tau = 1 + \frac{cos^{-1}\left(\frac{1}{e}\right)}{\omega_n}, \qquad (7a)$$

$$T_r = \frac{cos^{-1}(0.1) - cos^{-1}(0.9)}{\omega_n}, \qquad (7b)$$

$$T_s = \infty, \quad T_o = \frac{2\pi}{\omega_n}, \quad T_{max} = \frac{\pi}{\omega_n}, \quad (7c, d, e)$$

$$y_{max} = 2, y_{osh} = 1, \qquad (7f, g)$$

$$POSH = 100, \quad RR = 1. \qquad (7h, i)$$

To be able to make comparisons with the step response

characteristics of the fractional order system dealt with in the next section, and as well as for the sake of completeness, the step responses of the second order system in Eq. (2a) are shown in Fig. 1 for a few values of ξ. In the same respect, some of the time domain characteristics are plotted in Fig. 2. The derived transcendental equations for τ and T_r (see Eqs. (4a,6a) and Eqs. (4a,6b), respectively) are solved numerically to obtain the plots for relevant characteristics in Fig. 2. This approach is not needed for obtaining the remaining characteristics in the figure for the necessary formulas are presented explicitly.
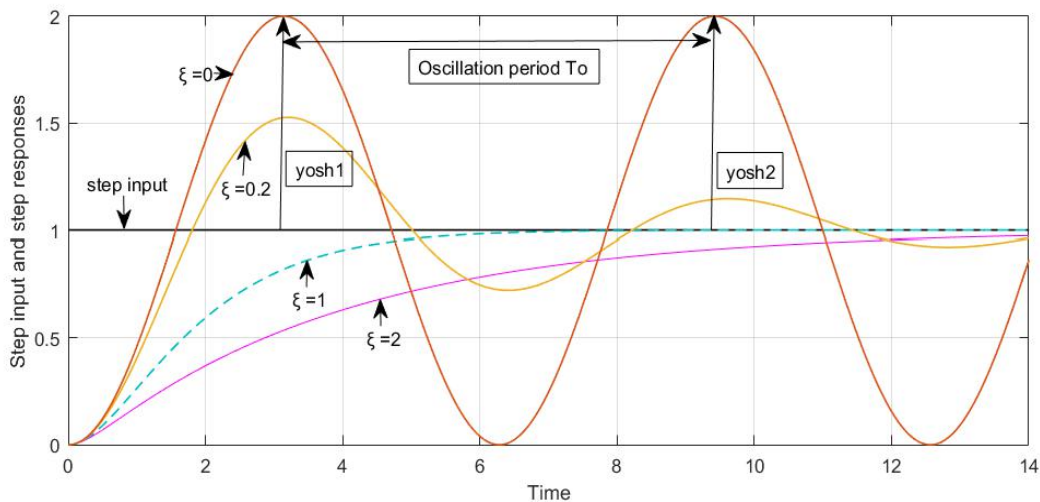
Fig.1: Step responses of the system in Eq. (2a) for values of ξ =2,1,0.2, 0; $\omega_n = 1$.
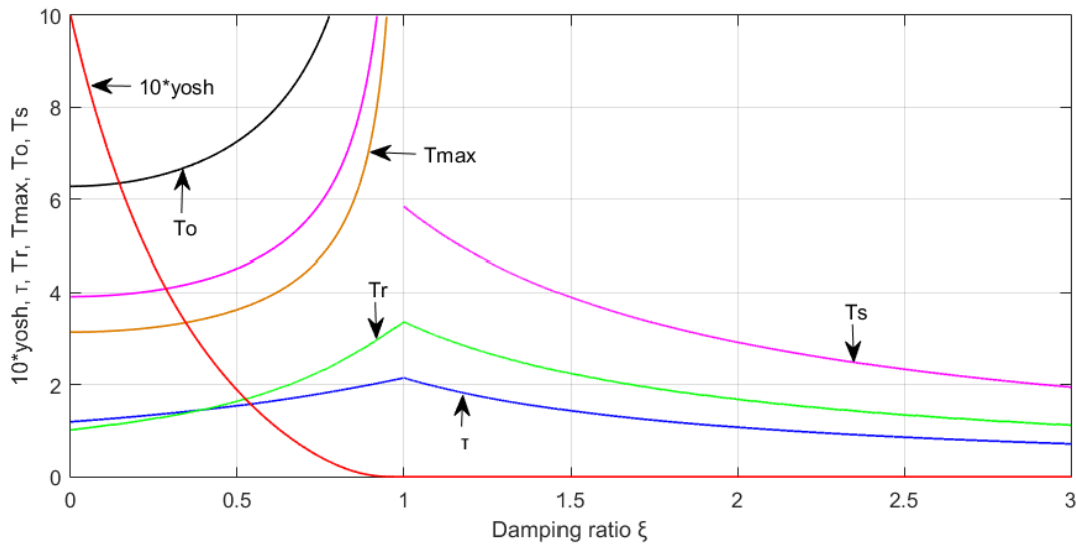
Fig.2: Some time domain characteristics of the system in Eq. (2a) for $\xi \in [0,3]$.

III. INVESTIGATION OF THE SIMPLE FRACTIONAL ORDER SYSTEM

Consider the fractional order transfer function with a constant numerator and 2-term fractional denominator

$$H(s) = \frac{1}{s^\alpha + 1}. \qquad (8)$$

When $\alpha = 1$ (2), the transfer function is a 1st order (2nd order with $\omega_n = 1, \xi = 0$) integer type system.; hence, the step response is an increasing exponential (sustained oscillation). But there are differences in the step responses for the general values of α:

Fig. 3 shows the step responses for $\alpha \in [0.01, 1.99]$. All the responses tend to the reference value 1 as $t \to \infty$, since inserting $s = 0$ and assuming $\alpha \neq 0$ in Eq. (8), dc gain of this system is seen as 1. For small values of α (for eg. $\alpha = 0.01$), the step response is almost equal to ½ (the transfer function is equal to a constant gain of ½ for $\alpha = 0$); except $t = 0$ and $t \to \infty$; for these values, the response starts from 0 and tends to the reference value 1 (this can not be seen in the figure since the final value of t is chosen 30 in simulations). In the figure, exponential like increase of step response for $0 < \alpha \leq 1$, exponential-like decaying oscillations for large α (for eq. $\alpha = 1.99$) are obviously seen. For $\alpha > 1$ but not too much, there is an overshoot in the response then after exponential-like decaying to 1 without oscillations are also seen. For $\alpha > 2$, the system is unstable, and the step response increases exponentially and oscillatory like manner, which is a case not shown in the figure.

We note that those responses for $1 < \alpha \leq 2$ and $0 < \alpha \leq 1$, although resemble to those of a second order and of a first order integer order systems, respectively, there are important differences.
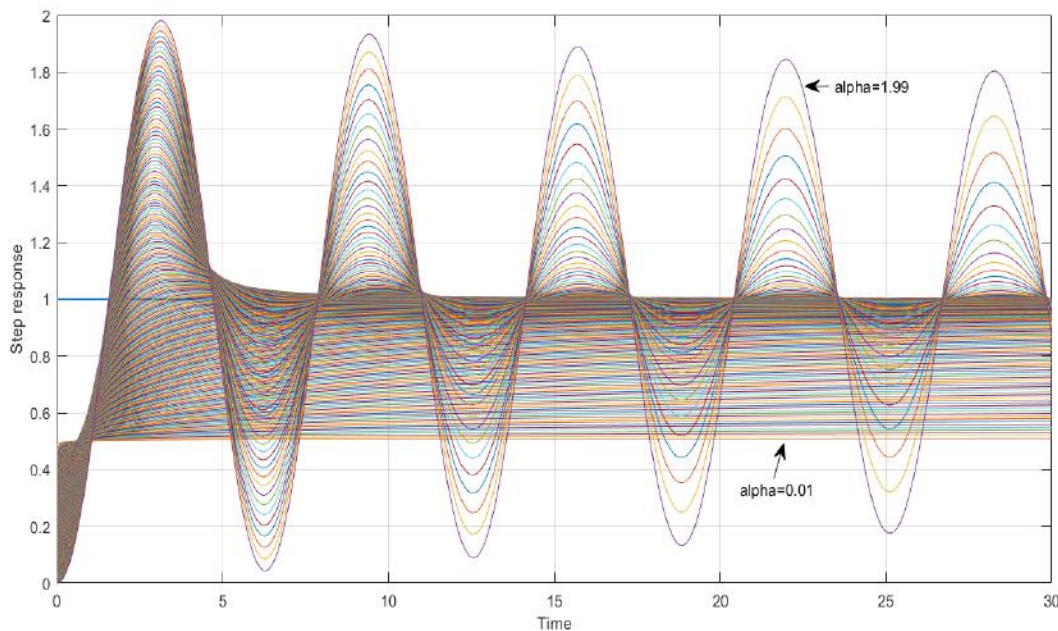
Fig.3: Step responses of the FOS in Eq. (8) for different values of α.

For example, if there exist oscillations, the oscillation period is not constant and naturally the peak times do not occur uniformly as shown in Fig. 4. This figure shows the change of oscillation periods starting from each T_{max}. Numerical data show that the first oscillatory like response (number of maximums = 2) occurs for $\alpha = 1.34$, for which the period of oscillation is 6.1750. But this case is not observed on the graph. The plot starts from the case where there exists 3 maximums and resultantly 2 oscillation periods; this case occurs for $\alpha = 1.49$ for which the first period is 7.188 and the second one is 5.4470. The plot for this case is indicated in the figure. It is seen that the first oscillation period for each α is maximum and it decreases with increasing α. Further, for each α the oscillation period decreases for subsequent oscillations. This decrease reaches to its highest value just before the oscillations stop. For $\alpha = 1.99 \cong 2$, period of oscillations is almost constant being 6.284 for first

oscillation, $6.283, 6.283, 6.284$ for the following 3 oscillations. The change in the 3rd digit after decimal,

though expected since $\alpha = 1.99$, may originate from numerical errors.
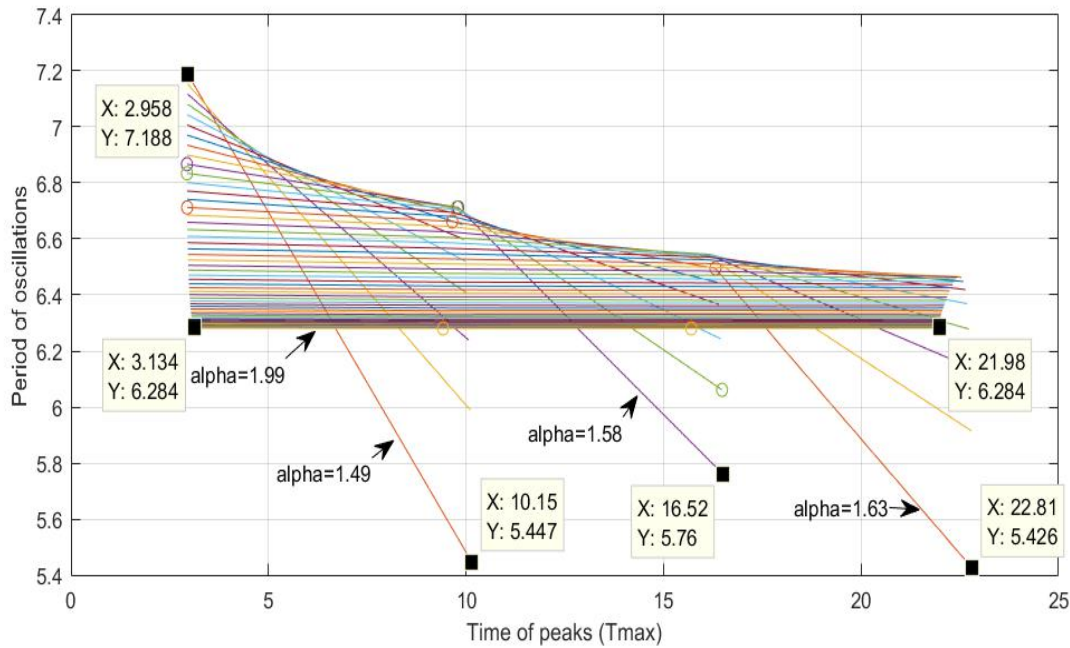
Fig.4: Change of oscillation period with T_{max}.

The exponential decays or increases do not have fixed time constants; hence reduction ratio decreases for succeeding maximum values as seen in Fig. 5. This figure shows the reduction ratio of subsequent peaks. Reduction ratio starts from $\alpha = 1.34$ where at least 2 peaks (maximums) occur for the first time (Reduction ratio = 14.4192) and ends at $\alpha = 1.99$ where 5 peaks occur until $t = 30\ s$. Hence, reduction ratio is defined for the first 4 peaks. In the figure, the plot for $\alpha =$ $1.34, 1.35, \ldots, 1.48$, reduction ratio can't be plotted (since point plot is not used). Therefore, the first curve starts from $\alpha = 1.49$ for which 3 peaks occur, and 2 reduction ratios are defined (20.0430 and 3.3023). It is seen that the reduction ratio from the first peak to the second one decreases as α is changing from 1.49 to 1.99. Further, the ratio of the subsequent peaks for each α decreases with time (or the oscillation number).
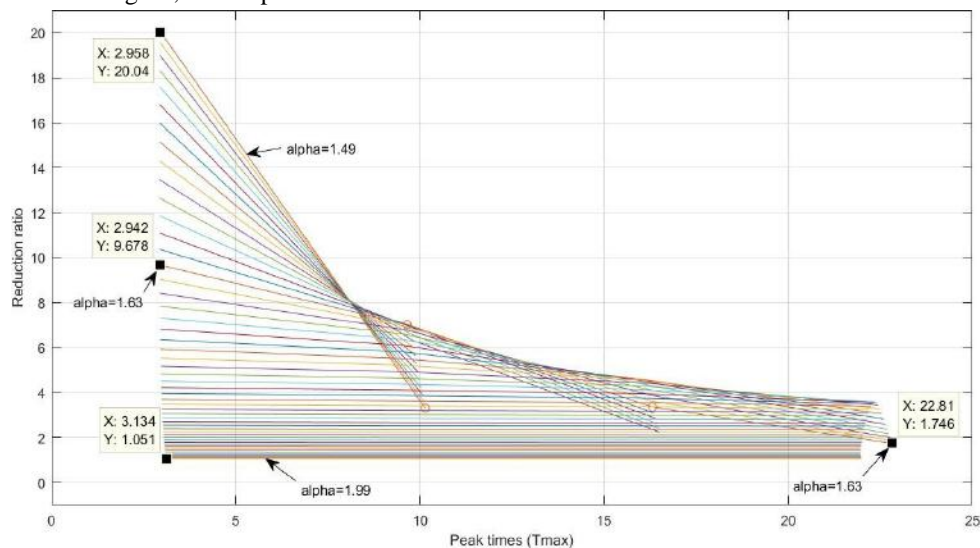
Fig.5: Reduction ratio of subsequent peaks against peak times T_{max}.

The size of overshoots is shown in Fig. 6. For $\alpha = 1.2$, there is a single overshoot which is 0.0744; this is not shown in the graph since there is not a second one so that response is not oscillatory.

In Fig. 6, the values of overshoots are plotted against the time of maximums. The first maximum occurs for $\alpha = 1.01$; since a single point plot is not shown, the plot in the figure is started from $\alpha = 1.34$ where the second peak occurs for the first time; (for $\alpha = 1.34$, the first overshoot and the second one are 0.1640 and 0.0114, respectively). Hence, for $\alpha \in [1.01, 1.33]$ there is one maximum in the step response and no other maximums occur until $\alpha = 1.34$. Note that this last statement is confined to the present numerical data. More elaborate numerical simulation covering values of α to four decimal digits show that this interval is $\alpha \in [1.0001, 1.3395]$, and no other maximums occur until $\alpha = 1.3396$.

In the simulation results shown in Fig. 6, for $\alpha \in [1.63, 1.99]$, there are five peaks in the step response. The overshoots, as a general rule, change so that for each α subsequent peaks decrease, while the rate of decrease gets stronger. Note that among the peaks occurring for $\alpha = 1.67$, the minimum one is the fifth one and it is equal to 0.0001018660; this point could not be data tipped due to the crowdedness of curves near to it, the minimum peak value is found from the workspace data.
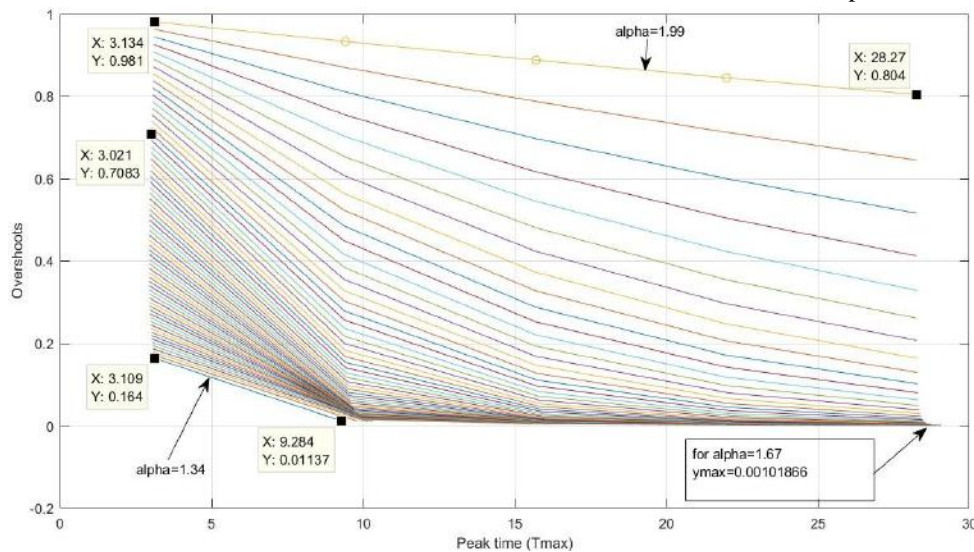
Fig.6: Overshoot against peak times T_{max}.

Fig. 7 shows the maximum value of step response against its occurrence time. This figure is plotted for the case of responses that have at least 2 maximum values for $t \in [0, 30]$. These responses are for $\alpha = 1.34, 1.35, \dots, 1.99$. $\alpha = 1.34$ is the first value of α where at least 2 maximums (hence oscillatory like response) occur. More elaborate numerical simulation shows that this value of α is $\alpha = 1.3396$ (as mentioned) for which oscillatory damping starts with period of oscillation 6.0680. After the oscillations start at $\alpha = 1.34$, the number of oscillations increases with increasing α so that 5 maximums occur for $\alpha = 1.99$ in $[0, 30]$. The time of occurrence of the maximums are not the same; they get near to each other as $\alpha \to 1.99$, and they get more different values as $\alpha \to 1.34$.
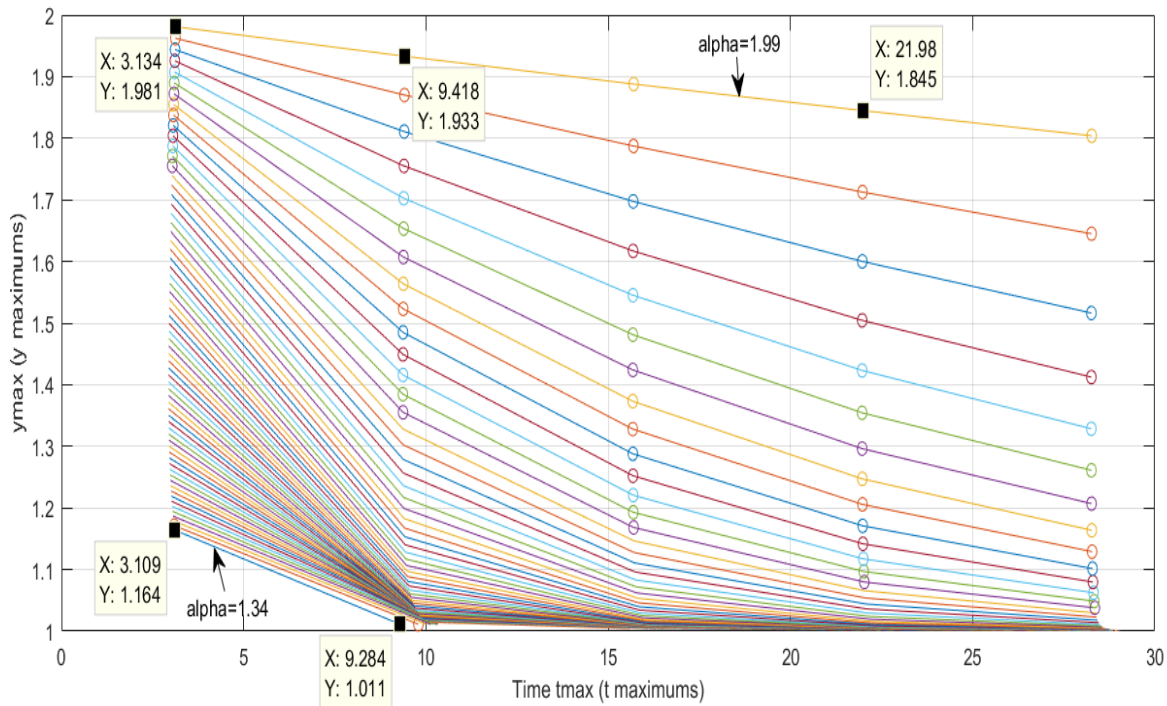
Fig.7: Maximum value of step response against the time of occurrence.

Next, it is worth to observe the change of first oscillation period and the number of peak values in the first 30 s. These are plotted in Fig. 8 . It is observed that there are no oscillations in the step response for $\alpha = 0, 0.5, 1$. For $\alpha = 1.2$, there are no oscillations but there exist 1 maximum with an overshoot of 0.0744 as mentioned before. For $\alpha = 1.7$, $\alpha = 2$, and $\alpha = 2.018$ there are 5 maximums in the interval $t \in [0, 30]$; whilst period of first oscillation changes with α, i.e., it is 6.543 for $\alpha = 1.7$, and it is 6.283 for both $\alpha = 2$ and $\alpha = 2.018$. Note also that period of succeeding oscillations is not constant for the same α.
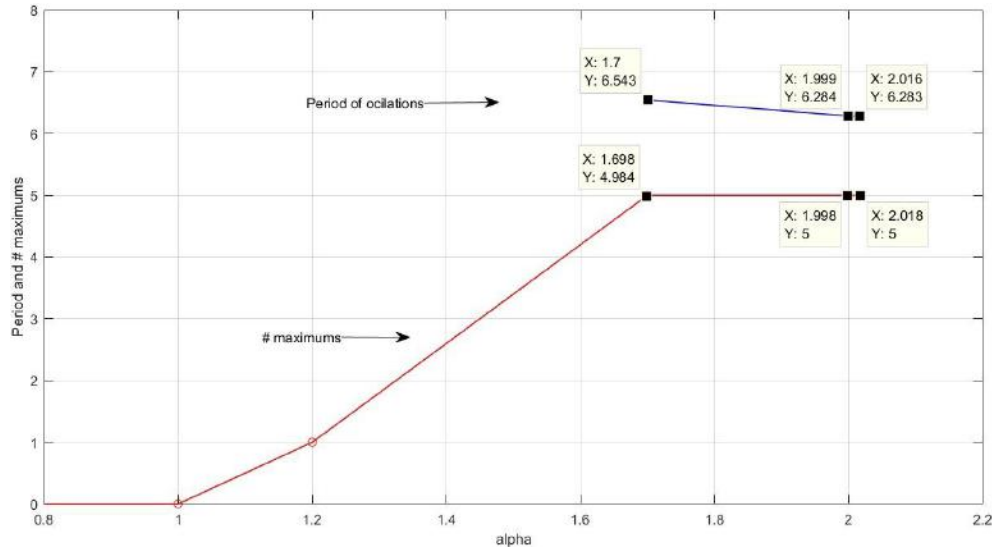
Fig.8: Period of first oscillation and number of peaks in 30 s against α.

In Fig. 9, the variation of the time constant τ, rise time T_r, and settling time T_s are plotted for $\alpha = 0.5, 1, 1.2, 1.7$. It

is seen that τ is the least effected by α. T_r could not be recorded for $\alpha = 0.5$ since it is greater than total run time $t = 30\ s$. For $\alpha = 1, \tau < T_r < T_s$, with values $1.001 < 2.198 < 3.913$. It is important to note that the settling

time gets large very rapidly with increasing α; infact for $\alpha \geq 2$ it is ∞. Therefore, the data for $\alpha = 2$ and $\alpha = 2.018$ is not included in the plot.
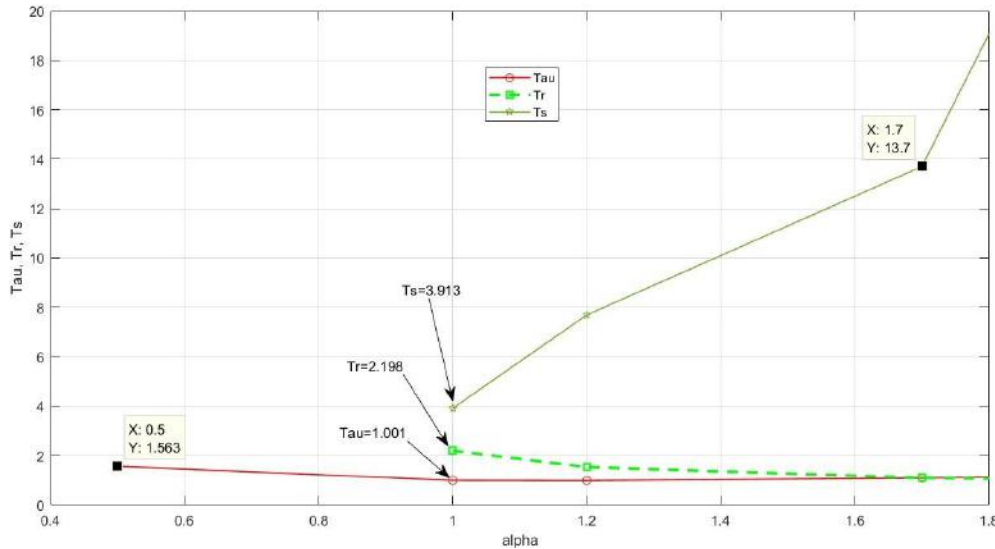
Fig.9: Variation of time constant ($\tau = Tau$), risetime (T_r) and settling time (T_s) with α included in the plot.

Finally, in Fig. 10, the damping ratio ξ of a 2nd order system and the fractional power α of the fractional order system are compared with respect to the overshoot. The

figure can be used for finding the values of ξ and α for the desired overshoot.
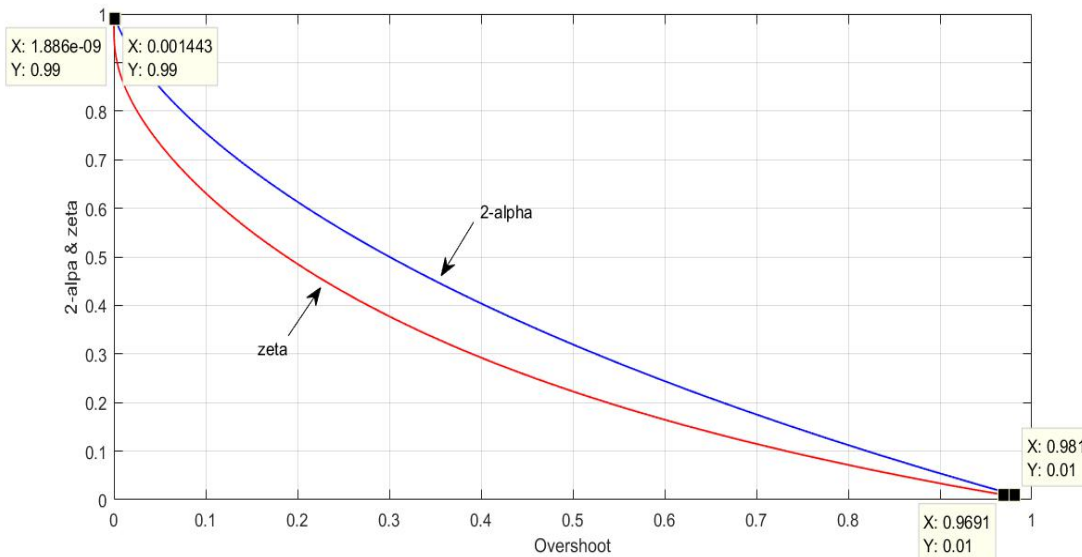
Fig.10: $\beta = 2 - \alpha$ versus overshoot and ξ versus overshoot.

The step response characteristic investigated so far are already enough to highlight the important properties and differences between some simple integer order and fractional order systems. Therefore, this section is ended at this step. However, for a continuous variation of step

response characteristics, such as period of oscillations, number of peaks, τ, T_r, T_s, POSH with the system parameters α and ξ, as well as variation of α for fractional order, and ξ for second order systems with the overshoot can be obtained, these are not included for the length

limitations of the paper. Further, they are not vital to observe the following comparisons.

IV. DIFFERENCES BETWEEN 2ND ORDER AND SIMPLE FRACTIONAL ORDER CHARACTERISTICS

We have the apparent observation from the previous two sections that the following important similarities and differences appear between the step responses of a second order system and the simple FOS considered. The comparison is done on the base of the transfer functions in Eq. (2a) for a second order integer system and Eq. (8) for a FOS. Being considered before, the extreme cases $\alpha = 0,$ $\alpha = 0$, and $\alpha = 2$ are not included in the comparison.

1) All the time domain characteristics of a second order system are expressed by analytic formulas as given in Eqs. (4-7). For FOS, there does not exist such analytical formulas; only graphical dependences on the fractional power α are available. See Figs. 4-9.

2) For $1 \leq \xi$ and $0 < \alpha \leq 1$, both of the systems exhibit monotonically increasing step responses starting from 0 and tending to the final value 1 as $Lim\ t \to \infty$. There is no overshoot in the responses. See Fig. 1 for 2nd order system, and Fig. 2 for fractional one.

3) For $0 \leq \xi < 1$ and $1 < \alpha \leq 2$, both systems generate overshoots which decay to zero and the step responses tend to the final value 1 as $Lim\ t \to \infty$. See Fig. 1 and Fig. 2, respectively.

4) For $0 < \xi < 1$ and $1 < \alpha \leq 2$, although the step responses of both the second order system and that of the FOS are similar in the sense that they are not monotonically increasing, they have overshoots, and they approach to unity at infinite time, they have completely different characteristics:

   a) There are infinitely many overshoots in the step response of the 2nd order system, whilst the number of overshoots in the step response of the fractional system increases with α. For example, there is only one overshoot and naturally one maximum for $1 < \alpha \leq 1.3395$, and the second overshoot starts for $\alpha = 1.3396$. Refer to Fig. 8 to see how the number of maximums (oscillations) increases with α.

   b) The period of sustained oscillations and their damping rate, that is RR, are constant for each $0 < \xi < 1$ and they do not change with time;

they are given by Eqs. (6d) and (6i), respectively. On the other hand, these quantities change with time for FOS; see Fig. 4 for the period of decaying oscillations (oscillation period decreases with time), and Fig. 5 for RR (RR decreases with time).

   c) As seen in Fig. 2, the period of oscillations monotonically increases with ξ for the second order system. On the other hand, as seen in Fig. 5 for the FOS, starting from 6.175 at $\alpha = 1.34$ the duration of the first oscillations first increases and it reaches to its maximum value 7.327 at $\alpha \leq 1.43$ and then decreases to 6.284 at $\alpha = 1.99$.

V. CONCLUSIONS

Time domain step response characteristics of the fractional order system with unity numerator and a 2-term denominator polynomial involving a single fractional power is studied in this paper. Many step response characteristics which are important for control engineering such as rise time, settling time, delay time, overshoot, oscillation period, damping time constant of oscillations, and some others are investigated, and the results are presented in graphical forms by figures. The study is conducted comparatively by considering integer order systems of 1st and 2nd order types. It is shown that the same simplicity and explicitness present for second order systems do not exist between the transfer function parameters and the step response characteristics for low order fractional order control systems. The results bring light for the design such systems which has been a vacancy fulfilled by this paper.

The derived transcendental equations for τ and T_r in Eqs. (4a,6a) and Eqs. (4a,6b), respectively), which have, as far as author knowledge, not been appeared in the literature before, are derived and solved numerically to obtain the plots for relevant characteristics in Fig. 2. This approach is not needed for obtaining the remaining characteristics in the figure for the necessary formulas are presented explicitly. For the simulation of the FOS, the subprograms of FOMCON toolbox of Aleksei Tepljakov [1] integrated with MATLAB R2017 [7] is used.

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The Implementation of Scientific Approach with Project Based Learning Model to Improve Students' Analytical Skill and Responds

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Abstract— *Scientific Approach used in the teaching and learning activities, has become one of the ways that is regulated by the government to improve the students' analytical skills. The Scientific Approach includes "5M" activities namely observing, questioning, experimenting, associating, and communicating. In implementing this approach in Indonesia, the teachers only use two kinds of books: teacher's and student's book; as a reference in the process of learning. One of the learning methods with the scientific characteristics is the Project Based Learning. Project Based Learning is a learning method that uses problems, as the first step to collect and integrate new knowledge, which is based on the real-life experience. The purpose of this research is to improve the students' analytic skill and responsiveness with the application of Scientific Approach-based learning using Project Based Learning Model. In the development of Scientific Approach-based resources with Project Based Learning model to improve the students' analytic skill, it was found that the average point of 3 validators for the lesson plan (RPP) was 4.66%, for the students' worksheet (LKDP) was 4.6% and for the achievement test (THB) was 4.66%; which have met the criteria of valid. Moreover, from the students' responds of the questionnaire, it was found that an average of 73.86% of the students stated that they liked the teaching and learning processes.*

Keywords— **Scientific approach, project based learning, analytic skill, students' response**

I. INTRODUCTION

The development of the era demands an effort to improve the quality of education. This is in line with the continuous development of the educational curriculum in Indonesia. The Ministry of Education and Culture of Indonesia or *Kemendikbud* (2013: 80) stated that the curriculum is an educational instrument to bring Indonesians to possess attitude, knowledge, and skills to be productive, creative, innovative and affective [1]. To realize this educational objective, the Ministry of National Education or *Depdiknas* undertakes the development and improvement of the curriculum. The curriculum development guide which is developed by the National Education Standards Agency or BSNP has a goal of providing opportunities for learners to learn to build and find their identities through an active, creative, effective and an enjoyable learning process. The curriculum is used as the motive and plan, while the implementation is employed in the process of the teaching and learning activities.

In Indonesia, students' analytical skills in understanding mathematics are very low. Anderson & Krathwohl (2010) states that the student' analytical skill is the ability of student to decipher information into smaller elements to determine the interrelationships between elements [2]. To address the problems that arise in the fields of mathematics subject, there is a need of a learning approach that can improve student's analytical skill. Scientific Approach is one approach used in learning which emphasis the use of scientific methods. The learning approach in the implementation of the 2013 curriculum is expected to be directed so that the students are able to not only solving the problems (by answering) but also formulating problems (by questioning). In teaching and learning activity, scientific approach includes some steps to be followed: observing, questioning, experimenting, associating, and communicating. Acording to Hosnan (2014: 34), regarding the scientific learning, "the implementation of 2013 Curriculum with scientific approach is a learning process designed in such a way that learners can actively construct the concepts, laws, or principles through observing stages (to identify or find problems), formulate problems, propose or formulate hypotheses, collect data with various techniques, analyze data, draw conclusions and communicate concepts, laws or principles found "[3] [4].

One of the learning that has scientific approach characteristics is Project Based Learning. Project Based Learning (PBL) is very important to improve the quality of the student activities. It contains several different learning processes [5] [6]. One of the learning subjects related to the real-life experience is the Statistics subject. Statistics is one subject in Mathematics that must be given to the junior high school / MTs students. Statistics material itself is studied by students from elementary school Grade 6 which will be further deepened in junior high school / MTs level. However, many constraints felt by teachers in teaching statistical materials such as presenting data in a pie-chart, including the mean, median and mode of the data, and teaching statistical materials to the students. An alternative approach that can be used in statistics subject is the Scientific Approach, while the learning model that can be used is Project Based Learning. Using scientific approach and PBL, the statistical material will be presented based on the problems close to the learner which require them to use their experience to solve the problem.

Based on a research (Yulistyana, pradita: 2015), after the implementation of project based learning that aimed to improve student achievement and creativity on the colloidal system subject, at Science Class XI in the even semester of Junior High School in Klaten, the students' mastery could reach 38,09% in cycle I and 76,19% in cycle II. Meanwhile, when viewed from the affective aspects of the students, the affective achievement is 78.31%. The application of learning model of Project Based Learning on colloidal system can also improve the students' creativity; students with high creativity is as much as 57,14% in cycle I and 66,67% in cycle II.

The purpose of this study is to improve the students' analysis and responsiveness in the application of Scientific Approach-based learning with Project Based Learning Model on seventh graders at class A, SMPN 1 Ambulu.

II. METHOD

This study is the research and development using Plomp development model. There are 5 phases in Plomp (2010) development model: (1) Initial Investigation, (2) Design, (3) Realization / Construction, (4) Test Phase, Evaluation, and Revision, (5) Implementation Phase. The reason of the researchers use Plomp model is due to the systematic sequence of the activities that is easy to be applied and understood. The population included in this study were students of Class VII A (Academic Year of 2017/2018), SMPN 1 Ambulu. They were in their even Semester. The class consisted of 30 students: 11 male students and 19 female students.

In this study, the researchers used the observation sheet guideline. The observation was a direct observation which

was done directly with the researchers as the observer of the teaching and learning activity. In this observation the authors used the student work sheets (LKPD), the result of the achievement test (THB) and the responses of the questionnaire of the students to the application of Scientific-based learning Approach with Project Based Learning Model. In addition to the author, this observation is also assisted by two observers who have mathematics education background.

The data of the student analytical skill was obtained from the achievement test result on the fifth phase. To know the student's response to the application of Scientific Approach-based learning with Project Based Learning Model, each student was given a questionnaire to be filled. According to Komalasari (2011: 81) questionnaire contains three parts: the title, introduction containing a purpose of the questionnaire, or a guideline to fill in the questionnaires, and the items of questions containing opinions and facts [7].

III. FINDINGS

The teaching and learning resources that have been developed are the lesson plan (RPP), students' worksheet (LKPD) and the achievement test (THB) that have been validated by the validators and met the valid criteria. Presented in Figure 1.
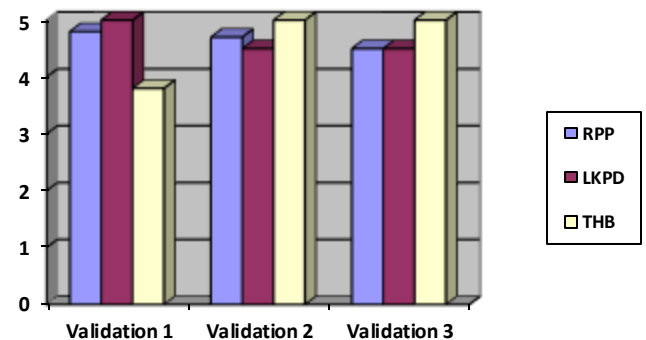
Fig.1: The validation result of the learning resources

From the validation results, the researcher conducted the research at Class VII A of SMPN 1 Ambulu; academic year of 2017/2018 in the even semester. The study consists of 5 cycles.

In the first cycle, the researchers employed lecturing method without the scientific approach. This is done to determine the student's response to the teaching and learning process in class. From the first cycle, it was found that there were 11 out of 30 students who were active in class. From the first cycle, it can be concluded that the lecturing method was less desirable by the students.

After the first cycle, the second cycle of this study used the Scientific Approach-based learning with Project Based Learning Model. The teachers distributed student work sheet (LKPD) to each group that had been formed for discussion. The student worksheet (LKPD) included the 5M stages of scientific approach (observing, questioning, experimenting, associating, and communicating). In the second cycle, the students were active and enthusiastic in following the teaching and learning activities. It was due to the activities which each group member presented the results of their discussion in front of the class; while other groups commented the result of the discussion. For the third and fourth cycles, the researchers used the student work sheets (LKPD) that included Scientific Approach-based learning with the Project Based Learning Model.

The students' analytic ability was obtained from the students' ability to answer the achievement test (THB) in the fifth cycle. The test consisted of 3 questions; each question has different difficulty level. The first and second questions contained moderate analytical skill questions with 30 score each, while the third contained a difficult analytic problem with a score of 40. This can be seen clearly seen at Figure 2.
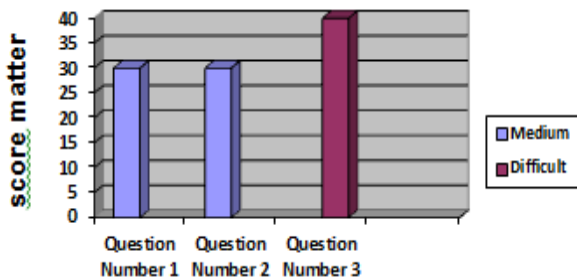
Fig.2: The category of the achievement test (THB)

In the First Cycle of the achievement test, the result showed that there were 10 students from 30 students who scored above the *KKM* or the minimum score to be obtained. On the other hand, there were 20 students scored below the minimum score criterion or *KKM*. The minimum score for mathematics subject is 70 in this school. The result of this cycle is due to the use of lecturing method without loading Scientific Approach or Project Based Project Learning.

In the fifth cycle, the test result from 30 students showed that there were 17 students who had score above the *KKM*, and 13 students who got the score under the KKM or the minimum criterion of the score obtained. The overall average of the succeed-students was 56.7% while the average of students who failed was 43.3%. This result was due to the implementation of Scientific Approach using Project Based Learning.

Regarding the results of the achievement test on the fifth cycle, it can be concluded that the ability of the students to analyze the problem had increased. From the result, we could see that a total of 17 students scored above the minimum criteria compared to the 13 students who scored below the minimum criteria because they were less able to understand each question on the test of learning outcomes.

In each cycle, the researchers also distributed a questionnaire to the students to determine the response of learners on learning activities. In the first cycle, it was found that the students were less attracted to the teaching and learning activity due to the lecturing method. On the other hand, the students engaged in the teaching and learning actively because the researchers have applied Scientific Approach-based learning using Project based Learning model. The students' responses can be seen in Table 1.

Table.1: Students Questionnaire on the Teaching and Learning activities with Scientific Approach Using Project Based Learning model

No.	Aspect	Questions to be responded
1.	Aspect 1	Do you like to follow the teaching and learning process which is based on scientific approach?
2.	Aspect 2	Do you find the learning process, teaching technique, classroom atmosphere, and sitting arrangement desirable?
3.	Aspect 3	Do you think that learning with the worksheet or *LKPD*, as well as stating and expressing ideas or opinion is desirable?
4.	Aspect 4	Do you have sufficient time to have a discussion in solving the problems and expressing your ideas?
5.	Aspect 5	Do you like to have other subjects of the study to employ scientific approach with project based learning model?
6.	Aspect 6	Can you comprehend the language features used in the worksheet?
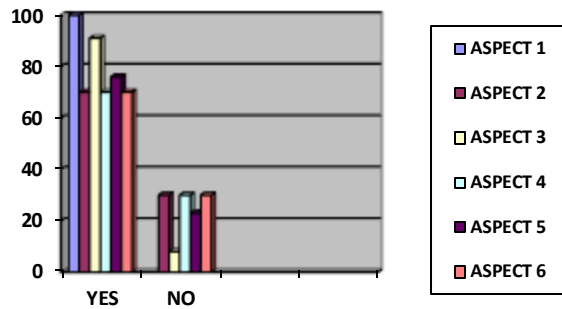
Fig.3: The result of the Student Questionnaire

Figure 3 shows that the students' responses on the questionnaire towards the implementation of the model to improve their analytical skills were very good. From the result of the questionnaire, it can be concluded that there were 73.86% students who liked the implementation of the approach, while there were 26.1% students who disliked the implementation in the teaching and learning activity.

IV. CONCLUSION

The application of scientific approach using project based learning model was able to improve the students' analysis ability in understanding every problem on the achievement test. It was also found that the students' responses from the questionnaire result were very positive. Firstly, it can be seen from the total of 56,7% students who passed the test and 43,3% of students who did not pass. Secondly, the positive responses of the teaching and learning activity were as much as 73.86%, while the negative responses were only 26.1%.

V. SUGGESTION

The implementation of scientific approach using project based learning model should be applied to other subject matters. Using this method, it can not only improve the students' analytic skill, but also improve the students' responses in the teaching and learning activities.

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Search and optimization of the periodic gait of leg locomotion systems

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Abstract— *The task of reproducing artificial legged locomotion presents lots of challenges, most of them related to the system dynamics, which is non-linear, hybrid and under actuated. Recently the scope of legged locomotion changed from static stability to dynamical stability, in which the dynamics of the system plays an important role in the development of control algorithms that have as a main goal the construction of a stable limit cycle. This article projects a periodic control for trot without the air phase for a quadruped though the multiple shooting method with Hermite-Simpson direct collocation. The algorithm was first tested in a monopod where the control for hopping and forward hopping was searched, such that the optimization occurred after finding the periodic gait and for each case the stability of the control was determined through the Floquet Multipliers from Poincare's map. The quadruped system could not be wholly analyzed because the search for the periodic gait failed for the initial estimation, leaving this analysis for future researches.*

Keywords— *Legged locomotion, Monopod, Optimization, Periodic gait, Quadruped, Stability.*

I. INTRODUCTION

The need to explore unhealthy and high risk environments for humans has brought the advent of autonomous robotics. Robots may be used to perform tasks that are too dangerous or difficult for humans to implement directly (e.g. nuclear waste cleanup) or may be used to automate repetitive tasks [1]. If there is one technological advancement that makes human living easier, robot would be the answer [2].

Robots that use the wheel as a means of locomotion have difficulties in dealing with rough terrain, crossing obstacles and moving on non-rigid or soft / penetrating terrain. In order to overcome these adversities, the alternative method of locomotion by legs is used.

Although many systems using leg locomotion have been proposed and constructed, none of them seem to be able to reproduce the elegance, energy efficiency, and apparent ease with which land animals move through various types of terrain and the various gears that they use.

Seeking to imitate these inherent abilities of animals, this article studies the search and optimization of the periodic gait of a quadruped robot locomotion system by legs.

II. METHODS

2.1 System Simulation

Due to the nonlinearity of the system and the complexity of the functions, the model developed does not have a trivial analytic solution. Therefore, the numerical integration was necessary to obtain the system solution, using the MATLAB "ode45" function.

In addition, the "ode45" function allows to define an auxiliary function that determines the occurrence of the pre-established events, interrupting the integration. The events used were: beginning and end of the contact of the feet with the ground. When one of the events occurs, the value at which the simulation stops is used to perform the discrete dynamics according to the established event and then the integration is resumed until the end of the March period or the next event.

2.2 Optimization

The goal of simulation optimization is minimizing the assets spent while amplifying the information acquired in a simulation experiment [3].

This work uses the multiple shooting direct optimization method. The multiple shooting [4] have been gaining much attention in the implementation of optimal control due to its success in many fields of robotics and trajectory optimization [5], [6] e [7].

The nonlinear problem (NLP) was solved using the "fmincon" function of MATLAB. As in [8], the "interior-point" method was chosen for the resolution of gait NLP.

There is no defined methodology for determining the initial conditions of an optimization problem. However, it is considered good practice to start with initial conditions in which equality constraints are met and there is no

violation of inequality constraints. In this work there are only equality restrictions, so the search for the periodic gait occurred before the optimization process, using the "fsolve" function of MATLAB.

2.3 Monopod model

To test the elaborated algorithm, a monopod model was used (Figure 1), which consists of three bodies: the hip, the leg and the foot.
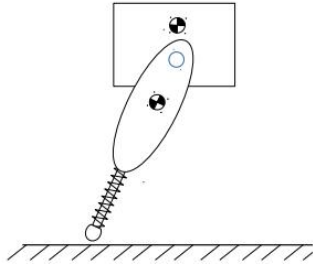
Fig. 1: Monopod scheme

The degrees of freedom that determine the complete dynamics of this system are in Table 1.

Table 1: Monopod generalized coordinates

Variable	Symbol
Hip horizontal position	q_1
Hip vertical position	q_2
Hip angular orientation	q_3
Leg angular orientation	q_4
Leg spring deformation	q_5

The algorithm sought the solution for the monopod in two situations: jump without advance and jump with advance.

2.4 Quadruped model

For the quadrupedal model, the configuration of the prismatic joint presented in [9] was used, because it presents a greater correspondence with the dynamics of locomotion observed in animals. Although the leg of an animal has several segments, this configuration can capture the main dynamics involved in walking, simplifying the system [10]. The configuration of the model is shown in Figure 2.
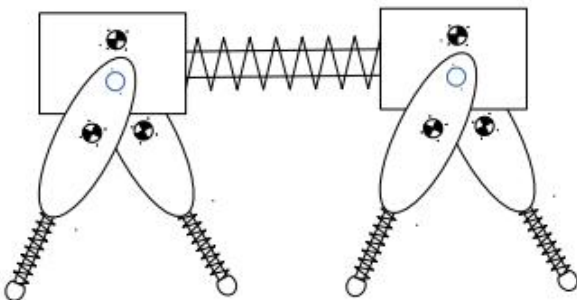
Fig. 2: Quadruped scheme

This model uses the degrees of freedom in Table 2.

Table 2: Quadruped generalized coordinates

Variable	Symbol
Front quarter horizontal position	q_1
Front quarter vertical position	q_2
Angled position of the forequarters	q_3
Angle position of left front leg	q_4
Angle position of right front leg	q_5
Deformation of left front leg spring	q_6
Spring deformation of the right front leg	q_7
Distension of the springs	q_8
Angle position of left rear leg	q_9
Angle position of right rear leg	q_{10}
Deformation of the left rear leg spring	q_{11}
Rear right leg spring deformation	q_{12}

For the quadruped, the gait is limited. The legs on the right side are in antiphase with those on the left side. Another point is that the trot can occur with or without aerial phase.

III. RESULTS AND DISCUSSION

3.1 Monopod results:

For the jump in the same position, only one Fourier series term was used for the initial estimate of the control. She was found by trial and error.

The search process for the periodic condition obtained the solution with the algorithm returning to the parameters of Table 3. The algorithm ended when the stop criterion related to the size of the step standard was obeyed.

Table 3: Periodic search results for Multiple Shooting

Iterations	Evaluated functions	Residual	Optimality	Lambda	Step rule
134	200	3.097e-26	6.33e-11	1e-09	3.296e-11

The periodic solutions returned by the algorithm are in Figures 3 and 4. As in the initial estimation, the other degrees of freedom and their first derivatives remained in the initial conditions throughout the period. The markers represent the value of the states in the final grid of the algorithm, the curve is the result of the integration of the system by the "ode34" function and straight marking the initial condition of the system.

The analysis of the stability of the periodic orbit is in Figure 5. The multipliers that are inside it are stable, those that are on it indicate neutral stability and the multipliers outside are unstable.
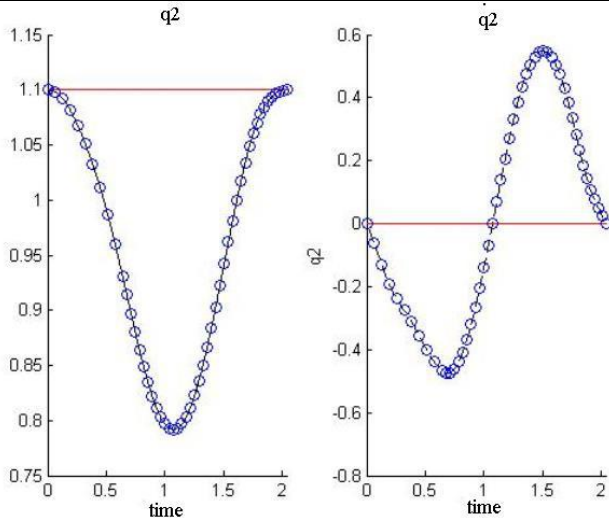
Fig. 3: Periodic solution for q2
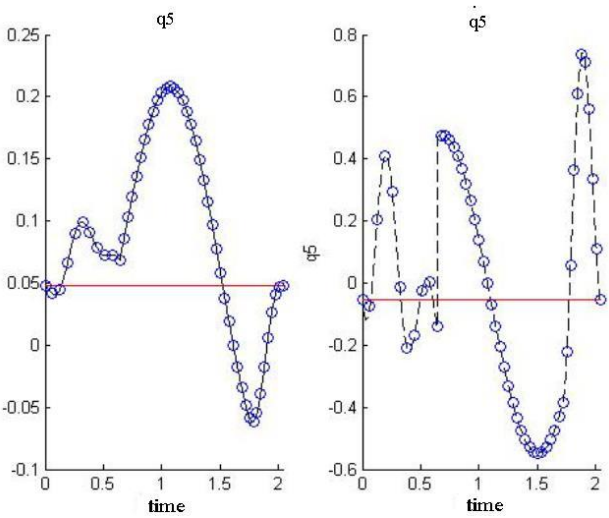
Fig. 4: Periodic solution for q5
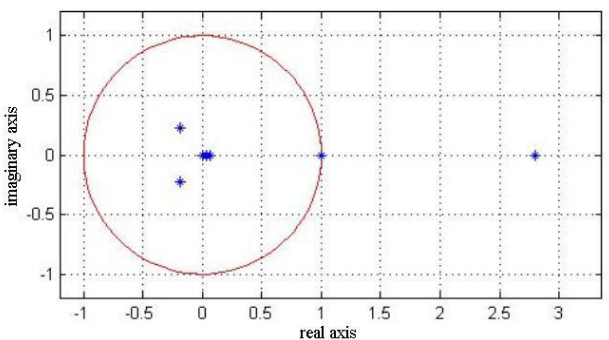
Fig. 5: Flock float multipliers with no feed

The other condition in which the search for the periodic march was used was the monopod jumping with a horizontal speed of one unit. For the optimization process, the initial conditions of the variables q1, q2 and its first derivative were kept fixed and the others were released for modification. The periodic constraint encompasses all variables, except for the horizontal position, which grows monotonically at each period.

The optimization was performed for the 10 terms of the Fourier series. The final values obtained are in Table 4.

Table 4: Optimization Results

	Not optimized	Optimized
Transportation costs	1.6812	1.0964
Travelled distance	0.6618	0.5291
Positive work	1.1126	0.5801
Frequency of excitation (Hz)	0.4695	0.3892

Floquet analysis can be seen in Figure 6. All eigenvalues are stable except for one in 4.6, indicating that although the solution obtained is periodic, it is unstable for more than one cycle.
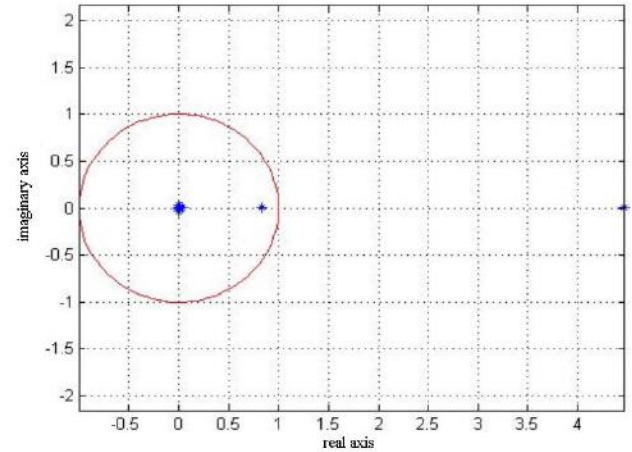
Fig. 6: Stability analysis for forward jump

3.2 Quadruped results:

The initial estimate was determined in order to ensure that the feet in the support phase did not penetrate the ground and that the normal force of the support phases were greater than 0. To this end, the trial and error first term of the Fourier series of the excitation function, until an acceptable initial condition was obtained.

The forces of normal reaction of the legs in the support phase and the vertical position of the legs of the legs in the balance phase for half the gait period are represented in Figures 7 and 8, respectively.
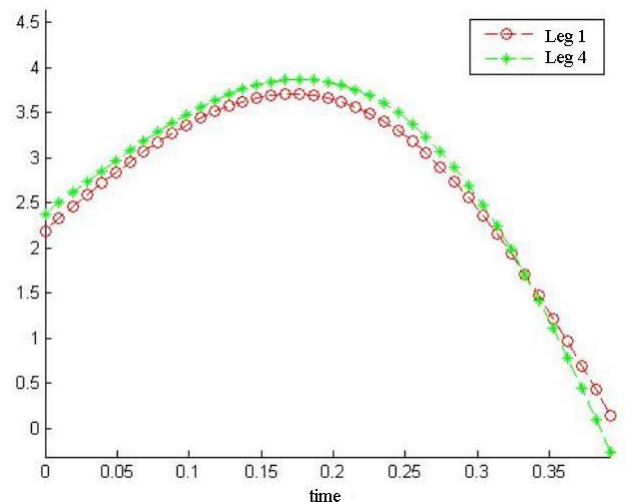
Fig. 7: Soil reaction forces on legs 1 and 4
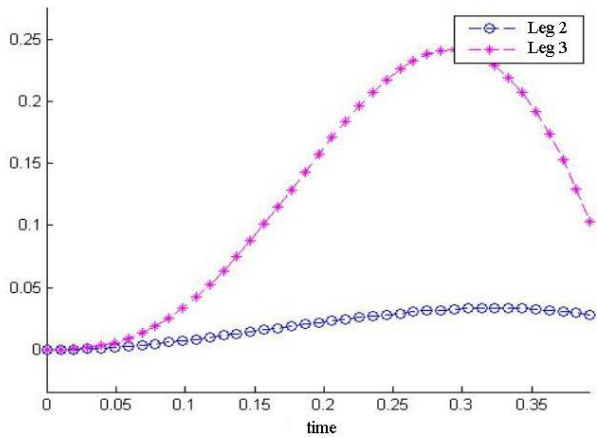
Fig. 8: Vertical position of the feet of the legs in the swing phase

It is important to emphasize that the initial estimate was constructed keeping in mind the condition of symmetry of the gait of the trot. Figures 9 and 10 show that the system cannot obtain periodicity over the initial estimated conditions, mainly because the legs 2 and 4 remain in the same state throughout the period.
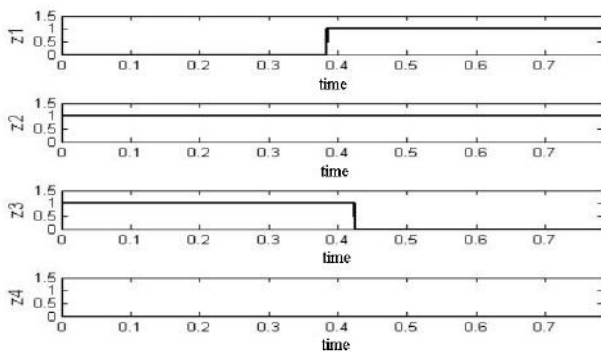
Fig. 9: Evolution of leg condition

For the proposed restriction conditions for the trotting gait in the quadruped system, it was not possible to obtain a positive result for the initial estimated conditions. The search process ends in the third iteration with residual of the violation of the restrictions of 2.862 (extremely superior value to the desired of 10^{-8}).
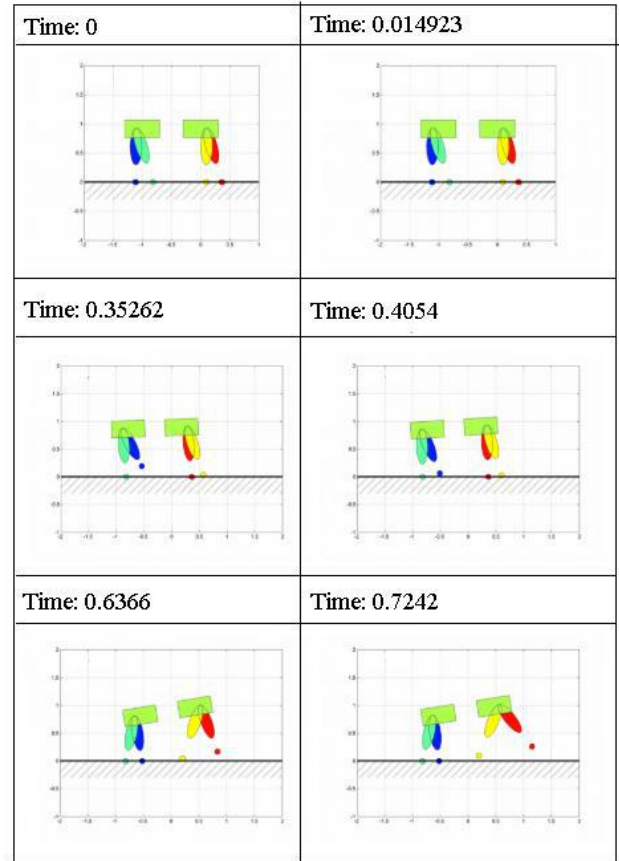
Fig. 10: Quadruple Animation

IV. CONCLUSION

This work presented a methodology for searching and optimizing the periodic gait of leg locomotion systems, more specifically a monopod and a quadruped, by the multiple shooting method.

The developed program was tested in the monopod for the search of the periodical gait of the jump in the same position and of jump with advance.

Although the leg restrictions for the quadruple system were in line with established conditions, it was not possible to find a periodic gait and perform an optimized gait search. Studies should be done to achieve a suitable initial condition for the search of periodic gait.

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Authentic Leaders form New Leaders to Assume the Command of their own Company: A Reflection on Authentizotic Organizations

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Abstract— *In this article we explore the transformation of a family company into an anonymous society, or rather, a joint-stock company, and the importance of the leader in this transformation process. It is a case study on an organization named Condor S/A, from Southern Brazil São Bento do Sul - Santa Catarina) in which a successful authentic family leader was able to inspire new leaderships that maintained the values of the company and in the future took over the company´s general direction. Our study, therefore, is directed towards an organization that manages, with its authentic leaders, to form internal managers capable of taking charge of the company itself. We discuss the importance of an authentic family leader who withdraws from the company and is succeeded by an external manager. Scholars such as Kets de Vries , M. F. R (2013) and Luthans, F.; Avolio, B. J. (2003) help us to construct our argument on "authentizotic" organization.*

Keywords— *Authentizotic organizations, Leadership, Authentic leader, Condor, Succession.*

I.   INTRODUCTION

In this article we propose to explore the condition of an "autentizotic organization", that is, the organization in which a successful authentic family leader was able to inspire new leaderships that maintained the values of the company and in the future took over the general direction. Our study, therefore, is directed towards an organization that manages, with its authentic leaders, to form internal managers capable of taking charge of the company itself. It is a case study about a company from Santa Catarina, more precisely, from the city of São Bento do Sul. We seek to discuss how an authentic family leader who withdraws from the company, is succeeded by an external manager. We investigated the phenomenon in which an organization with an authentizotic culture allied to authentic internal leaders was able to motivate within its own body of leaders left by the successful family, workers

capable of assuming the general command of the company after successive passages of external managers. In the context of the research, we developed our study of the culture of an autentizotic family business, its leadership, fruitful by an authentic family leadership that was succeeded by professionals from the market, that is, from outside the family. This authentic family leadership was, prior to the transfer of command of the company, a team of leaders committed to the values of the company, considered an authentic organization. This decision of the family leader who moved away from the command was strategically conceived, so that the team of his confidence functioned as support to the external managers, and at the same time they would prepare themselves to assume the direction of the company.

II.   AUTHENTIZOTIC ORGANIZATIONS. AND AUTHENTIC LEADERSHIP

In order to study Authentizotic organizations we will also have to explore, even briefly, the theory of authentic leadership (KETS DE VRIES, 2001). We are aware that the topic of leadership involves a complexity of aspects, because in every situation where there is more than one individual involved in a particular process, someone, in a certain way, takes the lead in the search for the goal that contemplates the best viable alternative. The Authentic Leadership Theory (LUTHANS and AVOLIO, 2003; GARDNER et al., 2005) is a more recent approach that emphasizesthe building of a leader's legitimacy through transparent and honest relationships with his/her followers. The leader values the contributions of those who follow ethical conduct. Usually, the authentic leader is able to construct a positive interaction, providing sufficient openness so that the leaders can believe in a relational transparency. Mutual trust is a permanent construct, by supporting the ones who follow the leader, by providing opportunities for the growth of the led workers. Authentic leaders acting in this way have a

positive performance that provides feedback from the workers who are led.

This construction of a positive atmosphere among commanded workers makes emerge an authentizotic atmosphere, authentizotic culture or even authentizotic organizations. Therefore, autentizotic organizations are those in which the workers see the company as an extension of their life purposes. In these organizations, fellowship and relational transparency prevails.

So there is an interweaving process among the leaders who are authentic, who honor values and the knowledge of themselves. They are self-confident people who convey confidence to the people they lead. Thus, these authentic leaderships are able to behave with their true "I" without dependence on a definite pattern to mirror (GARDNER et al., 2005).

Authentic leaders are those who exhibit the four behavioral tendencies, namely, self-awareness which is an accurate knowledge of the weakness of their strong side and idiosyncratic qualities; relational transparency that involves genuine representation of self in another; (GARDNER, AVOLIO, LUTHANS et al., 2005: ILIES, MORGESON & NAHRGANG, 2005).

AsKets de Vries argues, Authentizotic Organizations, Authentizotic Cultures, or even authentizotic climates are businesses where there is harmony in the workplace where well-being is a consequence of shared goals, where workers feel sheltered as an extension home, beyond the family environment (KETS DE VRIES, 2001). Leaders and led are integrated, creating a climate of intergroup trust that can provide a sense of purpose to their lives. Authentic Leaders have their ability to approach people with the characteristics that can fit this perspective of authenticity (AVOLIO et al, 2008). There is, therefore, no authentic organization without authentic leaders capable of interacting positively with the leaders.

In this sense, the two variables, Authentic Leadership and Authentizotic Organizations, have something in common: the perception that the led workers are firmly established in the company, develop their abilities there and make their career. We then agree that authentic leadership feeds an authentizotic environment, while the autentizotic organization feeds authentic leadership which contributes to an authentic environment, ideal to developing new leaderships. We will then in the next paragraphs, proceed to study the Condor S.A company which we consider an example of autentizotic organization.

III. CONDOR S / A: AN AUTHENTIZOTIC ORGANIZATION.

The organization Condor S.A was founded in 1929 by a German immigrant who arrived in Santa Catarina before the Second World War. Today the company is consolidated and very well acknowledged in the environment where it operates, both for its well-structured corporate governance and for the quality of its management, which makes it an important competitor in the market in which it operates. Its trajectory of nearly 90 years makes it respected by the values that support the whole company. Family organization may face serious problems if they are not adjusted in relation to management, property and families . Condor situation was not different.

The case of this company, in the third generation of family members, with a culture well established and with values of the founder reveals a climate of commitment, relational transparency, fair treatment, in which the employees stayed for a long time in the company. It was not differentiated in the third generation of the others: the existence of a diversity of family members has as a consequences diversity of interests. One realizes that family, property and management are mixed causing confusion. Thus, in 1996, when the grandson of the founder, the third generation , persuaded its members to move away from a family company in order for the company to pass to be managed by professionals outside the family. Surely it needed a maturation process. This process provided the team of in-house leaders with continuous learning which originated the company's sustainability. At the same time the leaders were prepared for the highest position in the company.

The first step in the succession was to form the Board of Directors, as a body that served as an interface between the management of the company and the owners, among whom those who had withdrawn themselves from management. This Board of Directors integrated, besides the relatives, a leader comingfrom the command of companies recognized in the region, such as WEG and Marisol. This professional has performed an important mission for the company: a conciliatory leader of the families in the Board of Directors, as well as, an important element for the professionalization to be consolidated in the organization.

IV. LEADER HEINZ ENGEL LEADER WHO DETECTED OTHER LEADERS TO TAKE OVER THE COMPANY

Discussing family organizations, Tucker (2006) emphasizes that the option for a new leader without a family bond is a plausible alternative. In the case of Condor company, in order to start this process of removing three family members, the management immediately realized that they needed a coordinating leadership. This perception was approved and would be respected heading towards a consensus. Terefore, that's

what happened: the Chief Executive Officer, the familiar Heinz Engel led this process.

Heinz Engel had a broad knowledge and was respected, determined, self-conscious, with self-regulation. With his comprehensive vision, and his life trajectory, he was able to start the process, that is, the exit of the family relatives from the company management. The entrepreneur used his characteristic of leader when trying to approach an external counselor with extensive business experience. After two years of the first external manager who led the company, three new external CEOs were hired in the period of nine years.

The diversity of cultures and the variety of knowledge, behaviors and attitudes of these external managers were fundamental factors for these internal leaderships to develop. Each onewith a management competency added their professional experiences to the whole workers. In addition to this, the internal leadership developed themselves through interaction with external Directors within the company.

As a result of the managerial development of these leaders formed by the family leader who retired in 2008, so 11 years after the management was transferred to external managers, one of the team leaders, OsmarMühlbauer took over the highest rank of the company, substituting an outside professional. Years later, however, this professional suffered a stroke. Provisionally an external manager took over to be later replaced by a new manager from thisinternal leadership team. Thus, since 2011 Alexandre Wiggers one of the internal leaders, has been the head of the organization in a process of growth and sustainable development. This is, therefore, a phenomenon in which internal leaders have developedthemselvein an autentizotic organization. Succeeding external managers he internal leaders acquired competence to assume the general direction of the company.

Like any family business, CONDOR had no way of escaping the problem that every family corporation faces: the confusion involving management, property and family. As a Condor team member , the founder's grandson, says: "And at some point, there was trouble, and my grandfather sent everyone away, at last only the son (Alfredo Klimmek) was left, and then the nephew who is Hein. Because Heinz is the oldest cousin." (in an interview to the researcher) Thus some situations which flow in a family business also influence their development.

Family firms usually retain values, among them, austerity, commitment, dedication, to a greater purpose as a passion for the company (GRZESZCZESZYN; MACHADO, 2009). For Condor, at the moment an external professional was important, since being a family member could be infected by the influence of this or that family. Mr. Heinz Engel realized that he, as a member of the family, had troubles to take some measures, so, as one of the company´s employee says, "Jean Luc arrived and took over Mr. Heinz's staff and continued the work."

On April 17, 1997, the family shareholders, Heinz Engel, Thomas Engel, Claus Klimmek, then directors of the company, led by Heinz Engel, left the executive management. Jean Luc Pierre was elected for the position of General Director and Marie GhislaeinJadoul was elected executive management.

Facing the new challenges, learning and commitment were required. In this context, Condor was building its learning about the new consensus format among the family members. One worker, in an interview to us, explains: "But then we learned how it's real governance, that's not just how to get everyone together! No! It must have a certain discipline, a certain organization and rights and duties"

A relevant aspect in the Authentic Leadership Theory is that the authentic leader has the ability to approach people with the characteristics that can fit this perspective of authenticity (WALUMBWA et al., 2008). Heinz Engel, as a leader who had a business integration with important personalities in this area, knew the competence of Vicente Donini, then attached to the well-known Marisol company located inJaraguá do Sul. "I know that Mr. Heinz went there to talk to him, I do not remember if it was someone else, if it was from Mr Heinz Engel or if that was Donini, but I know that he knew Donini before, already knew him from before. "(Interviewee 1). He interviewee completes: [...] and he was a very well-prepared person, he succeeded in making the meetings productive, conveying knowledge, helping a lot. He was an important piece for the company´s growth for the c. "(E7).

Kets de Vries (2001) advocates that in Authentizotic Organizations there is connectivity of the organization with its staff, commune in corporate terms, vision, mission culture and structure. It is perceived a process of dialectics in which the external manager makes their competences emerge, shares with the group of intermediate leaders, and these in turn are integrated, leading to a learning factor for both parties, once the external manager has arranged to interact with existing staff.

In our work, we interviewed the main actors who have been in charge of Condor trajectory, from 1997 to the present. We chose the interviewees based on information we obtained about their importance in the transitional process. In addition to the interviews, we used internal company´s documentation, such as minutes, Balance Sheets, Income Statement, records archived in file.

Before we explore the interviews, we would like to discuss, briefly, on what we mean by authentizotic organizations emphasizing the importance of the sense of belonging present in the whole worker environment.

V.   FOSTERING A SENSE OF BELONGING

Company employees have praised the way the outside knowledge has been passed on by the new leaders. They cite external managers such as Jean Luc, the first external manager after Mr. Heinz, as an important leader. Moreover, other leaders provided the appearance of new leaders.

Even considering that there was a culture clash with external managers, this diversity of views of external managers was able to sharpen the critical spirit of the internal leadership in a very interesting learning process. This identity of Condor Company comes from a culture developed over time. For Kets de Vries (2001), the trust, the pleasure of the working group to contribute to colleagues and to accomplish their task is visible Everything is done based on the understanding of the human being, enabling the individual to feel healthy within the organization.

Other interviewee, for example, reiterates that he values the spirit of leadership and affirms that in the company "... people have managed to put the company above, in their personal interest, and many with it doing wonderful careers ... [...] . People know that they have the opportunity to climb the stairs, all they want is that, as long as they prepare for it and fight for it. "(E 2). The interviewee further states that the company becomes your home where you can feel good saying that most feel very good here at Condor and like to work in the company.

There is, as far as the employees are concerning, a sense of belonging in the company, and this is a characteristic of the authentizotic organization as KETS DE VRIES (2001) has argued. There is a bonding in the company that encourages workers to stay for a long time. The fact that workers put the company above their personal interests leads one to deduce that the company is an extension of their family environment; by being in the companyone becomes a life purpose. In this respect, another official says that "... people have managed to put the company above their personal interest, and many are doing wonderful careers ... [...] people know they have the opportunity to climb the steps, as long as they prepare themselves for it and fight for it. "

What we can observe is that the workers started in some function and later they became managers, or started in the company as their first job and then became manager.By focusing on the potential of each company professional leadership has provided a culture of professional development. Authentic leaderships, as they intensify the

appropriate training, by identifying their potential, promote workers´ autonomy and group integration in a process of motivation that radiates in a constructive spiral. Heinz Engel, the staff claims, left a team of leaders with a developed philosophy formed, which continues today. "Because today, the people here, we speak that have a Condor way to be, and in this way to treat people well, take care of the process as if it were each one.

In the process of conducting the company by external managers, the existing cohesion in which there was shared managementbegan to be challenged. The atmosphere in which the middle managers formed a true united team had to be regained. In order to win back, it was necessary a trained manager to take over the company´s direction.

Interesting to realize that the shareholders themselves and the committee board realized the appreciation of the leadership among employees . The professionals felt that they could learn continuously and learn the best practices from nontraditional and often unexpected sources (Kets de Vries, 2004). We argue that learning can be linked to well-being, since when the person is learning he or she feels more accomplished, his/her positive perception of oneself gives one more individual autonomy and this leads to the concept of Authentic Leadership in an authentizotic organization, (CAMERON & CAZA, 2004; DUTTON & QUINN, 2003; KETS DE VRIES, 201, 2013).

It is important to note that Heinz Engel had an authentic leadership profile within theoretical concepts. And authenticity does not mean that the leader necessarily has an ability to dealkindly all the time . Within his/her authenticity one is fair to all, in pursuit of organizational goals to the detriment of his own interests and feels successful in achieving the goals . He or she will be respected because she/he is true. A Condor´s employee saysrelatFing to Heinz Engel: "he was always very authentic right, very direct and very transparent." Furthermore Heinz´s worker contends , " hewas a straightforward person, so sometimes he would come and pull one´s ear. But he explained the reasons, why he was doing it, and people accepted it and were really trying to evolve."

VI.   SOME CONCLUSIONS

So far we can draw some conclusions from our discussion: a) there is a significant view about the existence of Authentic Leadership in the company (average 4.3); b) in the same way as relating to the Authentic Leadership, but with a significant average of 3.8, there is a good perception of an authentic environment; c) there is a correlation between Authentic leadership and autentizotic organization.

We have seen many cases of workers who had Condor as their sole employer, children who worked for many years and had the same parents as having the company as their sole employer. Even today, one of the current directors who has been in the company for 40 years, says that his father has worked for Condor for 35 years.

Within Condor context, it was verified the construction of a culture typified by Kets de Vries (2001) as "Authentizotic organization", or authentizotic culture, or even coined by some authors of autentizotic identity, where the workers feel well, because the environment gives them something internal that they have as the purpose for their lives.

.The fact that Heinz Engel's decision to take over the command the process of turning the family company into a governance corporation makes us realize that he revealed a s leadership with the wisdom derived from his experiences. Leaders are guided by a set of transcendent values that mediate their decisions about what is fair and convenient for all stakeholders. These statements are found in the Authentic Leadership theory (GARDNER et al., 2005).

Heinz Engel's profile, as discussed above, contained all the characteristics of authentic leadership as advocated by scholars in the area. In theoretical terms, the combination of authentic Leadership, in the case of Heinz Engel, converges for Authentic Organizations, or authentic culture, the case of Condor. When the leader is able to produce healthy relations, both on the human side and on the organizational side, the opportunity for new leaders to emerge is great. Profile of authentic leaders reveal a transparent way of being, they are genuine, they are endowed with values where coherence and ethics are essential, which allows them to be trustworthy and at the same time transmit confidence to the workers in such a way that they commit themselves to the organization or to the group as well as to the leader (AVOLIO and GARDNER, 2005).

With the promotion of these internal leaderships the company has strengthened and today there is a culture of people development, commitment, sense of belonging. We emphasize the importance of these internal leaderships, identified with a profile of authentic leaders, like the leader, Heinz Engel. Even the workers with whom he has had no previous contact respect him for the name recognized by the internal leaders. These leaders, people who act transparently and with a culture that was initially built by the family and inspired by Heinz Engel , being able to develop themselves and reach the top of the organization. Another observation this team remained cohesive throughout this route in a dialectical construction in " Condor way of being."

Within these conceptions we conclude that an authentic family leader, Heinz Engel, incorporated in the atmosphere of leadership an authentic environment, where the well-being of the worker is stimulated causing a sense of purpose, competence, self-determination.These leaderships, with the culture of an authentizotic organization and with the formation of authentic leaderships was developed with the professionalization of the company, adding new competences for the integration with the successors who took over the company direction. The exercise of authentic leadership depends very much on the context in which these leaders act from their experiential trajectory, from the culture in which they are inserted. As far as Condor is concerned we saw that regardless of the external manager. So the premise is that they establish lasting relationships, such as the family leader, the middle leaders and the leader of the Board of Directors, Vicente Donini, who spent 16 years in the Council.

Finally, it should be noted that this research was not limited to the individual leader's perception, because it encompassed a culture, a team of leadership, the environment conditions that affect a person's ability to be a leader. There is a context to be considered as there is a history of the leaders within a context and the form of the relationships for the construction of an authentizotic environment.

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Graphite Piezoresistive Sensors in Polymeric Substrates

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Abstract— *In this work the results of the characterization by digital microscopy, scanning electron microscopy and EDX of the mechanical properties of the graphite 2B deposited by the GoP - Graphite on Paper process on A4 paper substrate are presented. The different properties and network structure of the graphite film and paper chosen for the development of sensing devices are aimed at practical applications in MEMS - Micro electromechanical devices.*

Keywords—MEMS, Sensors, Piezoresistive Effect, Polymers, Graphite.

I. INTRODUCTION

In recent years a wide range of devices and sensors using graphite films and paper substrates is being developed, including strain gauges, super capacitors, energy storage and electromagnetic radiation detectors in the mid-infrared range [1]. The literature shows that most of the work in the area focuses on sensor production methods and the exploration of new applications of cellulose as substrate for different types of devices [2]. In this work the graphite is characterized by depositing itself on the paper, aiming to obtain a piezoresistive sensor. The results will be compared, in the future, with the results obtained by a numerical computational simulation [3].

II. PIEZORESISTIVE SENSOR ELEMENT ON POLYMERIC SUBSTRATE

2.1. Piezoresistive sensor element

A sensor has as main purpose the conversion of energy between the different domains, that is, to react to a signal and convert it to another type of signal. Piezoresistive sensors are an example of passive transducers because they require an external excitation that can be originated by a crimped beam or a source of electric current [3]. According to the literature [4], there are several methods to measure forces considering the changes of the dimensions of the materials due to the applied mechanical stresses. The strain gauge type piezoresistive sensors are

widely used for this purpose. The piezoresistivity consists in the reversible change of the resistivity that a material presents due to a mechanical effort [5]. The piezoresistive sensor has a direct dependence on the property of the material from which it is made. In electrical and thermal terms, the most significant properties for the manufacture of the sensors are those related to the resistivity and mobility of the load carriers. In mechanical terms, density, thermal expansion, modulus of elasticity and Poisson's coefficient [6] are considered.

In order to generalize the properties of the material to be used as sensor element, the piezoresistive coefficient, $\pi i j$, was defined as the entity that considers all the measurable properties of the material. These coefficients are related to the concentration levels of dopant impurities, crystallographic orientation of the material, temperature and, consequently, the conductivity type according to [7]. The piezoresistive coefficient is an intrinsic property of the material considered and chosen as a sensor element, and it is possible to adjust its magnitude in the laboratory, that is, to improve the physical properties of the material [6].

These parameters are important for the technological processes of manufacturing the sensing devices and actuators since they are related to the sensitivity of the devices [3, 8, 9]. The piezoresistive effect is defined by equation (1),

$$\frac{\Delta \rho i j}{\rho} = \pi_{\pi i j k l} T_{kl} \qquad (1)$$

Where, $\pi i j k l$, is the piezoresistive coefficient tensor, an intrinsic property of the material chosen as sensor elements and which can be adjusted by specific doping techniques. The mechanical stress in the structure of the material is given by $T kl$, where $\Delta \rho i j$ / ρ is the ratio of the electric resistivity when the material is subjected to external tensile forces or mechanical deformations.

In general, the structures of the films deposited on the substrates have a thickness much smaller than the

thickness of the substrate itself, therefore, the mechanical stresses are transmitted integrally from the substrate to the film according to the theory of the small deflections. Surface and substrate roughness can also produce thermal and mechanical hysteresis effects through the creation of concentrated mechanical stresses which produce loss of sensitivity and adhesion of deposited films.

A deformation in a given material, exerted along a given direction, always causes changes in all dimensions. The piezoresistive effect can be described by expressing the change in electrical resistance, ΔR, in a macroscopic manner as a function of the mechanical stress, mechanical strain, ε, and the sensitivity factor or gauge factor, GF given by equation (2).

$$GF = \frac{\Delta R}{R\varepsilon} \qquad (2)$$

The sensitivity factor is dependent on the crystallographic orientation of the material and is related to the piezoresistive coefficient through the Young's modulus, E, given by equation (3),

$$GF = \pi_{ij}E \qquad (3)$$

The relationship between the change in sensor dimensions and sensitivity is given by the Poisson coefficient through equation (4),

$$GF = 1 + 2\vartheta + \frac{\Delta\rho}{\rho\varepsilon} \qquad (4)$$

Where θ is the Poisson's coefficient and the term $1 + 2\theta$ represents the change in the dimensions of the material and $\varepsilon = \Delta L / L0$ is the mechanical deformation.

2.2. Graphite Characteristics

Graphite is formed of carbon atoms that bond together by covalent bonds. Each carbon atom is attached to three other carbon atoms in the same plane. An atom is arranged in such a way that its bonds are the vertices of a triangle, leading to the formation of hexagonal rings. Thus sheets of carbon atoms bonded together by covalent bonds are formed. The layers of atoms forming the graphite are bonded together by very fragile bonds. In general graphite is a soft mineral, being an electric conductor, has applications in electronics, as in electrodes and batteries. Graphite is the most stable crystalline form of carbon. It consists of infinite layers of carbon atoms hybridized in sp² bonds. In each layer, called a graphene sheet, one carbon atom binds to three other atoms, forming a planar arrangement of fused hexagons [10].

Hybridization of the sp² type occurs with carbon atoms forming a double bond. Carbon hybridization results from a double bond and two single bonds. Graphite is a good conductor of electric current, however it does not allow thermal conduction.

The density of the graphite turns around 2.26 g / cm³. Graphite can be found in natural or synthetic form and comes in three distinct forms: amorphous, crystalline and flakes. Natural graphite is one of the allotropic forms of

carbon found in nature, while synthetic is produced industrially with the use of high temperatures and pressure.

2.3. Process of deposition of the graphite film

Figure 1 shows the process steps of deposition of the piezoresistive sensor elements on the substrate by mechanical exfoliation of graphite 2B, a process known as GoP-Graphite on Paper [11,12] produced by traces of pencils.
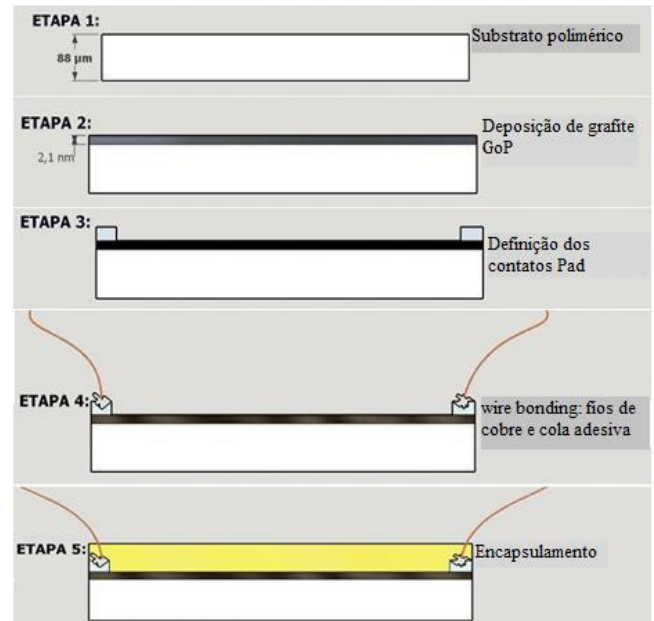
Fig. 1: Stages of piezoresistive sensor element processing of graphite.

Figure 2 shows a photograph of the piezoresistor obtained through a digital microscope Dino-lite model AM-313T. To finalize the sensors the encapsulation was done with epoxy glue.

Fig. 2: Digital photograph of piezoresistor graphite on paper.

In order to determine the chemical composition, the X-ray fluorescence analysis was performed by dispersive energy

(see Table I) in a SPECTRO spectrometer model MIDEX.

Table.I: Chemical composition of the graphite deposited on paper

Element	Concentration (%)	Symbol
Silicon	2,37	Si
Sulfur	54,91	S
Calcium	14,21	Ca
Titanium	8,76	Ti
Rhodium	2,21	Rh
Paladin	5,76	Pd
Silver	3,79	Ag
Cadmium	3,60	Cd

The X-ray diffraction technique was used for the determination of the atomic structure in equipment brand Philips model X'Pert -MPD. The resulting Diffractogram can be seen in Figure 3.
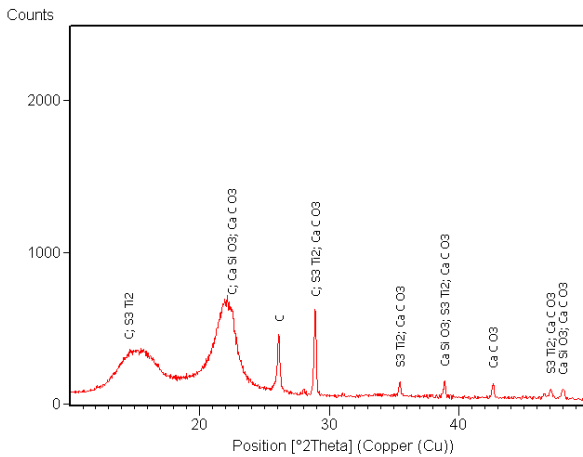
Fig. 3: X-ray diffraction for sample of graphite deposited on paper.

The microscopy was used to observe how the deposition of the graphite occurs in the polymeric substrate. Fig. 4 shows an optical microscopy of the graphite film on paper substrate.
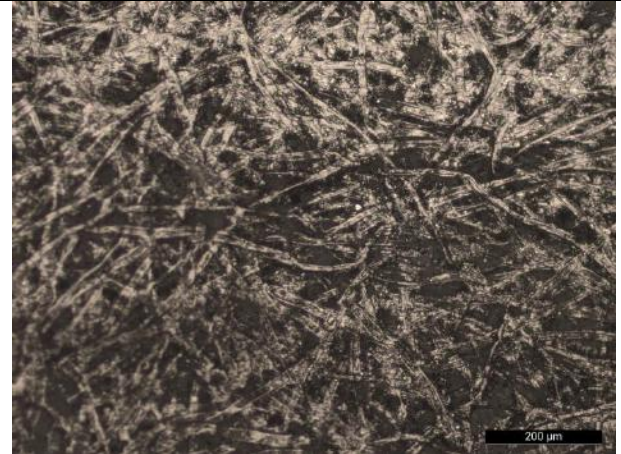
Fig. 4: Optical microscopy for graphite on paper. Increase by 10x.

Figure 5 shows in more detail aspects of the graphite matrix and cellulose fibers of the substrate when analyzed by digital microscopy.

Fig. 5: Digital microscopy for graphite on paper. 150x magnification.

Figure 6 obtained with SEM reveals the graphite flakes deposited on the substrate through the technique of mechanical exfoliation of graphite - GoP.
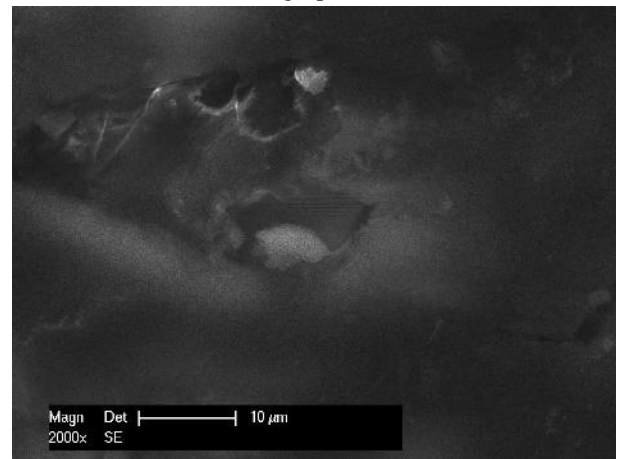
Fig. 6: SEM for graphite on paper. Increase of 2000x.

Figure 7 shows the dimensions of the graphite flakes constituting the deposited film in this piezoresistor manufacturing process.
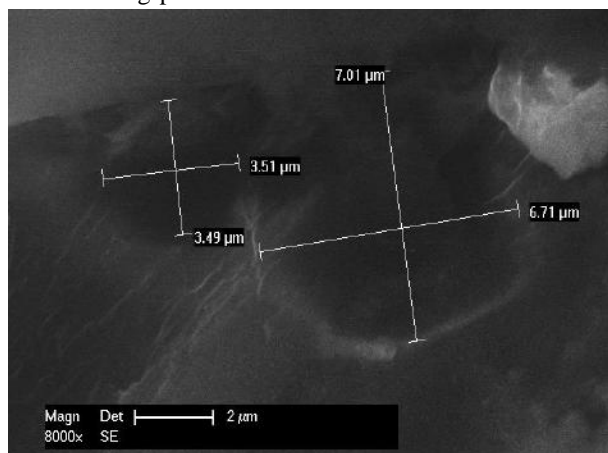
Fig. 7: Scanning electron microscopy – SEM for graphite on paper, determination of the size of the flakes. Increase of 8000x.

Figure 8 shows the EDX analysis for the graphite slides. The images were obtained with a Keygen VK-X digital microscope and Philips scanning electron microscope model XL 30 ESEM. This analysis shows the composition of the graphite used to manufacture the sensor elements.
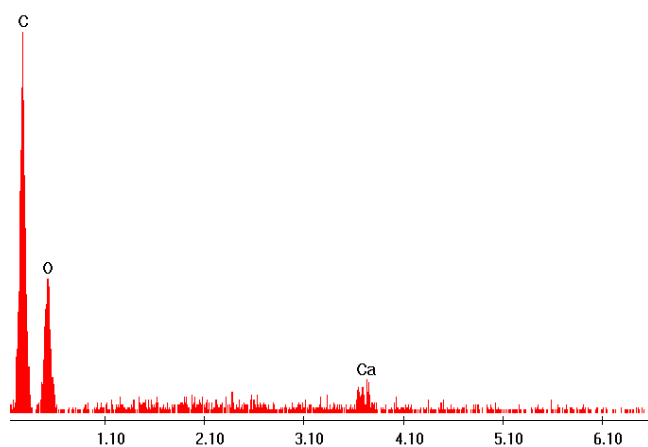
Fig. 8: EDX analysis for graphite flakes

III. RESULTS AND DISCUSSIONS

The characterizations made for the graphite deposited on a polymeric substrate, A4 paper, made it possible to better understand and know the conductive material and, mainly, how the substrate / conductive material interface is given. X-ray fluorescence (XRF) made it possible to identify several chemical elements, and Sulfur and Calcium are present in greater amounts. The other identified chemical elements are residues from the substrate manufacturing processes. X-ray diffraction analysis allowed to identify a series of compounds mainly hexagonal carbon. Through optical and digital

microscopy it was possible to visualize and identify the graphite sheets adhered between the fibers of the paper as well as other particles considered undesirable impurities. An EDX analysis of these impurities identified them as being calcium particles, a result consistent with the other analyzes performed (DRF and XRD). In addition, the scanning electron microscopy allowed measuring the size of the graphite slides, which vary between 3.5 μm and 7 μm. EDX analysis can confirm the composition of the constituent particles of the film, carbon being the main component found. The results are consistent with the literature review, allowing reliable and reliable data for the production of piezoresistive graphite sensors.

IV. CONCLUSION

The results found in the performed analyzes are consistent with the literature review, allowing reliable data for the production of piezoresistive graphite sensors using a low cost process when compared to silicon technology.

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Predictive Control applied to a mathematical model of a Flotation Column

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Abstract—As the flotation process is multivariable, this work investigates the implementation of a predictive multivariable controller for operation a typical flotation column. This controller was tested using a model with delays of a prototype column mounted on Nuclear Technology Development Center (CDTN). Taking as input signals the flushing wash water, air feeding, and non floated fraction flow rates, the controller determines the froth layer height and air holdup in the recovery zone. This control maintains stability. The operation of the controller is based on the optimization of a cost function. The conducted tests were based on the change of setpoint of the controlled variables. It was intended to analyze the system behavior for different operation conditions, considering the constraints of the process and the response speed.

Keywords—Flotation Column, Multivariable Predictive Control, Mining, Optimization, Restrictions.

I. INTRODUCTION

As one of the most used processes in the mineral industry, flotation makes it possible, economically and with satisfactory yields, to use complex and / or low-grade ores. The floating column is one of the outstanding equipments in this process. The achievement of better concentrates, higher metallurgical yield and lower capital investment justify this importance.

In the control of a flotation column, the main objective is to obtain better recovery rates and concentrate content. Due to the difficulties in online measurements of these variables, it is commonly chosen to control them indirectly through other variables [1].

The control system in the column flotation process must act directly on the manipulated variables, being able to maintain, properly, the controlled variables in their reference values, even in the presence of load disturbances or any other disturbances.

Because the column floating process is multivariate, interactions among variables are inevitable, so manipulation of input variables can affect all output variables.

The proposal of a multivariate control using a predictive controller (MPC), the subject of this work, seems to be very pertinent to the process, since its use is advantageous both in reducing sensitivity to system disturbances and in maintaining stability.

The motivation for the development of a multivariate predictive controller applied to the flotation column comes from the interest in improving the development of this process, knowing that this results in the maximization of the level of production, not impacting the quality of the product. In this case, the result should lead to a decrease in energy costs and chemicals added to the process, maintaining the physical and chemical specifications of the product with the lowest operating cost.

II. METHODS

2.1 Flotation Column

Flotation column is intensively used in the mineral processing industry [2]. The success of column flotation depends on the hydrophobic and hydrophilic nature of particles or it may be imparted using reagent[2].

The classical scheme of a flotation column is shown in Fig. 1. It consists of two main zones: the collection zone (or recovery zone) and the cleaning zone .
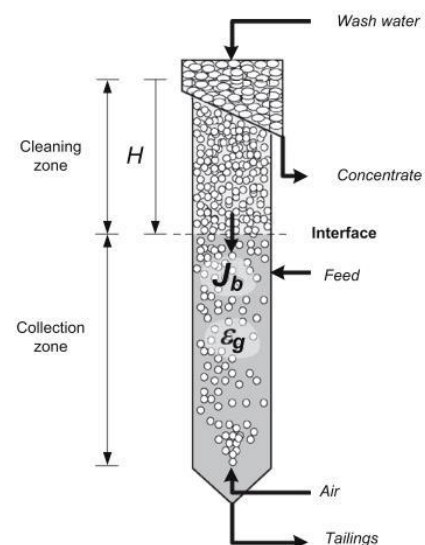
2.2 Mathematical model

Fig.1:Basic schematic of flotation column [3]

The data used in this work are from a pilot column mounted at the Nuclear Technology Center (CDTN)

located in Belo Horizonte, Minas Gerais, Brazil. The process variables worked in this plant are:

- Manipulated variables: flushing wash water(U_W), non floated fraction flow rates (U_T)and air feeding (U_g).
- Controlled variables: froth layer height (h) and air holdup in the recovery zone (ϵ_g).

The mathematical model for this pilot column in the biphasic system is developed in [4] being identified in terms of the functions of transfer in continuous time in the transfer matrix of Equation 1:

$$\begin{bmatrix} h(s) \\ \epsilon_g(s) \end{bmatrix} = \begin{bmatrix} G_{11} & G_{12} & G_{13} \\ G_{21} & G_{22} & G_{23} \end{bmatrix} \begin{bmatrix} U_W(s) \\ U_g(s) \\ U_T(s) \end{bmatrix} \quad (1)$$

Where each term is represented by Equations 2, 3, 4,5, 6 and 7:

$$G_{11} = \frac{-0,034e^{-10s}}{s} \quad (2)$$

$$G_{12} = \frac{-0,015}{s} + \frac{4,414e^{-60s}(-681,88s+1)}{(80,68s+1)(486,46s+1)} \quad (3)$$

$$G_{13} = \frac{0,016}{s} \quad (4)$$

$$G_{21} = \frac{0,18e^{-20s}}{94,91s+1} \quad (5)$$

$$G_{22} = \frac{0,37e^{-60s}}{48,26s+1} \quad (6)$$

$$G_{23} = \frac{0,07e^{-20s}}{(38,11s+1)} \quad (7)$$

2.3 Predictive Control

The Model Predictive Control (MPC) predictive control strategy can deal with several situations, such as: to be applied to control monovariable (SISO) and multivariable (MIMO) plants, to incorporate a dynamic process model, which allows to consider the future effect of manipulated variables under control, and entry and exit restrictions can be included in the formulation of the control law [5] and [6].

In MPC there is no need for pairing between controlled variables and manipulated variables, i.e., it is not necessary to define which MV will control a specific CV. Therefore, the MPC dispenses this step in the design of the control system which facilitates its implementation and eliminates the possibility of a bad pairing [6].

The MPC control refers to a set of methods that make explicit use of the process model to obtain the control signal from the minimization of a cost function [7]. From the process model, we obtain the future outputs for a prediction horizon N_P. These predicted outputs are calculated at each instant t, using the past values of the inputs, outputs and control signals.

In contrast, future control signals are determined by the optimization criterion in order to minimize the difference between the predicted response of the process and the desired response.

The model was manipulated using the MatLab® S-function level 2 block, applied to the state-space modeled pilot plant written in incremental form.

2.4 Predictive control tuning for the flotation column

For the elaboration of the control system it is necessary to initially define the controlled variables (h e ϵ_g), and the manipulated variables (U_W, U_g e U_T). The next step is the tuning of the parameters: control horizon (N_c), prediction horizon (N_P) and sampling time.

The control and prediction horizons chosen after the control tests were 40 and 30, respectively.

The time worked was 5 seconds according to [4]. The discrete time model was obtained using the ZOH (Zero Order Insurer) discretization method, considering that the control remains constant between the sampling instants.

The MPC algorithm used a quadratic cost function subject to the linear constraints represented in Table 1.

Table 1: Conduit Restrictions

Variable	Minimum Value	Maximum Value
$U_W/U_g/U_T$	0	100%
h	20 cm	140 cm
ϵ_g	0	20%

Control weight was assumed equal to 1 for each input variable. It was found, after testing, that different weights did not show significant variations in the results.

III. RESULTS AND DISCUSSION

In order to evaluate the performance of the system with the proposed predictive controller, tests were carried out by means of simulations of the mathematical model of the pilot plant of the fl otation column with delays.

The tests consisted of verifying the ability of the closed loop system to trace reference signals with satisfactory accommodation time and zero error in steady state. Tests were performed by changing the setpoints of the controlled variables, the sensitivity of the controller and the model were analyzed with the presence of noise in the outputs.

The first test consisted in increasing the desired value of the height of the foam layer (Fig. 2). The time of accommodation of the foam layer height was approximately 1044 seconds, with a highlight of 0.23%. The air holdup time in the collecting zone was 1299 seconds, with a highlight of 0.30%. The flow rates obeyed the actual restrictions imposed on the process, that is, the control signals were between 0 and 100%. The most sensitive variable to this change was U_g .

The test shown in Fig. 3 consisted in varying the reference value of the height of the foam layer from 80 to 90 cm at the instant equal to 2000 seconds and from 90 to

80 *cm* at the instant equal to 6000 seconds. The air holdup reference value in the collection zone ranged from 19% to 18% at the instant of 4000 seconds and from 18% to 15% at the instant of 10000 seconds.

Fig 2: Behavior of the system with the change of setpoint at the froth layer height

For the test analyzed, the height of the foam layer ranged from 79.34 to 94.95 *cm*. The air holdup in the collection zone ranged from 17.86% to 19.70%. The manipulated

variables varied between: U_W from 0% to 27,50%; U_g from 7,25% to 35,71% and U_T from 61,57% to 100%. Table 2 shows some points of each variable throughout this experiment. The results showed that all operating restrictions were met.
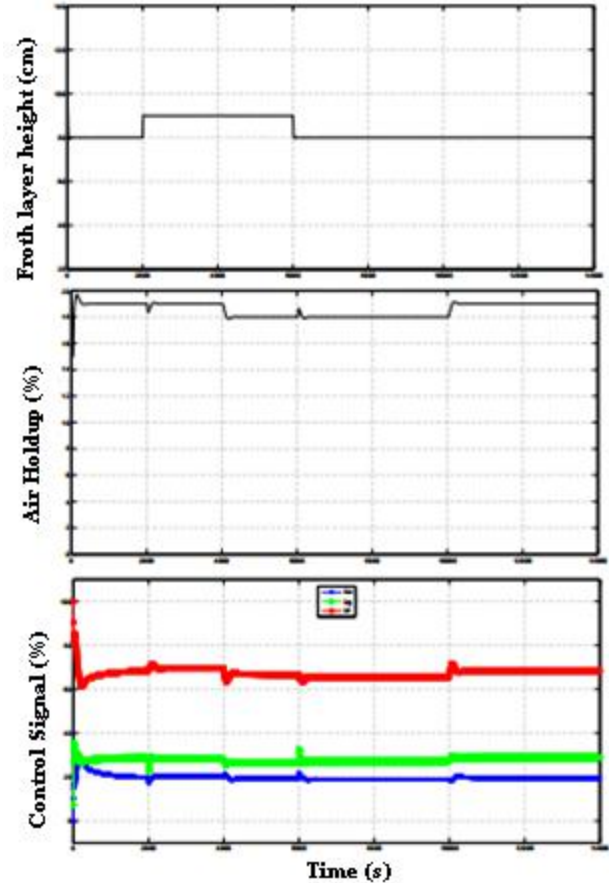
Fig 3: Monitoring of operating restrictions of the pilot column

Table 1:Values of the Variables throughout the experiment

time (*s*)	0	2000	4000	6000	10000
h(*cm*)	80	80	90	90	80
ϵ_g (%)	18	19	19	18	18
U_W (%)	0	19,74	20,26	19,62	18,87
U_g (%)	7,25	28,81	28,33	26,51	27,08
U_T (%)	100	68,28	69,60	66,60	65,48

The experiment of Fig. 4 consists of the introduction of a Gaussian noise of variance 0,1 at the outputs of the system. The test relies on changing the value in the reference signal in the air holdup in the collection zone from 15% to 18%. The variation occurs at the instant 1002 seconds. The setpoint of the height of the foam layer remained constant at 79 *cm* throughout the experiment.

It is observed that even with the presence of noisy signals, the MPC controller maintained the stability of the system and followed the desired performance criteria.
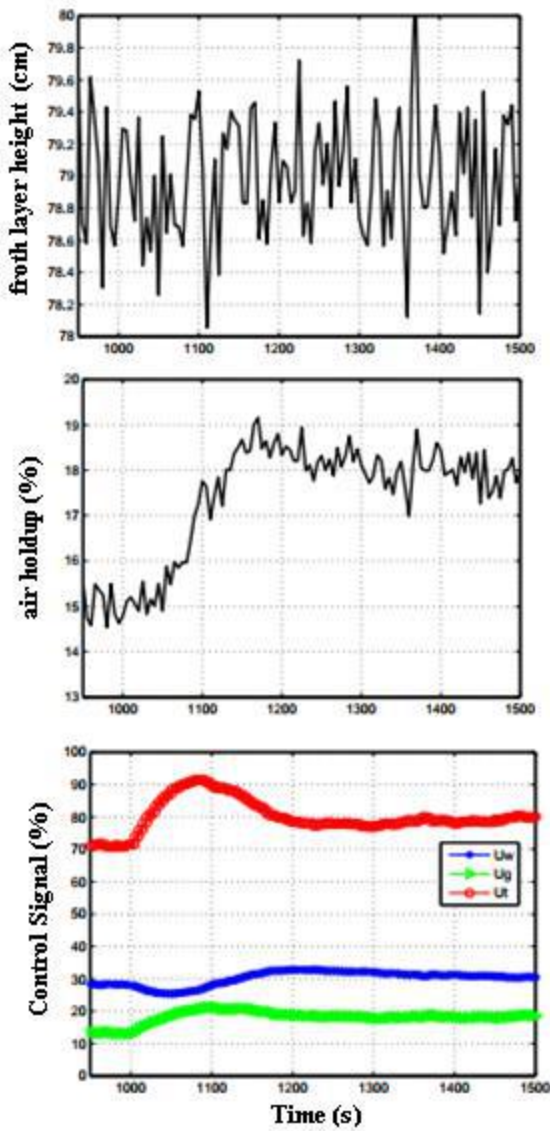
Fig 4: Robustness analysis

The objective of this experiment (Fig. 5) is to analyze the effect that parametric variation has on the implemented controller. In the test, 20% increase in the percentage value gain was obtained for the speed of the non-flotation pump, the air holdup in the collection zone, and the controller with the same parameters of the previous tests remained. The test consists in increasing the desired height of the foam layer from 80 to 85 *cm* at a time equal to 1002 seconds. The air holdup setpoint in the collection zone remained constant at 15%.
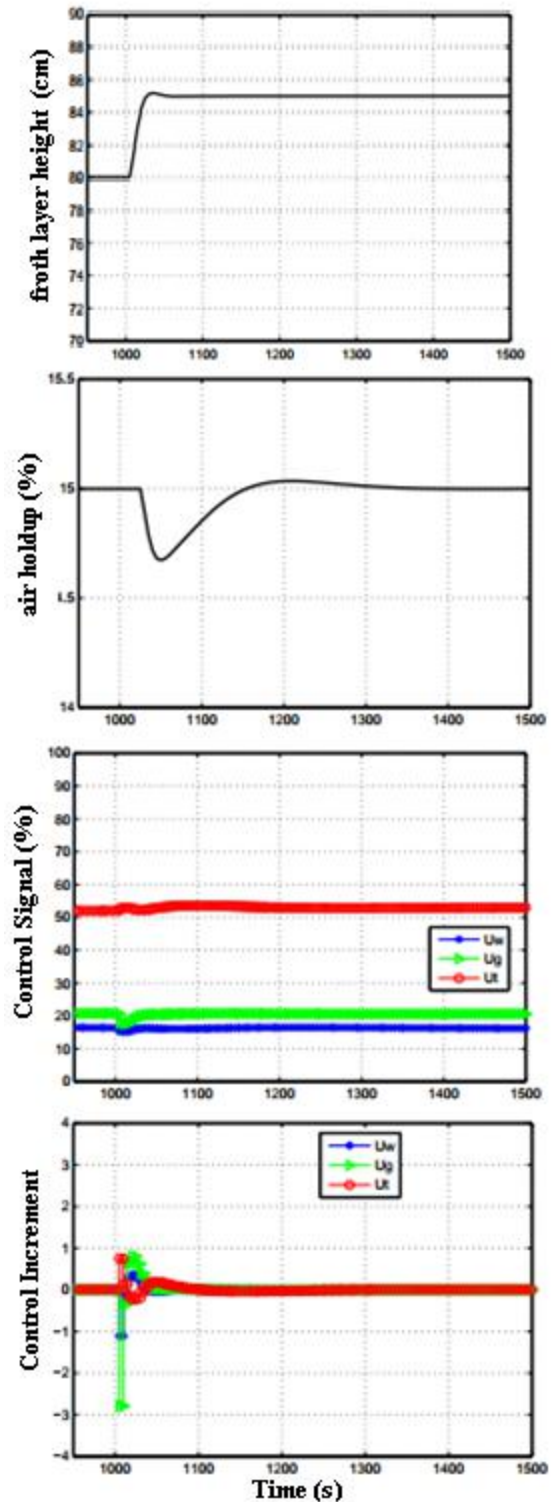
Fig 5: Sensitivity analysis with change in the gain of the U_T manipulated variable of the air holdup in the recovery zone

IV.   CONCLUSION

The predictive controller was implemented using the S-function level 2 block on the MatLab® platform with the aid of Simulink®. An analysis was also made of the behavior of the system for various operating conditions, considering the points of operation of the actuators and the speed of response.

The most arduous step of the work was the adjustment of configurable parameters, such as input and output weights and control and prediction horizons. There is no unified and well-defined strategy for choosing these parameters. A bad adjustment of them makes control of the process impossible.

The proposed MPC technique was applied to the state space process model and optimized system control by minimizing a quadratic cost function. This function weighted the mean square error of the controlled variable and the control effort, finding the appropriate control signal.

This controller is designed to control the height of the foam layer and air holdup of the floating column by manipulating control signals from the wash water inlet valve, air inlet valve and pump speed of the non-floated material. This means that the studied system used a multivariable mathematical model with 3 inputs and 2 outputs.

The height of the foam layer is one of the most important parameters to be controlled, and it has been observed that its stability is strongly linked to the air flow at the base of the column.

This structure presented the capacity to deal with the constraints imposed on the float column, respecting the minimum and maximum values of its manipulated and controlled variables. For manipulated variables, the actuators should be in the range of 0 to 100%, the holdup should be 0 to 20% and finally, the height of the foam layer should respect its minimum value of 20 *cm* and maximum of 120 *cm*.

The experiments performed meet the control requirements: transient performance requirements such as stability, low response time and adequate damping, and performance requirements in steady state, such as low or zero reference errors. The predictive controller implemented was able to stabilize the system and maintain at zero the error between the permanent system output and the reference signal, even when changes occurred in the setpoints of the foam layer height and air holdup in the collection zone, and with the variation of process inputs.

The MPC was able to maintain the stability of the system and follow the reference of the controlled variables even with the addition of Gaussian noise in the outputs of the system and changes in the mathematical model. That is, these variations did not affect the performance of the controller implemented here. The tests also allowed to observe a satisfactory accommodation time when compared to other controls already implemented. That is, for a variation of the height of the foam layer from 80 to 85 *cm*, the time required for accommodation was 42 seconds. For air holdup variation in the collection zone from 15% to 18%, it took 283 seconds. It is observed that,

although the air holdup needs a longer time to reach the permanent regime, its projection is smaller than the height of the foam layer.

By analyzing the system responses with the closed loop predictive controller, it is possible to consider that the methodology applied to the design is adequate for the column floating process. The results showed that the implemented controller followed the response tendency of the robust controller.

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An Artificial Lightweight Aggregate Based on Non-ferrous Metallurgy Slags

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Abstract— *This paper relates to the obtaining of an artificial porous aggregate from slag waste of non-ferrous metallurgy. The developed technology permits to widen raw stuff basis of producing artificial porous aggregates for lightweight concretes.*

The investigations have demonstrated that granulated slags which are a by-product and are obtained through making non-ferrous metals, can be utilized as a basic starting raw material for manufacturing an artificial porous aggregate.

From the results of the investigations expansion intervals of a mass based on the studied slags of metallurgical plants are determined. The technology of obtaining an artificial porous aggregate with the prescribedphysico-mechanical characteristics has been worked out.

The main physico-mechanical characteristics of the produced aggregate have been studied. It has been revealed that the obtained artificial porous aggregate meets the requirements of the acting standard GOST 9757-90 "Gravel, Crushed Stone and Sand, Artificial Porous" by its physico-mechanical characteristics.

It is found that the strength of the obtained aggregate 1.5-2.0 times exceeds that of the well-known aggregate- keramzit gravel.

Using porous sand lightweight concrete of B7.5-B40 strength class with density of 1100-1600kg/cu.m has been produced on the base of the obtained gravel and high-strength lightweight concrete of strength class B25-B50 with density of 1500-1800 kg/cu.m has been manufactured with the use of dense sand and plasticizing additives.

Keywords— *artificial porous aggregate, density, strength, expansion temperature, high-strength lightweight concrete.*

I. INTRODUCTION

Economy of fuel and energy resources, reduction in consumption of materials of building structures, improvement of their quality, increase in heat-shielding characteristics, lessening of mass of buildings and structures are the most important problems of construction.

One of the most efficient ways of solving these problems is the manufacture and use of products and structures from lightweight concretes made with artificial porous aggregates.

The reduction in proper weight of reinforced concrete structures at the expense of using lightweight concrete instead of heavy-weight one brings about considerable economy of building materials and improvement of thermal technological features of buildings and structures.

One of effective ways of solving this problem is the production of lightweight concretesmade with artificial porous aggregates [1, 2, 3, 4, 5].

The broadening of raw stuff basis of making an artificial lightweight aggregate by means of utilizing waste of industrial enterprises leads to improvement of ecological situation. In this case a method of obtaining a lightweight aggregate with the use of metallurgical slags as the basic raw staff is of practical significance and presents a topical problem [6,7, 8].

The use of slags in the manufacture of artificial porous aggregates makes it possible to save material, labour and natural resources, to solve the problem involving secondary resources in the production of building materials to some extent and to protect environment from pollution [9, 10].

The aim of the research is to reveal a possibility of obtaining and determining the main regularities of

guided control of porous structure and phase composition of aggregates based on slag waste of non-ferrous metallurgy and to develop a technology of producing porous aggregates with the prescribed physico-mechanical characteristics.

The basis of research is the working hypothesis about the possibility of obtaining porous aggregates with uniform porous structure, regulated phase composition and prescribed physico-mechanical properties in transition from pore formation of fire-liquid slags to the expanding of granules originated from granulated slags. These aggregates were planned to be obtained from metallurgical slags.

Investigations aimed at broadening raw stuff basis and utilizing industrial waste to produce high-effective aggregates were performed at the Research and Design Institute of Building Materials named after S.A.Dadashev (Baku) and a new technology of obtaining artificial porous aggregates for lightweight concretes from glass-containing waste-slags of non-ferrous metals – was elaborated using the results of the above-mentioned investigations [11, 12].

II. EXPERIMENTAL PROCEDURE

The experimental investigations were conducted using various granulated slag of non-ferrous metallurgy and correction additives as the main raw stuff.

In developing batch composition plastic clays were taken as binding additives for the purpose of raw granule hardening and mineral, organic or organ mineral additives were employed as gas-generating agents.

The experimental investigations were conducted in three stages: preparation of the batch and raw granules making at the first stage, studying into mass expansion kinetics and aggregate structure formation at the second stage, studying into petrography and physico-mechanical properties of the artificial porous aggregate being obtained at the third stage. When performing the experimental investigations X-ray (diffraction), differential thermal and petrographic analyses were employed.

The performance of industrial tests and specification of technological parameters of porous gravel fabrication were carried out on a production line of the Research and Design Institute of Building Materials named after S.A.Dadashev.

III. MATERIALS

In conducting the experimental investigations slags of Karabash integrated copper smeltery and slags of Ufaley integrated nickel plant were used as the basic raw stuff materials.

The bulk density of non-ferrous metallurgy granulated slags varies between 1670 and 1920kg/cu.m. The density of such slags is 2.78-2.92 g/cu.cm. Basicity modulus of the granulated slags of Karabash integrated copper smeltery is 0.17 which relates to a group of acid slags and basicity modulus of the granulated slags of Ufaley integrated nickel plant is 1.28 which relates to a group of basic slags. Chemical compositions of the granulated slags from nickel and copper production are given in Table 1.

Table.1: Chemical composition of non-ferrous metallurgy slags after magnetic separation

No	Kind of slag	Oxide content, %							
		SiO_2	Al_2O_3	$FeO + Fe_2O_3$	MgO	CaO	S	SO_3	$\sum$
1.	The slag of Karabash integrated copper smeltery	37,41	6,28	47,0	0,89	6,59	0,61	1,22	100,0
		52,75	12,3	16,2	1,4	12,84	0,85	2,80	99,2
2.	The slag of Ufaley integrated nickel plant	44,50	9,78	21,5	11,0	12,3	-	0,12	100,0
		45,54	12,8	14,8	13,6	12,9	-	0,16	99,8

Note: above the line – oxide content before magnetic separation

under the line – oxide content after magnetic separation

With the use of a gas-generating and a binding additive a batch was being prepared which was ground till the specific surface of 2500-3500sq/cm/g and specimens in the shape of cylinder with diameter and height of 16 mm as well as granules of 5-10 mm fraction were made from the obtained powder on a plate granulator.

The specimens prepared from the non-ferrous metallurgy slags of Ufaley integrated nickel plant with basicity modulus of $M_0 > 1$ and from the slags of Karabash integrated copper smeltery with basicity modulus of $M_0 < 1$ were expanded under various conditions.

IV. ANALYTICAL INVESTIGATIONS

One of the main requirements for pore formation of the masses under study made on the base of metallurgical slags is primary crystallization of phases contained in the slags. X-ray (diffraction) analyses show that in the process of rapid cooling granulation in both kinds of slags occurs in normal enough conditions, degree of crystallization is nearly absent. The main constituent on the X-ray photograph of the granulated slags is vitreous phase.

FeO content is 21.5% in chemical composition of the slag of Ufaley integrated nickel plant while $FeO +Fe_2O_3$ content in the slag of Karabash integrated copper smeltery reaches 45-47%.

That is why for pore formation of the mass prepared from such slags having high content of iron oxide or monoxide in its composition it was intended to subject the dispersed powder obtained from the slags to magnetic separation with the purpose of lowering iron content in the mass composition.

To achieve this aim, after the slag grinding the powder was passed through a magnetic separator and then its chemical composition was determined. The investigation results given in Table 1 demonstrate that after magnetic separation iron content in the slag composition falls considerably. A decrease in Fe_2O_3 content in the mass composition causes a rise in SiO_2 and Al_2O_3 content in the mass composition which is positive for the nature of mass bloating. Due to this fact it is recommended to pass the batch through magnetic separator after grinding for further studies and also when organizing production of a porous aggregate on the base of non-ferrous metallurgy slags.

The specimens prepared using gas-generating and binding additives were subjected to expansion.

The results of investigations into expansion of the mass based on the studied slags as well as a change in density of the expanded specimens can be seen in Fig.1.
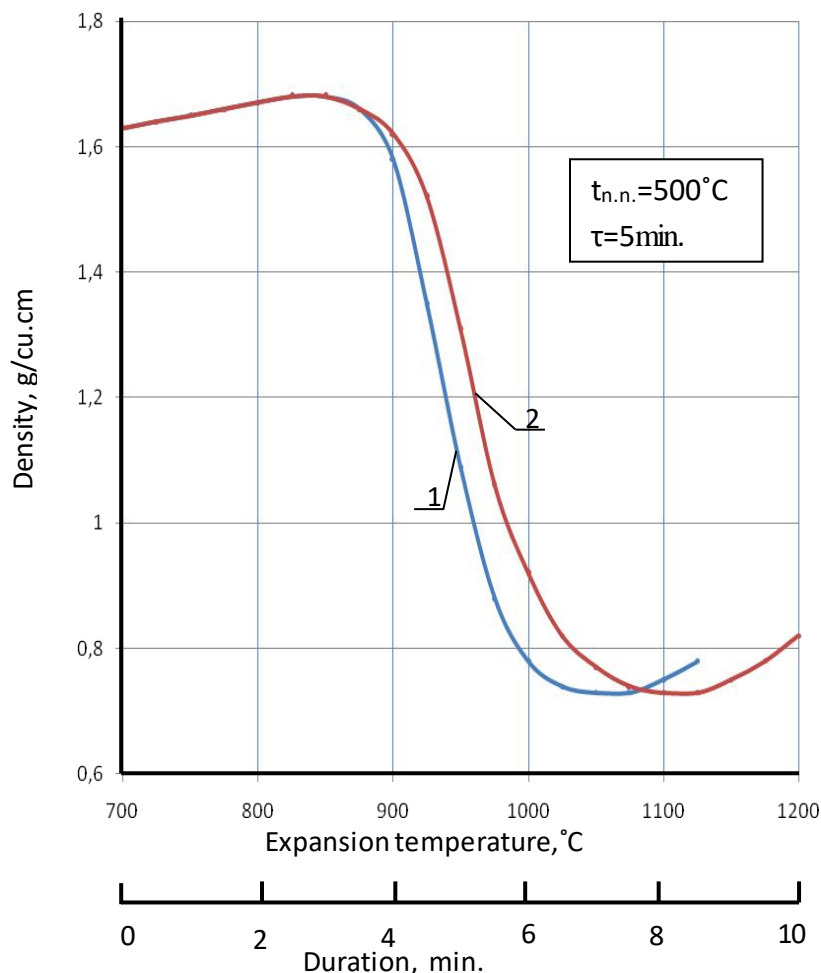

Fig.1: The influence of expansion conditions on pore formation process and density of the expanded specimens based on the mass from non-ferrous metallurgy slags.

1- slags of nickel production;
2- slags of copper production.

It is seen from Fig.1 that the process of pore formation of the mass and of appearance of porous

structure of the aggregate is substantially influenced by their expansion conditions.

The primary porous structure arises during formation of raw specimens in the shape of cylinders and granules. The density of raw granules in dried state is 1.60-1.62g/cu.cm. A major part of pores formed in this period is observed in the course of their thermal treatment.

The investigation results have demonstrated that under the action of high temperatures the softening of individual particles, sintering, compaction and deformation of the specimens develop within a temperature range from 750^0C to 850^0C. The density in this case goes up to 1.66-1.68 g/cu.cm. The evolution of gaseous phase starts at a temperature of $850-880^0C$ and these gases which cannot escape through the shell create excessive pressure in the inner cavity under the action of which bloating – expansion of granules begins.

Intensive expansion and formation of porous structure continue before a temperature of $1050-1150^0C$. Optimal porous structure develops at a temperature of $1000-1150^0C$. The density of the expanded specimens goes down to 0.72-0.73 g/cu.cm. The expansion process ends when the gas evolution process is completed. A further rise in expansion temperature up to $1120-1200^0C$ brings about an increase in the density of the expanded specimens to 0.80g/cu.cm. Optimal expansion temperature lies in the range between 1050 and 1150^0C^0C.

From Fig.1 it is seen that during high-temperature treatment transition of the material to pyroplastic state, deformation and maximum shrinkage take place within 3 or 4 minutes.

The start of gas evolution and a decrease in density are observed after the fourth minute. Intensive expansion and porous structure formation occur for 4-7minutes. The completion of the expansion process is detected at the seventh or ninth minute. A further increase in expansion duration to 10 minutes results in fusion of the surface of granules and a gain in the aggregate density.

The investigation results show that the process of expansion and obtaining of the aggregate from non-ferrous metallurgy slags consists of three main stages: dispersion and development of primary structure during granulation, sintering with the formation of closed pores and expansion itself under pressure of gases evolving inside closed pores.

The obtained aggregate expanded at a temperature of $1050-1150^0C$ is characterized by dark grey color, fine pore structure. The pores are of various shapes, they are chiefly regularly spherical, of 5-8 mcm to 0.5mm in diameter. The pores are uniformly distributed over the whole volume of granules, beginning from the granule surface to its centre. Structure elements are represented by vitrified substance interspersed by amorphized material of dark grey color.

The pore content attains 68-70%. Fig. 2 demonstrates microstructure of the aggregate manufactured on the base of non-ferrous metallurgy slags.

So, the investigation results have shown that when non-ferrous metallurgy slags are used as basic raw stuff for producing the artificial porous aggregate they must be ground together with gas-generating and binding additives, the mass must be granulated, raw granules should be made and expanded under optimal conditions. If gas-generating additives are utilized it is necessary to use mineral and organic additives in combination.

The results of laboratory investigations have undergone tentative industrial tests on the production line of the Research and Design Institute of Building Materials named after S.A.Dadashev. A tentative production batch of porous gravel based on slags of Karabash integrated copper smeltery was manufactured. Physico-mechanical characteristics of a pilot batch of slag gravel were tested according to GOST 9757-2012 "Inorganic Aggregates for Concrete. Testing Methods" [13].
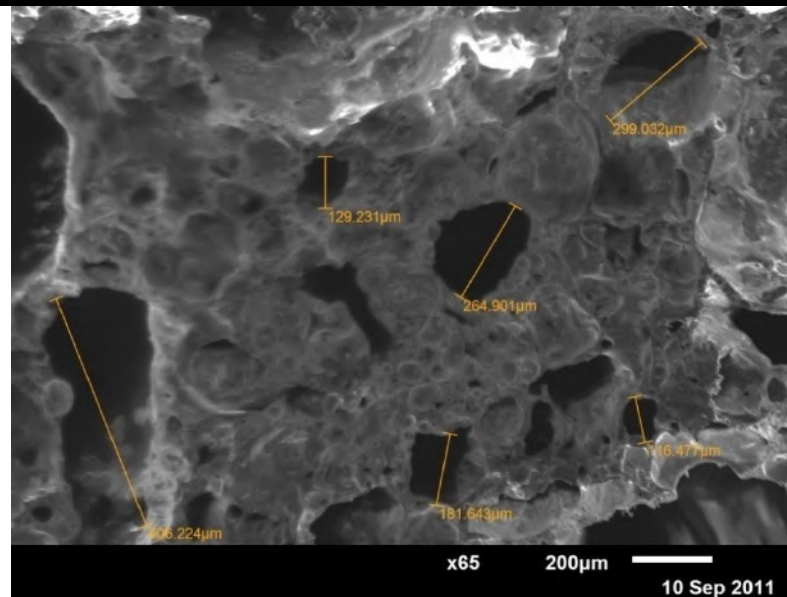
Fig.2: Microstructure of porous gravel based on granulated slags of non-ferrous metallurgy (magnification x 65).

Batch compositions, burning conditions and physico-mechanical properties of slag gravel fabricated on the pilot production line are given in Table 2.

Table.2: Batch compositions, burning conditions and physico-mechanical characteristics of slag gravel manufactured on the base of slags of Karabash integrated copper smeltery(semi-production tests)

Batch composition, % by mass			Burning conditions		Physico-mechanical characteristics of the aggregate	
slag	clay	additive	expansion temperature, ^{0}C	expansion duration, min.	bulk density, kg/cu.m	compression strength in cylinder, MPa
73,5	15	mineral 10% organic 1,5%	1050-1070	6-8 8-10	420 480 520 580 650 760	3,0 3,8 4,8 6,2 7,8 9,6

The obtained aggregate is of rounded shape, its surface is slightly rough, by shape and nature of the surface of granules it is classified as a gravel-like artificial porous aggregate. The main physico-mechanical properties of the manufactured aggregate are studied.

It has been revealed that by its physico-mechanical properties the obtained porous aggregate meets the requirements of the acting standard [14]. It has been found that the obtained aggregate is 1.5-2.0 times stronger than the well - known keramzit gravel.

The results of the conducted investigations and semiproduction tests demonstrate that it is possible to obtain a lightweight aggregate with highly favourablephysico-mechanical properties on the base of slag waste of non-ferrous metallurgy. Such aggregates can be effectively used as basic raw stuff when manufacturing an artificial porous aggregate for the production of

lightweight heat-insulating, heat-insulating structural and structural concretes.

The obtained porous gravel is tested in concrete and optimal compositions of concrete mixes are worked out. It has been revealed that using porous gravel and sand lightweight concrete of B7.5-B40 strength class and density of 1000-1700kg/cu.m has been obtained and with the use of natural dense sand and plasticizing additives lightweight concrete of B25-B250 strength class and density of 1600-1800kg/cu.m has been made. The consumption of cement for 1cu.m of concrete is 210-550kg.

V.   CONCLUSIONS
1.   The possibility of utilizing non-ferrous metallurgy slags as basic raw staff for manufacturing an artificial porous aggregate is proved.

2. Expansion kinetics of the mass based on non-ferrous metallurgy slags is studied, mechanism of expansion process and regularities of porous structure formation are revealed, dependencies of the main physico-mechanical properties of the obtained aggregates on temperature-and-time parameters are determined.

3. The technology of producing artificial porous aggregates on the base of non-ferrous metallurgy slags is developed and a qualitatively new light weight aggregate with bulk density of 420-760kg/cu.m and compression strength in cylinder of 3.0-9.6MPa is obtained under production conditions.

4. The obtained porous gravel is tested in concrete. It has been found that using porous gravel and sand lightweight concrete of class B7.5-B40 by strength and density of 1100-1700kg/cu.mis produced and with the use of natural dense sand lightweight concrete of B25-B50 strength class and density of 1600-1800kg/cu.mis made. The consumption of cement for 1cu.m. of concrete is 210-550kg.

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Study of Pulsed RF Signal Extraction and Irradiation from a Capacitive Nonlinear Transmission Line

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Abstract—Research on Nonlinear Transmission Lines (NLTLs) has long been carried out to produce oscillating pulses. The radiofrequency (RF) pulses generated by the NLTLs can be radiated by antennas connected to the output of the lines. Possible applications of NLTLs as an RF generator include aerospace radars, telecommunications, battlefield communication disruption, and medical devices. There have been relatively few articles that presented experimental results regarding the extraction and the radiation of the RF signal from NLTLs. This article reports the excellent results obtained with a low voltage lumped capacitive NLTL in which oscillations of the order of 230 MHz were produced and radiated using Double-Ridged Guide (DRG) antennas. The RF signal was extracted using a decoupling circuit based on a Chebyshev high-pass filter. The NLTL was evaluated through time domain and frequency domain analyses of the pulsed RF signal measured on a resistive load connected to the output of the line, as well as on transmitting and receiving by antennas. The LT-SPICE model of the line was implemented and the comparison of simulation and experimental results presented a good agreement.

Keywords— Nonlinear transmission lines (NLTLs), RF radiation, varactor diode, filter.

I. INTRODUCTION

Recently, the NLTL technology has been studied to produce high power microwave signals. The NLTLs can be used as an alternative technique for pulsed high-power transmitters that includes the RF generator and the solid state (SSA) / traveling wave tube (TWT) amplifiers [1,2]. High power pulses with a peak power of 20 MW have been produced in the frequency range of 1 GHz [3]. In [4], a capacitive NLTL produced a peak power of 60 MW at 200 MHz. Other works presented the development of high power NLTLs for medical applications [5,6]. They are studying the physiological responses of pulsed RF signal focusing on cancer treatment. Another study demonstrated the design of Radiofrequency Identification (RFID) system based on NLTL [7]. RFID uses electromagnetic fields to identify and track tags attached to objects. It is often seen as an important component of the Internet of Things (IoT) [8].

The high power NLTL could be used as a transmitter section of aerospace radars that includes the pulse modulator and the high power amplifier. In a pulsed radar, the transmitted RF pulsed signal reflects from a surface of an object and returns to a receiver giving information about the location and the speed of the object. Signal processing of this information can be used to create a high-resolution image of the object. This technology is used in Synthetic Aperture Radar (SAR) [9].

A recent article presented the advances that have enabled CubeSats as viable platforms for radar missions. However, the size and weight constraints of the CubeSat drive many of the radar RF design challenges [10].

Considering that the NLTLs used as a pulsed RF transmitter offer advantages such as simplicity, lightweight, compactness and lower cost, this technology can be seen as a promising alternative for space missions involving nanosatellites.

Very few articles presented experimental results regarding the transmission and reception of the RF signals generated by lumped capacitive NLTLs.

Although most of the studies are concentrated on high voltage NLTL, an experiment with low voltage has the advantage that the NLTL can be assembled with commercial-off-the-shelf (COTS) components and the measurements can be performed with good accuracy in the laboratory. This kind of experiment is important to evaluate the soliton propagation characteristics such as time delay, width, number of oscillations and voltage

modulation depth (VMD).

Previous works investigated the performance of low voltage capacitive NLTLs. They analyzed the nonlinear partial differential equation (PDE) of these networks, the influence of the input pulse shape and the resistive load on the RF generation [11-13].

This paper reports an investigation of the performance of a 20-section lumped capacitive NLTL based on varactor diodes. In this work, the line was driven by a 13 V input signal with a frequency repetition rate of 5 MHz to produce a pulsed RF signal with oscillations of voltage modulation depth (VMD) of about 5 V and frequency around 230 MHz.

The pulsed signal generated by the NLTL was first measured on a resistive load. Then a Chebyshev filter was designed and connected to the line output to extract only the high-frequency spectral components of the signal.

The output signal was radiated and received using two double-ridge guide antennas. The NLTL performance was evaluated through time domain analysis and Fast Fourier transform (FFT) of the RF signal. An LT-SPICE model of this line was used for comparison between simulations results and experimental data.

II. NLTL BASIC THEORY

A capacitive NLTL is implemented using inductors and variable capacitors as nonlinear components arranged in a series of LC section low pass filters (Fig.1). In this experiment, a varactor diode is used as a variable capacitor (Fig. 1). The capacitance of the diode varies according to the applied reverse voltage.
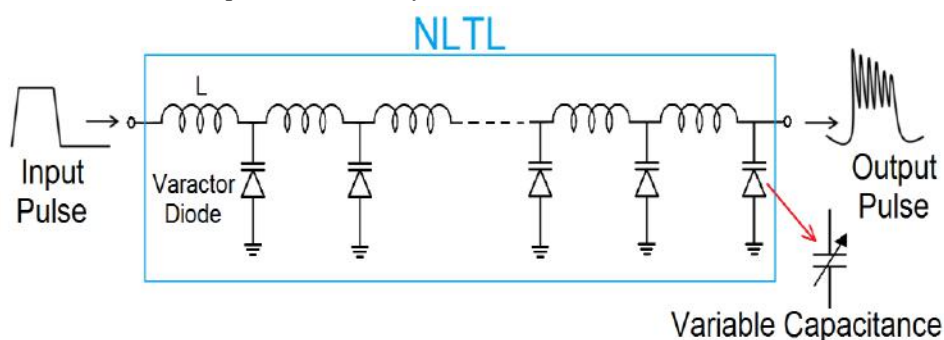

Fig. 1: NLTL circuit using varactor diodes as variable capacitors.

The input pulse injected into the line propagates down the line length. As the capacitance of the varactor diodes decreases with the pulse amplitude, the portion of the pulse with higher amplitude will travel faster than its part with lower amplitude. It happens because the propagation velocity of the pulse increases as the voltage increases. In this case, the soliton wave formed by the higher voltage overtakes the wave produced by the lower voltage, and then the oscillating soliton is formed in the final section of the line. The phase velocity can be calculated using [14]

$$\upsilon_p = 1/\sqrt{LC(V)} \qquad (1)$$

where C(V) is the variable capacitance as a function of the voltage applied across the varactor diode and L is the inductance.

The cutoff frequency of the line, known as the Bragg frequency, is given by [14]

$$f_c = 1/\pi\sqrt{LC(V_{max})} \qquad (2)$$

where C(Vmax) is the capacitance at the maximum voltage applied across the varactor diode.

Another important parameter of the line is the characteristic impedance [14]

$$Z_0 = \sqrt{L/C(V)} . \qquad (3)$$

The impedance of the line also depends on the reverse voltage applied on the diode varactor. As reported before the diode capacitance decreases with the voltage.

III. EXPERIMENTAL AND SIMULATION RESULTS

The measurements were performed on a 20-section capacitive NLTL that was built with linear inductors of 100 nH and SVC236 varactor diodes (Fig. 2).
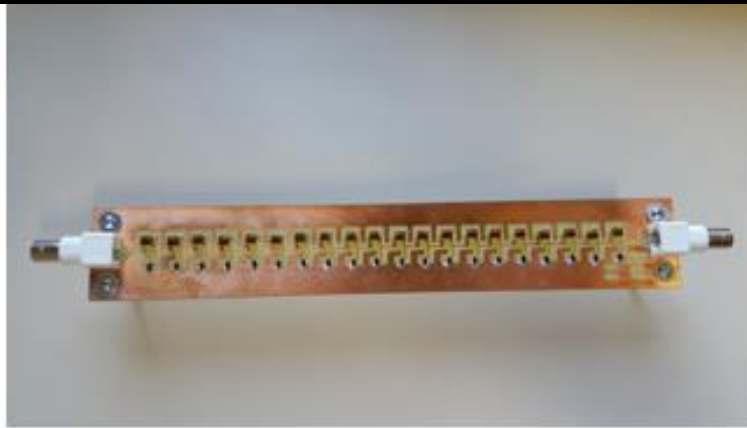
Fig. 2: Photograph of the 20-section capacitive NLTL.

The SVC236 diode capacitance-voltage behavior obtained from the manufacturer's datasheet [15] is shown in Fig. 3.
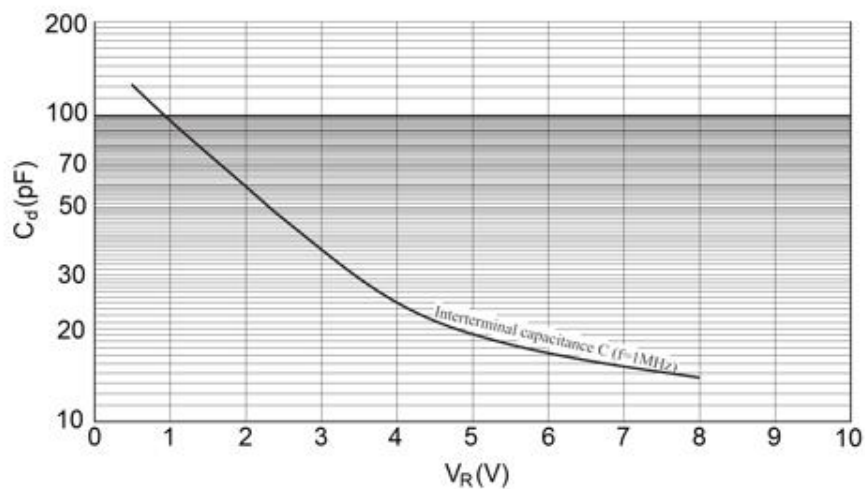
Fig. 3: Diode capacitance (C_d) as a function of reverse voltage (V_R).

From Fig. 3, making an extrapolation of the curve one obtains that $C(V_0)$ is of the order of 155 pF and $C(V_{max})$ is of about 11.5 pF, which gives 93% of capacitance change from the unbiased value to the capacitance value at 10 V.

Since the NLTL never fully matches the load as the line characteristic impedance according to (3) varies from an unstressed value of 93 Ω to a stressed value of 25 Ω, a resistive load of 50 Ω was used during the measurements at the output of the line and a pair of antenna with 50 Ω impedance was also used for radiation measurements.

The capacitive NLTL was driven by a function generator (HP 33120A) and a voltage amplifier (Apex PA98). It was supplied an input voltage of 13 V peak. A digital oscilloscope (Rohde & Schwarz RTE 1052) was used to perform the measurements.

3.1. LT-SPICE MODEL

The simulations were performed using the LT-SPICE software. The schematic circuit with 20 sections used for the simulations of the line directly connected to a resistive load and to a high-pass filter is shown in Figs. 4 and 5, respectively. In these models, the Ohmic losses (R_L=0.3 Ω and R_D=1.0 Ω) and the self-stray capacitance of the inductors (C_P=1.5 pF) were also considered. The simulation results were compared with the corresponding experimental results.
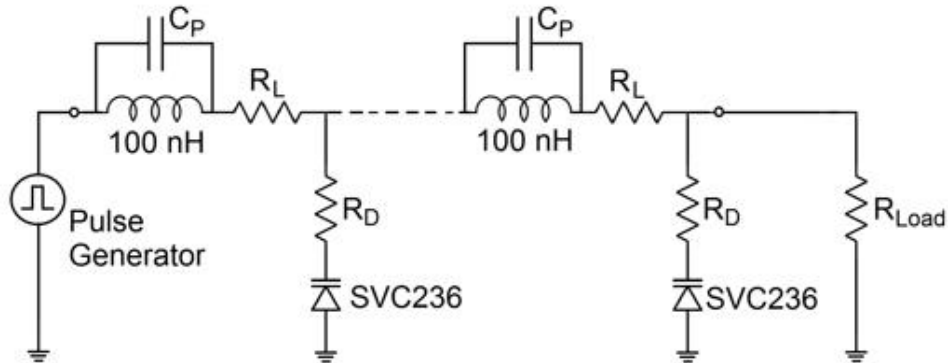
Fig. 4: NLTL schematic circuit model for the LT-SPICE simulations.
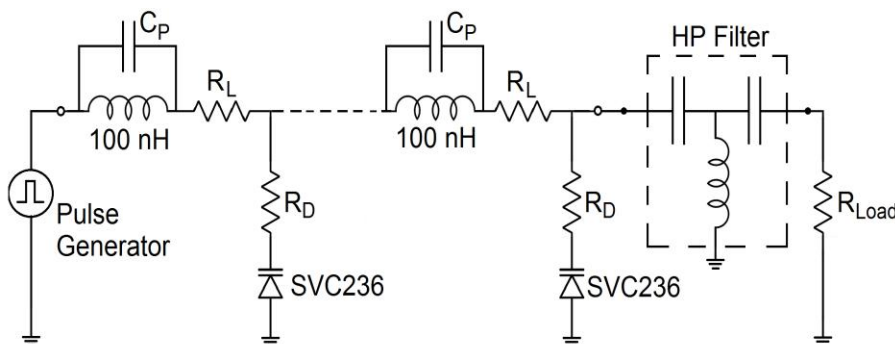
Fig. 5: NLTL schematic circuit model for the LT-SPICE simulations with the high-pass filter.

3.2. RESISTIVE LOAD MEASUREMENTS

The measurements were evaluated from the signal measured through the 50 Ω input of the oscilloscope. A 30 dB attenuator was connected between the line output and the oscilloscope input (Figs. 6 and 7).

Fig. 6: Block diagram of the experiment with the 50 Ω load.
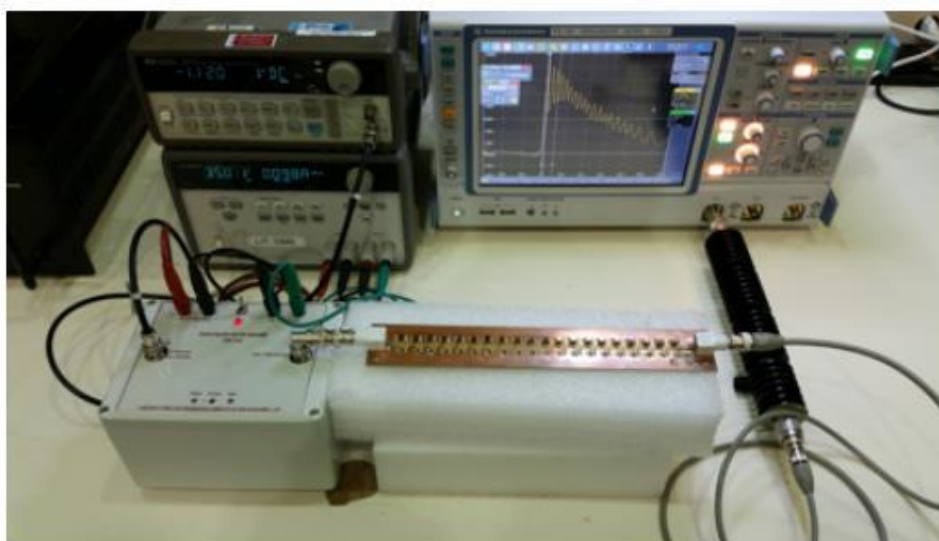
Fig. 7: Photograph of the test setup.

The time response of the simulation and experimental measurement at the 50 Ω resistive load, according to the test setup shown in Fig. 6, is presented in Fig. 8 in short-time and long-time scales to show the pulse repetition frequency of 5 MHz.

(a)

(b)
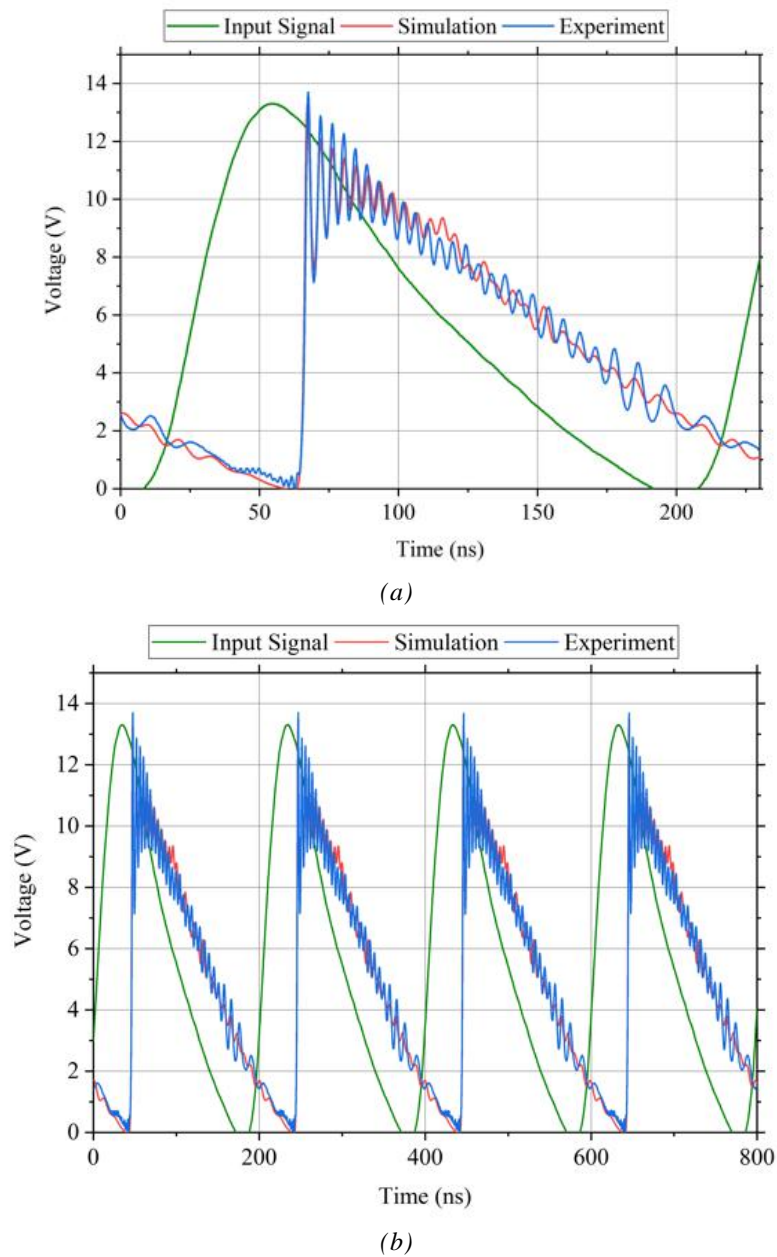
Fig. 8: Time domain plots of the input pulse (experimental) and the waveforms obtained on the 50 Ω resistive load (simulation and measurement) in a short-time scale (a) and in a long-time scale (b).

The frequency domain plot on the decibel scale is shown in Fig. 9. The frequency of the oscillations obtained from measurement and simulation is around 230 MHz.
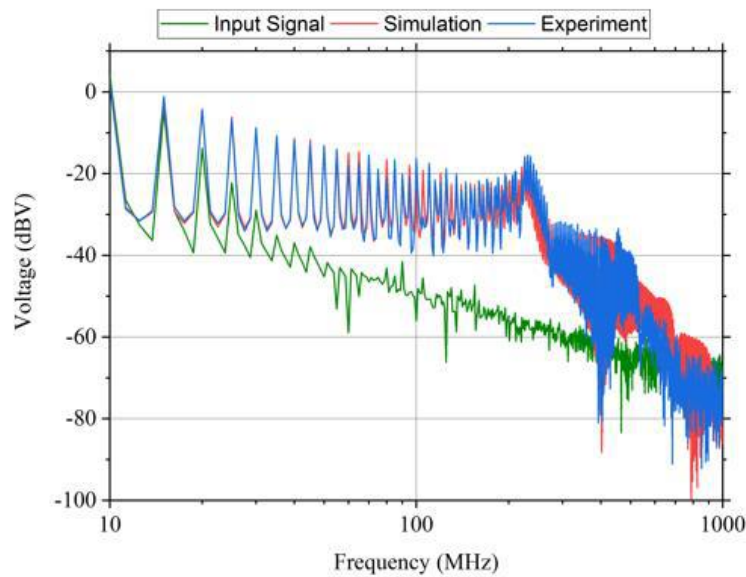
Fig. 9: FFT plot of the input pulse (experimental) and the pulsed RF signal (simulation and measurement) at the 50 Ω resistive load.

3.3. HIGH-PASS FILTER DESING AND MEASUREMENTS

According to Fig. 9, frequency component around 230 MHz was generated by the capacitive NLTL. In order to separate this frequency from the low voltage components of the input pulse signal, a high-pass filter with a cutoff frequency of 200 MHz was designed and connected at the output of the line. A third-order Chebyshev high-pass filter with T topology was chosen for this experiment. The Chebyshev response has ripples in the passband. For this experiment, 0.25 dB ripple was chosen as a designed parameter. Considering the line impedance equal to load impedance, the element values (C_1', L' and C_2') for a normalized Chebyshev filter with 0.25 dB ripple are 1.3034, 1.1463 and 1.3034, respectively [16]. The filter components were calculated according to [17,18]

$$C_1 = C_2 = 1/2\pi f C' Z_0 = 12.21 \ pF \qquad (4)$$

$$L = Z_0/2\pi f L' = 34.71 \ nH \qquad (5)$$

where L is the shunt inductor, C_1 and C_2 are the series capacitors connected to the line and the load, respectively, C'=C_1'=C_2'=1.3034 and L'=1.1463 are the normalized component values for the Chebyshev filter, Z_0 = 50 Ω and f = 200 MHz.

The circuit was implemented using a commercial standard capacitor and inductor values (Fig. 10).
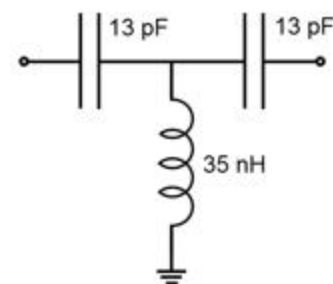
Fig. 10: High-pass 3rd order Chebyshev filter.

The filter was constructed in a separated circuit board to be characterized before the connection with the line (Fig. 11).

Fig.11: Filter photograph.

For insertion loss calculation the filter circuit is represented by impedances (Fig. 12).
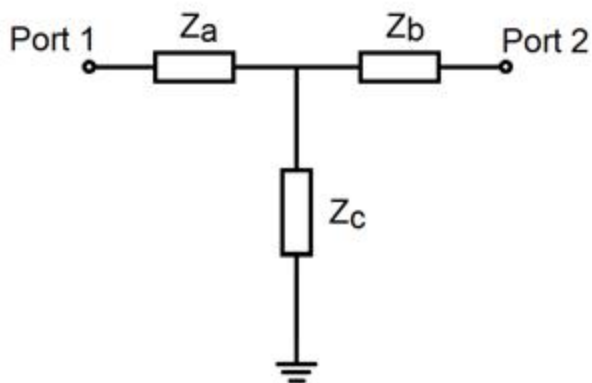
Fig. 12: Open-circuit impedances structure.

The network between port 1 and port 2 can be represented with the ABCD matrix as:

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & Z_a \\ 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 \\ 1/Z_c & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & Z_b \\ 0 & 1 \end{bmatrix} \quad (6)$$

The impedances Z_a, Z_b, and Z_c can be calculated by

$$Z_a = -1/j\omega C_1 \quad (7)$$

$$Z_b = -1/j\omega C_2 \quad (8)$$

$$Z_c = j\omega L \quad (9)$$

where C1=C2=13 pF, L=35 nH and $\omega = 2\pi f$.

Then the elements of the ABCD matrix were calculated below

$$A = 1 + Z_a/Z_c \quad (10)$$

$$B = Z_a + Z_b + (Z_a Z_b/Z_c) \quad (11)$$

$$C = 1/Z_c \quad (12)$$

$$D = 1 + Z_b/Z_c \quad (13)$$

The relation between the input voltage (V_1) and current (I_1) and output voltage (V_2) and current (I_2) of a two-port network (Fig. 13) can be represented as:

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix} \quad (14)$$

where A, B, C, and D coefficients are frequency dependent.
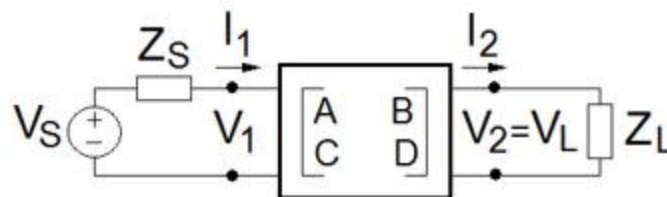
Fig. 13: Two-port network.

The transfer function V_S/V_L for the circuit in Fig. 13 is given by

$$\frac{V_S}{V_L} = \frac{AZ_L + B + CZ_S Z_L + DZ_S}{Z_L} \quad (15)$$

where V_S and V_L are the source and load voltages, respectively, and Z_S and Z_L are source and load impedances, respectively.

Then, using (7)-(9), (10)-(13), and the ratio V_S/V_L given by (15), the insertion loss function can be calculated by

$$\frac{P_1}{P_2} = \left(\frac{Z_L}{Z_S + Z_L}\right)^2 \left|\frac{V_S}{V_L}\right|^2 \quad (16)$$

where P_1 is the power delivered to the load when the network is removed from the circuit whereas P_2 is the power delivered to the load when the network is in place.

Finally, the insertion loss (IL) of the filter can be expressed in dB:

$$IL = 10 \log\left(\frac{P_1}{P_2}\right) \; (dB). \quad (17)$$

Considering $Z_S = Z_L = 50$ Ω the insertion loss was calculated and measured through a Vector Network Analyzer (VNA) for the frequency range between 10 MHz and 500 MHz (Fig. 14).
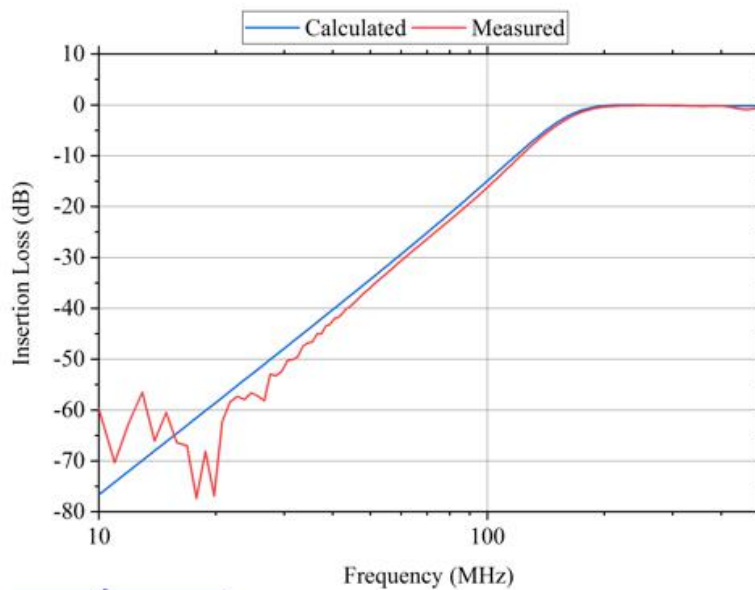
Fig. 14: Filter Insertion loss.

According to Fig. 14 the calculated insertion loss presents a good agreement with the measurement results.
The high-pass filter was connected to the output of the capacitive NLTL. The measurements were evaluated from the signal measured through the 50 Ω input of the oscilloscope (Fig. 15).

Fig. 15: Block diagram of the experiment with the high-pass filter.

The time response of the simulation and experimental measurement at the NLTL connected to a 50 Ω load through a high-pass filter, according to the test setup shown in Fig. 15, is presented in Fig. 16 in short-time and long-time scales. The frequency domain plot on the decibel scale is shown in Fig. 17.
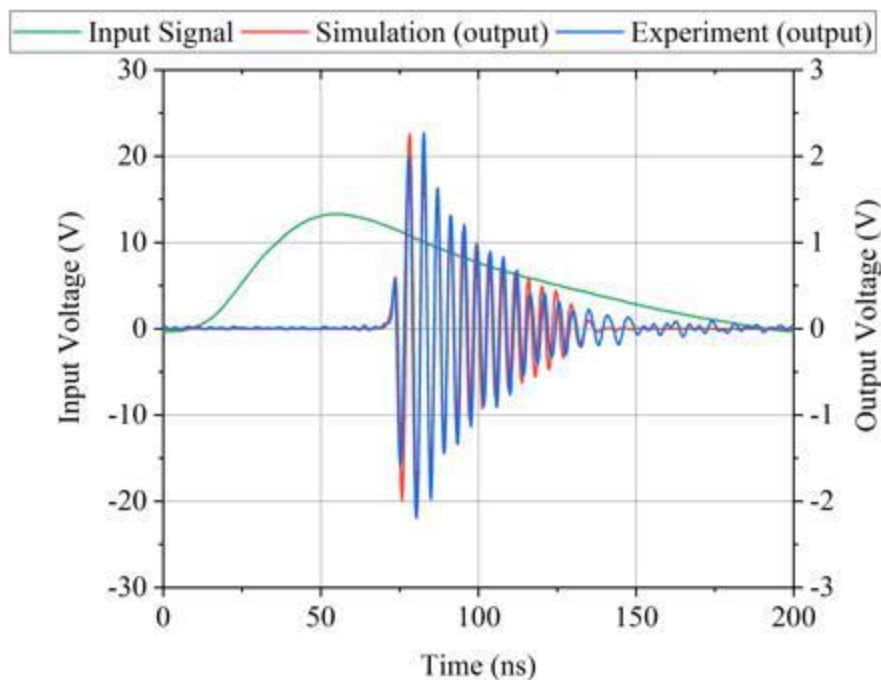
(a)
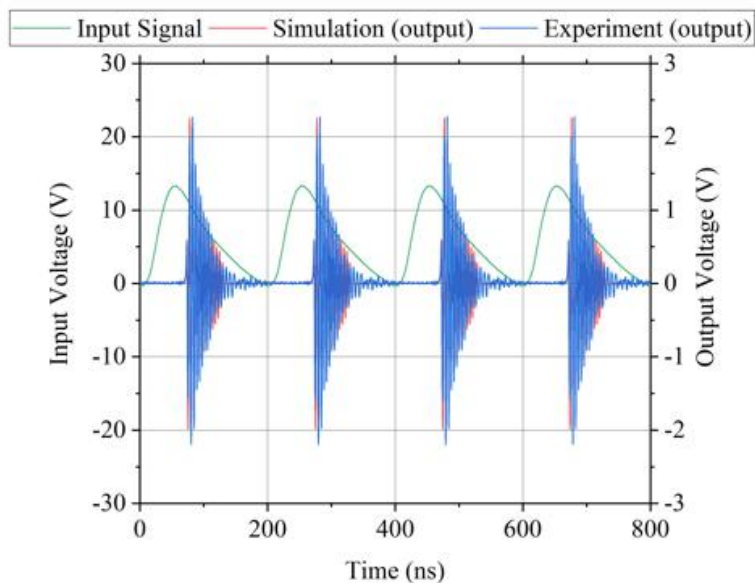
(b)

Fig. 16: Time domain plots of the input pulse (experimental) and the waveforms obtained on the 50 Ω resistive load (simulation and measurement) in a short-time scale (a) and in a long-time scale (b).
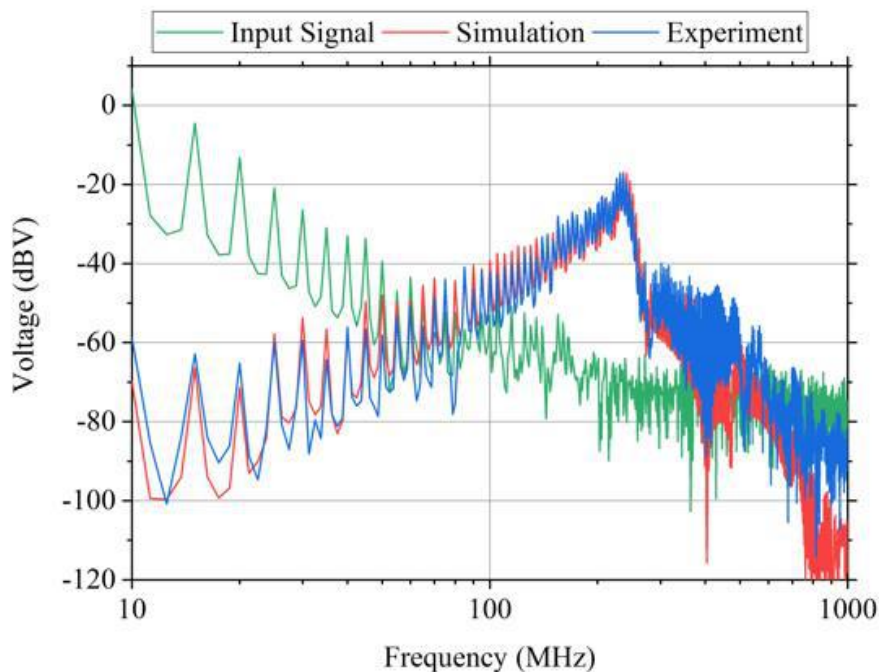
Fig. 17: FFT plot of the input pulse (experimental) and measured on the 50 Ω resistive load when the filter is connected to the line (simulation and measurement.

Fig. 18 shows the comparison between the measurements of the RF pulsed signal at the output of the line without the high-pass filter (Fig. 9) and with the high-pass filter (Fig. 17). It is possible to see that the filter provided a high attenuation for the low-frequency components.
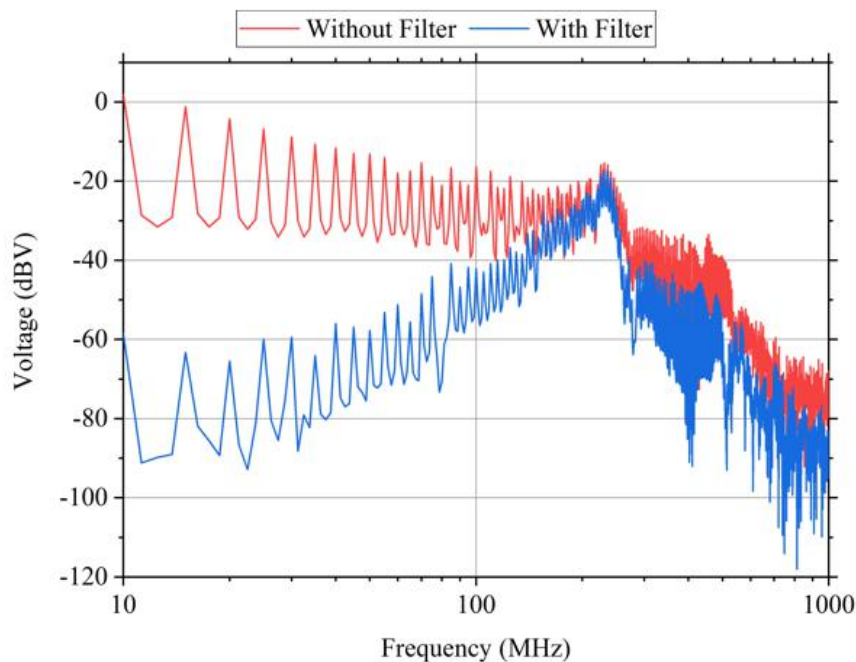
Fig. 18: FFT plot of the pulsed RF signal measured at the 50 Ω with and without the high-pass filter.

IV.   RADIATION MEASUREMENTS

Two Double-Ridged Guide (DRG) antennas (ETS-Lindgren 3106B) were used to transmit and receive the RF signal. It is a broadband antenna that operates in the frequency band from 200 MHz up to 1 GHz.

The antennas were placed in vertical polarization with a two-meter spacing. The receiving antenna terminal was connected through a coaxial cable to the 50 Ω input of the oscilloscope.

The measurements were performed in an anechoic chamber to avoid electromagnetic interference (Figs. 19 and 20).
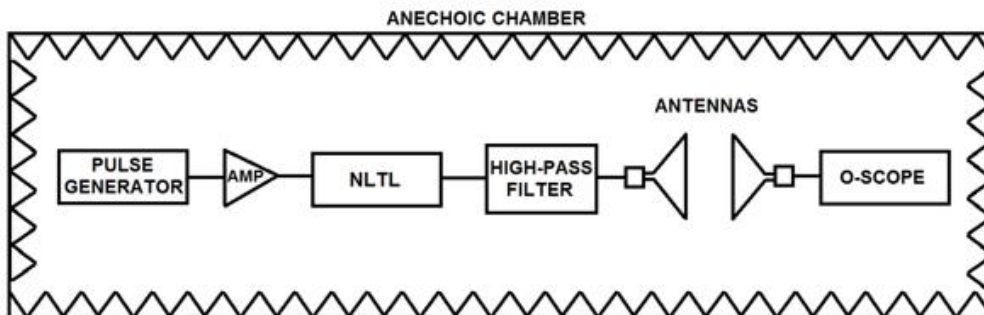
Fig. 19: Block diagram of the experiment with DRG antennas.
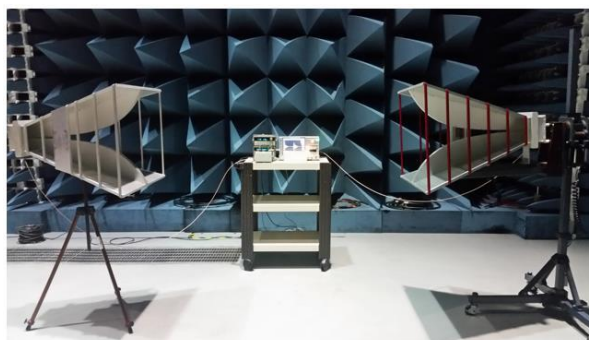
Fig. 20: Photograph of the test setup in the anechoic chamber.

The time response of the RF signal measurement captured by the receiving antenna, according to the test setup shown in Fig. 19, is presented in Fig. 21 in short-time and long-time scales. The frequency domain plot is shown in Fig. 22.
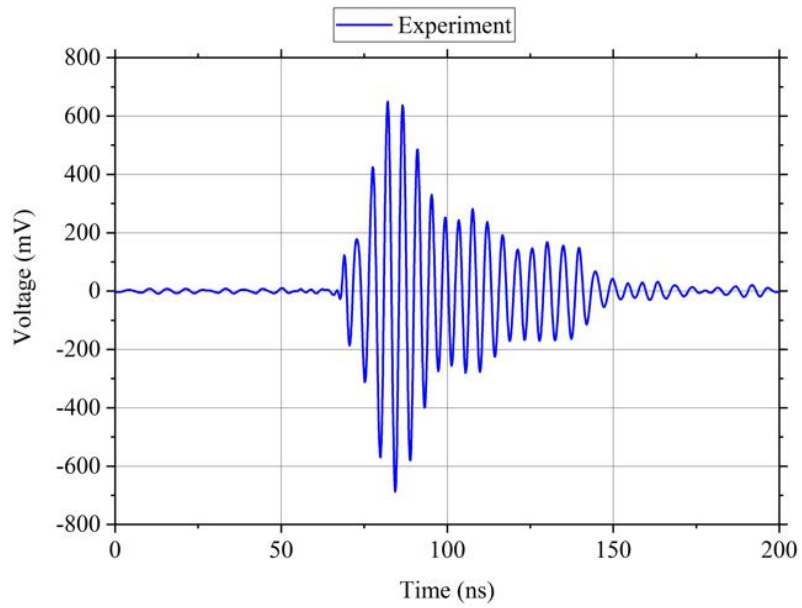
(a)
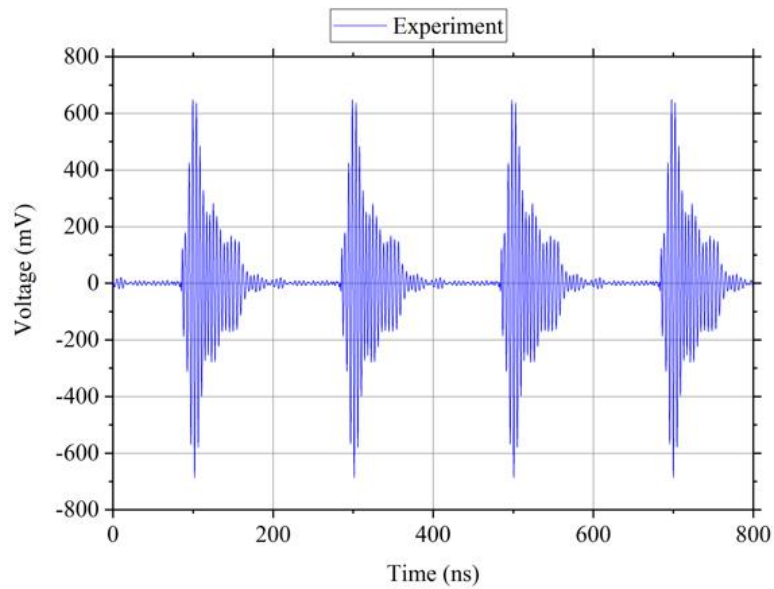
(b)

Fig. 21: Time domain plots of the signal received by the DRG antenna in a short-time scale (a) and in a long-time scale (b).
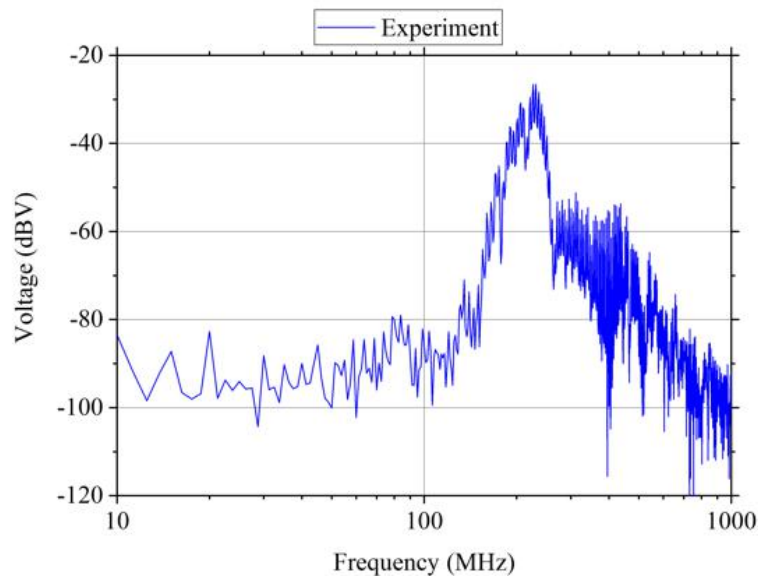
Fig. 22: FFT plot of the pulsed RF signal received by the DRG antenna.

Fig. 23 shows the comparison between the RF pulsed signal at the output of the line without the high-pass filter (Fig. 9), with the high-pass filter (Fig. 17) and received by the DRG antenna (Fig. 22).
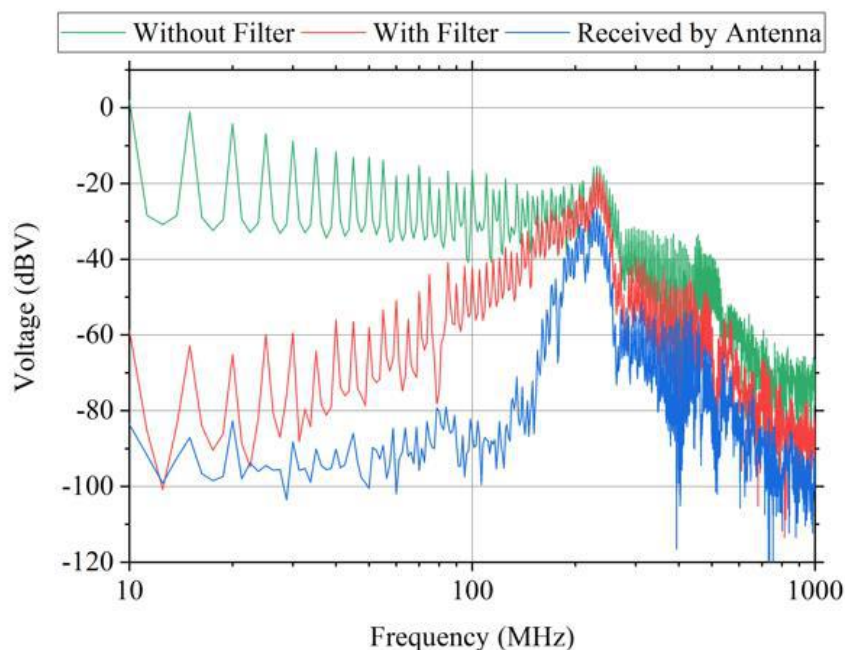
Fig. 23: FFT plot of the pulsed RF signal measured at the 50 Ω load with and without the filter and received by the DRG antenna.

V. CONCLUSION

This article reports the excellent results obtained with a 20-section low voltage lumped capacitive NLTL in which oscillations of the order of 230 MHz were produced and radiated using Double-Ridged Guide (DRG) antennas. The performance of the line was investigated focusing on the extracting of the RF signal from the line and the irradiation by an antenna.

The LT-SPICE models implemented for simulations presented a good agreement with the experimental data.

It was demonstrated that the Chebyshev filter is very efficient in extracting the RF signal from the soliton pulse. The insertion loss is less than 1 dB within its passband and it provided a 60 dB attenuation for the lower frequency components. The oscillation frequency remains practically the same around 230 MHz for the three different cases:

- Measurement of the signals performed directly at the 50 Ω load;
- Measurement of the RF signals extracted from the line through a high-pass filter;

- Measurement of the RF signals received by an antenna.

The RF pulses have been perfectly transmitted and received by the DRG antenna. Future work shall include the analysis of different filter topologies for the decoupling circuit.

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Study and Analysis of Intz water tank with manual and software-based design with base isolation

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Abstract— *The seismic response of an overhead water tank, cylindrical, extra-large water storage tank by using triple friction pendulum system is analyzed. Most of the overhead tanks have a fundamental frequency which includes a series of resonance of greatest earthquake ground motions. It is an operative way to reduce the response of an isolation system used for storage of water tanks under a sturdy earthquake. However, it is problematic to implement in preparation with common isolation bearings*

The research is directed with study of existing studies in the field of seismic behavior of intz water tank. Base isolation is one of the technologies applied to decrease the consequence of earthquake effect. The principle is to separate the base of the overhead water tank from footing ground. The problematic is taken as Intz water tank design to survive water tank against seismic accomplishment. three categories of base are used to analyses and compare overhead first is manual design of intz water tank with fixed base + response by SRSS and second case is intz water tank with fixed base by sap2000 and Third case with is intz water tank with triple friction pendulum on sap2000.

The software SAP 2000 are used to assessment fixed and triple friction pendulum base intz water tank. It is primary period in India when overhead water tank is tested with triple friction pendulum isolation are analyzed for seismic zone V. It is initiate from results that deflection and base shear analyzed with triple friction pendulum are lesser than fixed base with outstanding margin and it is determined that study endorses use of triple friction pendulum base isolation for seismic zone V in India.

Keywords— Intz water tank, Seismic, Fixed Support, triple friction pendulum Support, SAP2000, Deflection, base shear.

I. INTRODUCTION

Elevated Water tanks are salvation developments which are being constructed in growing numbers to store water for drinking purpose. The capacities of these containers are huge and have capacities of around 1800 m³ or it may be large depends on the population of that area. Elevated water tank consists of an RCC container or it may made up of steel tank, which contains the large amount of water, the seismic study of these structures is a difficult and thought-provoking task because the construction of the tank based on the with a smaller number of footing and column as compare to building and the soil erection contact must be considered. water tanks present an excessive risk if they were failed during an earthquake.

Base isolation is a demonstrated knowledge for the seismic strategy of structures. The system diminishes the probability of structural and non-structural damage to a water tank exposed to seismic forces. By using base isolation, we can reduce the lateral forces and displacement of the structure which can damage the structure through earthquake. Due to which we can save the government property and water which get distributed to people.

However, in spite of base isolation's safety benefits, the technology is under operated. Although tall, flexible, and non-critical facilities such as office buildings are not the most ideal candidates for base isolation, they may still achieve an optimal seismic design by using the technology. Therefore, in order to increase the quality and prevalence of base isolated structures, there is a need to study the technology's seismic performance enhancements and cost effectiveness for projects on which the system is infrequently used.IS 1893:2002 is the code to design structures under earthquake zones. There are two major methods of seismic analysis which are

1. **Response Spectrum Analysis:** This Analysis is based on ideal predefined statistics which are not actual time data collected since actual earthquake in the part.

a) SRSS b) CQC

2. **Time History Analysis:** This Analysis is based on genuine real time data composed under actual earthquake. Elevated water tank response and behavior is composed in real time and can be used to design future elevated water tank under seismic loading.

Need of study

1.Baseisolation technique is newly isolated structure which is provided at the base of structure.it is only performed on building and hospital etc. None of the research is done on base isolation on elevated water tank.

2.So the approach is done on Base isolation for Elevated water tank or manual and software comparison.

II.   PROBLEM DESIGN

The design of overhead Intze Water Tank is carried out using the manual and computer aided design software sap2000 Elevated storage reservoir. The design is carried out as per relevant analysis procedures combined with Indian Standard Codes of Practices. The water tank dome is designed by working Stress's method. The foundation forces at the level of safe bearing capacity are also evaluated The software also gives the shape description of the tank and keeping various constraints, one can change the governing constraint to get the optimum result and safe design with economy.

PLAN DATA: Structural design of intz water tank of capacity 900000 liters.

Location of site: BHUJ (GUJARAT)

Type of tank: Intze water tank

Staging System Chosen: Column Braced

Geometrical Data

Seismic Zone: V

Soil properties

Soil Description: Medium soil

Safe Bearing Capacity at Depth 1 m: 150 Kn/m²

Manual Design of intze water tank :-
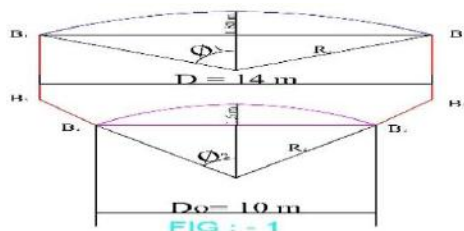
Fig. 1: Dimension of intz tank

Volume of water Tank = 900000.00 litre capacity

Height of Staging =16.00 m

Suppose the Diameter of Cylindrical's portion = D = 14.00 m

And Radius of Cylindrical's Portion R = 7.00 m

Suppose the Diameter of Ring Beam B2 = Do = 10.00 m

And Radius of Ring Beam B2 = Ro = 5.00 m

Suppose Height h_o of Conical Dome = 2.00 m

Suppose Rise h1=1.800 m ;   Rise h2 = 1.600 m

The Radius R2 of lowest dome is given by

  $h2 * (2 * R2 - h2) = R^2 0$

$1.6 * (2 * R2 – 1.6) = 5^2$

Radius of lowest dome R2=8.610 m

$\sin Ø2 = 5/8.61 = Ø2 = 35.500^o$

$\cos Ø2 = 0.8141$ $\tan Ø2 = 0.71330$

suppose h be the height of cylindrical's portion

From which h = 4.780 m

Permitting for free board keep h = 5.00 m

For the top dome, the Radius R1 is given by

  $h1* (2 * R1 – h1) = R^2 0$

$1.600 * (2 * R1 – 1.600) = 7.00^2$

Radius of lowest dome R1=14.510 m

$Sin Ø1 = 5.00/14.510 = 0.48240$

$Ø1 = 28.840^o$

$Cos Ø1 = 0.87600$

2 - DESIGN OF TOPMOST DOME

Suppose Thickness t1 = 100.00 mm

Taking Live load = 1500.00 N/m²

Total P per sq.m of dome = 0.1 x 25000.00 + 1500.00

Ptotal= 4000.00 N/m²

Meridional's Thrust's at edges

T1= P*R1/1+ CosØ1

T1= 4000.00 * 14.510 / 1.00+00.8760 = 30938.00 N/m

Meridonal's.Stress's per metre = T1/t x d

Meridonal's.Stress's per metre = 30938.00 / 100.00 x 1000.00

Meridonal's.Stress's =00.31 N/mm² -: safe

Extremes hoops Stress's arises at the centre and its magnitude's = P*R1/t1 x 2

=4000.00 x 14.510/2.00 x 0.10=290200.00 N/m²

Extremes hoops Stress's= 00.29 N/mm² -: safe

Since's the Stress's are in safe limit, offer's nominal reinforcements @ 0.3 %

As = 00.30 x 100.00 x 1000.00 / 100.00

As = 300.00 mm²

Using 8 mm Ø bar , AØ = 50.00 mm²

Space = 1000.00 x 50.00 / 300.00 = 160.00 mm

-: 8.00 mm Ø bar @ 160.00 mm c/c in both direction

3 DESIGN OF TOPMOST RING BEAM B1

Horizontal Element of T1 is given by

P1 = T1 * CosØ1

P1 = 30938.00 x 00.8760 =27102.00 N/m

Whole tension's tending's to ruptures the beams = P1 x D/2

Ac = 27102.00 x 14.00 / 2.00 =189712.00 N

Whole's tensions tendings to rupture's the beam = 189712.00 N

Permissible Stress's in HYSD bars = 150.00 mm²[IS 456 :2000]

Ash = Whole tension tending to rupture the beam/ Permissible Stress's hysd bars

Ash = 189712.00 / 150.00 = 1265.00 mm²

Ash actual = 1265.00 mm²

No. of 20.00 mm Ø bars = Ash actual / Area of bar

No. of 20.00 mm Ø bars = 1265.00/ 314.160

No. of 20.00 mm Ø bars = 4.00

Actual Ash offerd = 314.160 x 4.00 =1257.00 mm²

The areas of cross sections of rings beams is given by

Ac =Whole tension tending to rupture the beam/A+(m-1) x Ashp

 = 189712.00 / A + (13.0-1.0) x 1257.00 =A = 143014.00 mm²

Offer ring beam of 360.0 mm depth and 400 mm width. Tie the 20 mm Ø rings 6.00 mm Ø Nominal stirrups @ 200.00 mm c/c

Topmost Ring Beam =400.0x360.0 =144000.0 mm² **-: Safe**

4 DESIGN OF CYCLINDRICAL's WALL's

In the membrane analysis , the tank is projected to be free at top and bottom. Extreme hoops tension's occur's at the base of wall ,its magnitude is given by :-

    P = w * h x D / 2

    P = 9800.00 * 5.00 x 14.00 / 2.0

    P = 34300.00 N/m

Area of Steel Ash = P / Permissible Stress's

Ash = 34300.00 / 150.00

Ash = 2286.00 mm² per metre height

Provided that ring's on both the faces,

Ash on each-face = 2286.00/2.00

Ash on each-face = 1143.00 mm²

Space of 12 mmØ rings@per m =1000.00 x 113.00 / 1143.00 =98.90 mm

Offer 12 mm Ø rings @ 95 mm c/c at bottom. This space can be increased at the top

Actual Ash offerd = 1000.00 x 113.00 / 95.00

Actual Ash offerd = 1190.00 mm² on each-face

Permitting 1.200 N/mm² Stress's on composite section

1.2= At /1000.00 x t +(m-1) Ash offerd x 2.00

1.2= 343000.00 / 1000.00 x t + (13.0-1.0) x 1190.00 x 2.00

t = 257.330 mm

minimum thickness = 3H' +5.00 = 3x5.00 + 5.00 =200.00 mm

Average t = 300.00+200.00/ 2.00 = 250.00 mm

% of distribution steel =0.30 [250.0-100.0/450.0-100]x0.1 =0.24

Ash offerd = 0.24 x 250 x 1000 / 100 = 650.00 mm²

Area of steel on each-face = 325.00 mm²

Space of 8 mm Ø bar = 1000.0 x 00.785 x 8² / 325 = 155. mm

-: offer 8.00 mm Ø bars @ 150.00 mm c/c on both faces

To resist the hoop tension at 2 m below top

    Ash =2.00 x 2286.00 /5.00

    Ash = 914.400 mm²

Space of 12.00 mm Ø rings = 1000.00 x 113.00 /914.40/2.00

Space of 12.00 mm Ø rings = 247.00 mm

-: offer Space of 12.00 mm Ø rings 240.00 mm c/c in the top 2.00 m height's

At 3.00 m below's the top

    Ash =3.00 x 2286.00 /5.00

    Ash = 1372.00 mm²

Space of 12.00 mm Ø rings = 1000.00 x 113.00 /1372.00/2.00

Space of 12.00 mm Ø rings = 164.700 mm

-: offer Space of 12.00 mm Ø rings 160.00 mm c/c in the next 1.00 m height's

At 4 m below's the top

    Ash =4.00 x 2286.00 /5.00

    Ash = 1829.00 mm²

Space of 12.00 mm Ø rings = 1000.00 x 113.00 /1829.00/2.00

Space of 12.00 mm Ø rings = 123.60 mm

-: offer Space of 12.00 mm Ø rings 120.00 mm c/c in the next 1.00 m height's

-: offer Space of 12.00 mm Ø rings 95.00 mm c/c as found earlier

5 DESIGN OF RING BEAM B3

   The ring beam joins the tank wall through conical dome. The vertical load at the junction of the wall with conical dome is shifted to ring beam B3 by meridional's thrust's in the conical dome. The horizontal's element of the thrust's causes hoop's tensions at the joint The ring beam is offerd to take up this hoops tensions refer fig 2 the load W transmitted through tank wall at the top of conical dome consist of the following
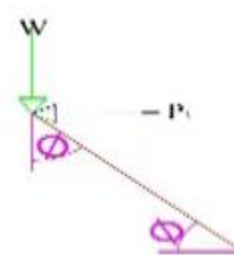
Fig. 2: Load Transmitted

1) Load's of top dome = T1 SinØ1 = 30938.00 x 0.4824.00 = 14924.00 N/m

2) Load's due to the ring beam B1 = 0.360 x (0.40 – 0.20) x 1.00 x 25000.00 = 1800.00 N/m

3) Load's due to tank wall = 5.00 (0.20 + 0.30 / 2.00) x 1.00 x 25000.00 = 31250.00 N/m

4) Self 'sload's of beam B3 = (1.00 – 0.30) x 0.60 x 25000.00 = 10500.00 N/m

Entire W=14924.0 + 1800. 0+31250.0 +10500.0 =58474.0 N/m`

Angle of conicals domes wall with Vertical Ø° = 45.00°

$sin Ø^o = cos Ø^o = 0.70710$ $tan Ø^o = 1.00$

$Pw = W \times tan Ø^o = 58474.00 \times 1.00$

Pw= 58474.00 N/m

Pw1 = w x h x d3 = 9800.00 x 5.00 x 0.600

Pw1 = 29400.00 N/m

-: hoops tension's in the rings beams is given by

P3 = (Pw + Pw1)x D/2

P3 = (58474.00 +29400.00) x 14.00 /2.00

P3 = 615118.00 N

This to be resisted entirely by steel hoops, the area of which is

Ash = P3 / permissible Stress's

Ash = 615118.00 / 150.00 = 4100.00 mm²

Number of 28 mm Ø bars = 4100.00/615.75.00

-: offer 7 rings of 28 Ø bars

Actual Ash = 0.785 x 28 ² x 7

Ash = 4310.26 mm²

Stress's in equal section = P3 / d x h + (m-1) x Ash offerd

Stress's in equal section = 615118.00 / (1000.00 x 600.00) + (13.0 -1.0) x 4310.260

Stress's in equal section = 00.940 N/ mm² < 1.200 N/mm² safe

 8.00 mm Ø distribution's bars offerd in the wall @ 150.00 mm c/c should be taken to rounded off the above ring acts as stirrups

6 DESIGN OF TAPERING DOME

1)Meridional's thrusts; - the weight's of water (fig 3)
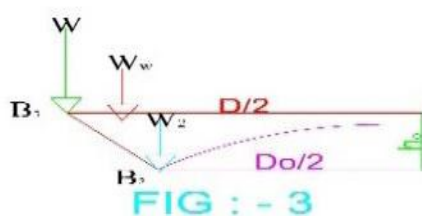
Fig. 3: Forces at conical section

$Ww = \frac{\pi}{4} D^2 * h + \frac{\pi}{12} * ho (D^2 + Do^2 + D * Do) - \frac{\pi}{3} h * 2^2(3R2-h)$

Ww = 4392368.00 N

Suppose the thickness of conical slab be 400.00 mm

-: Total Self Weight Ws is given by

$Ws = [\pi * \left(\frac{D+Do}{2}\right) x \, l \, x \, to] \, x \, \gamma c$

Ws = 25000.00 x 3.140 (14.00+10.00/2) x 2.820 x 0.40

Ws = 1066131.00 N

Weight W at B3 = Pw

W = 58474.00 N/m

-: Perpendicular load W2 per metre run is given by

$W2 = \frac{\pi*D*W+Ww*Ws}{\pi Do}$

$W2 = \frac{\pi \, x \, 14.00 \, x \, 58474+4392368.00+1066 6131}{\pi x \, 10.00}$

W2 = 255613.00 N/m

Meridional's thrusts To in the conical dome

To = W2/cosØo

To = 255613.00 x 1.4140

To = 361437.00 N/m

Meridional's Stress's = To / b*d

Meridional's Stress's = 361437.00 / 1000.00 x 400.00

Meridional's Stress's = 0.900 N/mm²

00.90 N/mm² < 1.200 N/mm² -: safe

b) Hoop Tension: - Fig no 3 Diameter of tapering dome at any height h' above base is D' = 10.0 + (14.0-10.0/2)h' = 10.0 + 2h'

Intensity's of water pressure P= (5.00+2-h') x 9800.00 N/m²

Hoop's tensions P'o is given by

P'o = (P/cosØo + q x tanØo)D'/2

P'o = [(5.0+2-h') x 9800.0 x1.414.0 +1000 x 1{10.0 + 2h'/2.0}]

P'o = 535075.00 + 37720.00 x h' – 13859h'²

The value of P'o at h'=0 ,h'=1 and h'=2 are tabulated below

h'	Hoop Tensions
0	535075.00 N
1	558936.00 N
2	555079.00 N

Table .1: Hoop tension

For Maxima , d P'o /dh'= 0

37720.00 – 2.0 x 13859.00 x h' = 0

From Which   **h' = 1.3610 m**

Max Po' = 535075.0 + 37720.0 x (1.3610 – 13859.0) x (1.3610)²

Max Po' = 560739.00 N

C) Design of Walls : -

Meridonal's.Stress's = 0.900 N/mm²

Max Hoop Stress's = 560739.00 N

Whole of Which is to be resisted by steel

As = max hoop Stress's / permissible Stress's

As = 560739.00/150.00 = 3738.00 mm²

Area of Each-face = 3738.00 / 2.00 =1869.00 mm²

Space of 16.0 mm Ø bars=1000.0 x0.7850x 16.00²/100. =107.05

Space of 16.0 mm Ø hoops @ 100.0 mm c/c on each-face

Actual Ash = 1000.0x0.7850 x 16.0² / 100.0 =2010 mm²

Ash offerd = 2010.00 mm²

Max. tensile Stress's in composite's section

= 560739.00 / (400.0 x 1000.0) + (13-1) x 2010.0 x 2.0

Max. tensile Stress's in composite section = 1.3850 N/mm²

This tensile Stress's is more than the permissible, value 1.20 N/mm².-: increase the thickness **420.0 mm. this will reduce the tensile Stress's to 1.1980 N/mm² -: safe**

In the meridional direction offer reinforcement @ {0.30- [420.0-100.0/420.0-100.0] x 0.10} =0.210%

Asd =0.21 x 4200 =882.00 mm²

Asd on each-face = 882.00 /2.00 = 441.00 mm²

Space of 10 mm Ø bars = 1000.0x 0.7850 x 10²/441.0 = 178 mm

-: offer 10.00 mm bars @ 175.00 mm c/c on each-face clear- cover 25.00mm

7 DESIGN OF LOWEST DOME

Lowest dome develops compressive Stress's both meridionally's as well as hoop's, due to weight's of water buoyed by it and also due to its own weight

R2 = 8.610 m; sinØ2 = 0.58070; cosØ2 = 0.81410

Weight of Water Wo of the dome is given by

Wo=$[\frac{\pi}{4} Do^2 Ho - \frac{\pi}{3} h2^2(3R2-h2)]$ x w

Wo=$[\frac{\pi}{4} 10^2 x7 - \frac{\pi}{3} x1.6^2(3x8.610-1.60)]$ x 9800.00

Wo= 4751259.00 N

Let the thickness of bottom dome be 250.00 mm

Self-Weight = 2 x3.140 x R2 x h2 x t2 x γc [γc = 25000]

Self-Weight = 2 x3.140 x 8.610 x 1.60 x 0.250 x 25000.00

Self-Weight of dome = 540982.00 N

Total Weight WT = Ww +Wo

Total Weight WT = 540982.00+ 4751259.00

Total Weight WT = 5292241.00 N

Meridional's Thrust T2 =WT/3.140 x Do x sinØ2

Meridional's Thrust T2 = 5292241.0 / 3.140 x 10.0 x 0.58070

Meridional's Thrust T2 = 290093.00 N/m

Meridional's Stress's = T2 / b*d

Meridional's Stress's = 290093.00 / 250.00 x 1000.00

Meridional's Stress's = 1.160 N/mm²

1.160 ≤ 1.200 N/mm² -: safe

Intensity of loading per unit area = P2 = WT /2 x 3.140 x R2 x h2

P2 = 5292241.00 / 2.00 x 3.140 x 8.610 x 1.60

P2 = 61142.00 N/m²

Max. hoop Stress's at Centre of dome = P2*R2 /2*t2

Max. hoop Stress's at Centre of dome = 61142.0 x 8.61 / 2x 0.25

Max. hoop Stress's at Centre of dome = 1.050 N/mm² Safe

Area of minimum steel = 0.3 – [250-100/450-100] x 0.1 = 0.26 %

As =0.260 x 2500.00 = 650.00 mm² in each direction

Space of 10 mm Ø bars = 100.0 x 0.785 x 10² / 650 =121.00 mm

-: offer Space of 10.00 mm Ø bars @ 120.0 mm c/c in both directions also offer 16.0 mm Ø meridionals bar @ 100.0 mm c/c near water face. For 1.0 m length to take care of the continuity effect the thickness of the dome may be increased from 250.0 mm to 280.0 mm gradually in 1.0 m length

8 DESIGN OF LOWEST CIRCULAR BEAM B2:-

Inner thrust from tapering dome = To x sinØo

Inner thrust from tapering dome = 361437.0 x 0.7070

Inner thrust from tapering dome = 255613.0 N/m

outer thrusts from bottom dome = T2 x sinØ2

outer thrusts from bottom dome = 290093.0 x 0.81410

outer thrust from bottom dome =236165.00 N/m

Net Inner thrusts = Inner – Outer

Net Inner thrusts = 255613.00 – 236165.00

Net Inner thrust = 19448.00 N/m

Hoop compression in beam = 19448.00 x 10 / 2 =97240.00 N

Suppose the sizes of beams be 600.0 mm x 1200.0 mm

Hoop Stress's = 97240.0 / 600.0 x 1200.0 = 0.1350 N/mm²

0.1350 N/mm² ≤ 1.20 N/mm² Safe

Vertical load on beam per metre run = To x sinØo + T2 x sinØ2

Vertical load on beam per metre run = 255613+290093 x 0.5807

Vertical load on beam per metre run = 424070 N/m

Self-weight of beam = b x d x γc

Self-weight of beam = 0.6 x 1.20 x 1 x 25000.00

Self-weight of beam = 18000.00 N/m

The load on beam = W = vertical loading + self-weight = 424070.00 + 18000.00 = 442070.00 N/m

The loading on beam =W=442070.00 N/m

Let,s us support the beam on 8.00 similarly spaced column at a mean radii of lowest curved beam R = 5.00 m

2Θ = 45° ; Θ = 22.5°

C1=0.0660: C1=0.0300; C1=0.0050 [IS CODE TABLE 20.1]

Øm= 9.50°

MO = SUPPORT's MOMENT's B.M -VE = C1 X WR² X 2Θ

MO =0.066 x 442070.0 x 5.0² x 0.7580

MO = 572882 Nm

Extreme + ve B.M at support = Mc = C2 X WR² X 2Θ

Mc = 0.030 x 442070 x 5² x 0.785

Mc = 260401 Nm

Extreme To0rsional moment Mm = C3 X WR² X 2Θ

Extreme Torsional moment Mm =0.005 x 442070 x 5² x 0.785

Extreme Torsional moment Mm = 43400 Nm

For M-20 concrete [IS 456:2000]

σcbc = 7.00 N/mm² HYSD bars σst = 150.00 N/mm²

We have K=0.3780 : j = 0.8740 ; R=1.1560

-: effective depth = $\sqrt{\frac{572882 \ x \ 1000}{600 \ x \ 1.156}}$

effective depth = 909.00 mm

-: keep total depth = 1200.00 mm from shear point of view

suppose d = 1140 mm

Max shear force at support , Fo = W*R*Θ

Fo = 442070.00 x 5.00 x 3.14/8

Fo = 868002.00 N

SF at any point is given by F = WR(Θ – Ø)

At Ø = Øm ; F = 442070 x 5 x (22.50° - 9.5°) x 3.14 / 180

F = 501512.00 N

BM at the point of extreme torsional's moment's

Ø = Øm = 9.5° is given by

MØ = WR² (Θ x sinØ + Θ x cotΘ x cosØ – 1)

MØ = 442070 x 5² (Π/8 x sin9.5° + Π/8 x cot22.5° x cos9.5° - 1)

MØ = - 1421.00 Nm (sagging)

At the support Ø = 0

Mo = WR² (Θ - Ø) = 0

At mid span Ø = Θ = 22.5° = $\frac{\pi}{8}$ radians

MØ = WR² (Θ x cosΘ – Θ $\frac{cosØ}{sinØ}$ sinØ) = 0

At the support Mo = WT

Mo = 572882 Nm

At the Mid span

Mc = 260401 Nm sagging +ve

At the point of max. torsion (Ø=Øm =9.5°)

MØ = 1421 Nm

M$\overset{t}{m}$ = 43400 Nm

Foremost and Longtudinals Reinforcements

a) Section at point of extreme torsion

T = M$\overset{t}{max}$ = 43400 Nm ; MØ=M= 1421 Nm

Me1 = M + MT

MT = 76588 Nm

Me1 = 1421 + 76588 =78009 Nm

Ast1 =78009 x 100 / 150 x 0.874 x 1160

Ast1 = 513 mm²

No. of 25 mm Ø bars = 513 / 491 =1.05

Let us offer a minimum of 2 bars

Since MT > M

Me2 = MT – M

Me1 = 76588 – 1421

Ast2 = $\frac{75167 \ x \ 1000}{150 \ x \ 0.874 \ x \ 1160}$

Ast2 = 494.30 mm²

Number of 25 mm bar = 1 offer minimum of 2 bar at the pint of extreme torsion ,offer 2 -25 mm Ø bar each at top and bottom

b) Section at extreme hogging B.M (support)

Mo = 57882 Nm   M$\overset{t}{o}$=0

Ast = $\frac{572882 \ x \ 1000}{150 \ x \ 0.874 \ x \ 1140}$

Ast = 3767 mm²

No. of 25 mm Ø bar = $\frac{3767}{\pi x \ 25^2 / 4}$ = 8

Then Offer 6 no.s of 25 mm Ø bars in one layer and 2 layer in the 2nd layer offer at top of the section near support

c) Section at max. sagging B.M (mid span)

Mc = 260401.00 Nm : M$\overset{t}{c}$=0

For positive B.M ,Steel will be to th other fac , Where Stress's in steel (σst) can be taken as 190.00 N/mm². The

Constant for M-20 concrete having σcbc = 7.00 N/mm² , m = 13.00 will be

K = 0.324 : j = 0.892 : R = 1.011

Ast = $\frac{260401 \ x \ 1000}{190 \ x \ 0.892 \ x \ 1160}$

Ast = 1325.000 mm²

No. of 25 mm Ø bars = $\frac{1325}{\pi x \ 25^2 / 4}$ = 2.7

-: the structure of reinforcements will be follow's at the support, offer 6.0 – 25.0 mm Ø at top layer and 2.0- 25.0 mm Ø bar in the 2nd layer continue these up to section of extreme torsion at a distance = R x Øm = 5. 00x 0.166 = 0.830 m

          Ld = 52 x Ø = 52 x 25

          Ld = 1300.00 mm from support

At this point , discontinue 4 bars while the remaining 4 bar similarly offer 4 bar 25.00 mm Ø

At the bottom throughout the length. these bars will take care of both the max positive B.M as well as extreme torsional moment

Transverse Reinforcement: -

a) At point of max. torsionals moments

At point of max. torsion V = 501512.00 N(step – 8 value obtained)

Ve = V + 1.6 x $\frac{T}{b}$ Where T= M$\overset{t}{m}$ = 43400.00 Nm

 b = 600.00 mm

Ve = 501512.00 +1.60 x $\frac{43400.00}{0.60}$

Ve = 617245.00 N

τve = **Ve / b x d**

τve = 617245.00 / 0.60 x (1200.00 – 400.00)

τve = 0.887 N/mm²

This is less than τmax = 1.800 N/mm²

 for M-20 concrete   (IS 456 : 2000 table 20.8)

τc = 0.230 N/mm²

Since   τve > τc, Shear reinforcement is necessary

The area of cross section Asv of the stirrups is given by

Asv = $\frac{T \ x \ Sv}{b \ x \ d \ x \ \sigma sv}$ + $\frac{V \ x \ Sv}{2.5 \ x \ d \ x \ \sigma sv}$

Where b1 = 600 – (40 x 2) – 25 = 495.00 mm

          d1 = 1200 – (40 x 2) – 25 = 1095.00 mm

$\frac{Asv}{Sv}$ = $\frac{43400}{495 \ x \ 1095 \ x \ 150}$ + $\frac{501512}{2.5 \ x \ 1095 \ x \ 110}$ = 1.755

Minimum Transverse's reinforcements is governed by

$\frac{Asv}{Sv}$ ≥ $\frac{τve - τc}{\sigma sv}$ x b

$\frac{Asv}{Sv}$ = $\frac{0.887 - 0.23}{150}$ x 600.00

$\frac{Asv}{Sv}$ = 2.628

-: Depth $\frac{Asv}{Sv}$ = 2.628

Using,s 12.0 mm Ø 4 legged stirrups , Asv =4 x $\frac{\pi}{4}$ x 12²=452.0 mm²

Or Sv = $\frac{452}{2.628}$ = 172.00 mm

But, the space should not exceed the least of X1 , $\frac{X1+Y1}{d}$ and 300 mm

-: offer 12 mm Ø 4 legged stirrups @ 170 mm c/c

b) At the point of max. shear (support)

At support ; Fo = 868002 N

$\tau v = \frac{868002}{600 \, x \, 1160} = 1.25$ N/mm²

At Support ,

$\frac{100 \, x \, As}{bd} = \frac{100 \, x \, 8 \, x \, 491}{600 \, x \, 1160} = 0.564$

τc = 00.310 N/mm² , Shear Reinforcement is necessary

Vc = 00.310 x 600.00 x 1160.00 = 215760.00

Vs = Fo – Fs = 868002.00 – 215760.00 = 652242.00 N

Space of 10.0 mm Ø 4 legged stirrups having Asv = 314.0 mm²

Given by

$Sv = \frac{\sigma sv \, x \, Asv \, x \, d}{Vs}$

$Sv = \frac{150x \, 314 \, x \, 1160}{652242} = 83.80$ mm

-: offer 12 mm Ø 4 legged stirrups

$Asv = 4 \, x \, \frac{\pi}{4} x \, 12^2 = 452.39$ mm² at space

$Sv = \frac{150 \, x \, 452.39 \, x \, 1160}{652242} = 120.0$ mm

C) At Mid span

At the mid span, SF is Zero -: offer minimum shear reinforcement given by

$\frac{Asv}{bSv} \geq \frac{0.4}{fy}$

$\frac{Asv}{Sv} = \frac{0.4 \, x \, b}{fy}$ for HYSD bar fy =415 N/mm²

$\frac{Asv}{Sv} = \frac{0.4 \, x \, 600}{415} = 0.578$

Choosing 10 mm Ø 4 legged stirrups Asv =314 mm²

$Sv = \frac{314}{0.578} = 543$ mm

Max. permible space 0.75d = 0.75 (1200-40) = 870 or 300 mm

Whichever is less -: offer 10 mm Ø 4 legged stirrups @ 300 mm c/c

Side Reinforcement: -

Since the depth is more than 450 mm, offer side face reinforcement @ 0.1 %

At $= \frac{0.1}{100} x \, 600 \, x \, 1200 = 720$ mm²

Offer 3-16 mm Ø bar on each-face having total At = 6 x 201 =1206 mm²

9 DESIGN OF COLUMNS

The tank is supported on 8 columns symmetrically placed on a circle of 10 m mean diameter. Height of staging above ground level is 16 m let us divide this height into four panels each of 4 m height. Let column connected to raft foundation by means of a ring beam, the top of which is offerd at 1 m below the ground level, so that the actual height of bottom panel is 5 m.

A) Vertical loads on columns :-

1) Weight of water = Ww + Wo = 4392368 + 4751259 = 9143627 N

2) Weight of tank :-

i) Weight of top dome + cylindrical walls = 58474 x π x14 =2571821 N

ii) Weight of tapering dome = Ws = 1066131 N

iii) Weight of lowest dome = 540982 N

iv) Weight of lowest ring beam = 18000 x π x 10 = 565487 N

              Entire weight of tank = i + ii + iii + iv

       Entire weight of tank = 4744421 N

Total Superimposed load = weight of water + Total weight of tank

Total Superimposed load = 9143627 +4744421

Total Superimposed load = 13888048 N

Load Per column = 13888048 / 8 =**1736000 N**

Supposing the column be 700.00 mm diameter

Weight of column per metre height = $\frac{\pi}{4} x \, 0.7^2 x \, 1 \, x \, 25000$ =9620 N

Supposing the bracing be of 300 mm x 600 mm size

Length of Each Brace = L = $R \, x \, \frac{sin\frac{2\pi}{n}}{cos\frac{\pi}{n}} = 5 \, x \, \frac{sin\frac{2\pi}{8}}{cos\frac{\pi}{8}}$ = 3.83 m

Clear length of each brace = 3.830 – 0.70 = 3.130 m

Weight of Each brace = 0.3 x 0.6 x 3.13 x 25000 = **14085 N**

-: total Weight of column just above each brace is tabulated below

Brace GH:

W = (134720 + 11760 + 33060) + 4 x 9620 = 1774480.00 N

Brace EF:

W = (134720 + 11760 + 33060) + 8 x 9620 + 14085= 1827045.00 N

Brace CD:

W = (134720 + 11760 + 33060) + 12 x 9620 + 2 x 14085= 1879610.00 N

Bottom of column:

W = (134720 + 11760 + 33060) + 17 x 9620 + 2 x 14085= 1941795.00 N

Wind loads

Intensity of wind pressure = 1500.00 N/m²

Suppose take a factor of 0.7 for section in circular in plan

Wind load on tank, domes and ring beam

= [(5 x 14.4) + (14.2 x 2/3 x1.9) + (2 x 12.8) + (10.6 x 1.21)] x 1500 x 0.7 = 134720 N

This may be assumed to act at about 5.7 m above the bottom of ring beam.

wind load on each panel of 4 m height of column = (4x0.7x8) x1500x0.7 +(0.6x10.6) x1500

wind load on each panel of 4 m height of column = 33060 N

wind load at the top end of top panel = 0.5 x 23520 = 11760 N

wind load are shown in fig below
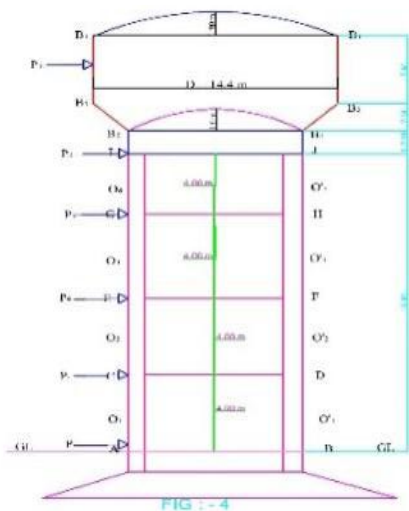
Fig. 4:wind pressure on intz tank

The point of contra flexure O1 O2 O3 and O4 are assumed to be at the mid height of each panel. the shear forces Qw and moment Mw due to wind at these planes are given below

Level	Shear Force Qw (N)	Moment Mw (Nm)
O4	146480.00	1060860.00
O3	179540.00	1712900.00
O2	212600.00	2497180.00
O1	245660.00	3418930.00

Table. 2: Shear force and moment

The Axial thrust Vmax = 4 x Mw / n x Do

The Axial thrust Vmax = 4 x Mw / 8 x 10 = 0.05 Mw

The Axial thrust **Vmax =0.05** Mw in the farthest leeward column the shear force

Smax = 2 x Qw / n = 2 x Qw / 8 =0.25 Qw

Smax = 0.25 Qw

In the column on the bending axis at each of the above levels and the bending moment

M= Smax x h/2 in the column are tabulated below

Table. 3: column forces and bending

Level	Vmax =0.05	Smax = 0.25 Qw	M= Smax x h/2
O4	53040	36620	73240
O3	85650	44895	89770
O2	124860	53150	106300
O1	170950	61420	153550

Table. 4: Axial force and moment

Level	Fartest leeward column		Column on bending axis	
O4O'4	Axial (N)	Vmax(N)	Axial(N)	M (Nm)
O3O'3	1774480	53040	1774480	73240
O2O'2	1827045	85650	1827045	89770
O1O'1	1879610	124860	1879610	106300
	1941795	170950	1941795	153550

The farthest leeward column will be endangered to the superimposed axial load plus Vmax given above The column on the bending axis on the permissible Stress's in the material may be enlarged by 33.33% for the farthest leeward column the axial thrust Vmax due to wind load is less than even 10 % of the superimposed axial load. -: the effect of wind is not critical for the farthest leeward column however, column is situated on the bending axis need to be considered to see the effect of extreme B.M of 153550.00 Nm . due to wind along with the superimposed axial load of 1941795.00 N at the lowest panel .

Use M-20 Concrete For Which

σcbc = 7.00 N/mm² σcc = 5.00 N/mm² [IS 456:2000]

For Steel σst = 230.00 N/mm²

All these three can be increased by 33.33%. When considering action.   Diameter of column = 700.00 mm

Use 13 bars of 28 mm Ø at an effective cover of 40 mm

$Asc = \frac{\pi}{4} x 28^2 x 13$

Asc = 8482 mm²

Equal area of column $= \frac{\pi}{4} x 700^2 x (13 - 1) x 8482$

Equal area of column = 486629 mm²

Equal moment of inertia $= \frac{\pi}{64} d^4 + (n - 1) \frac{Asc}{8} x d'^2$

Where d = 700.00 mm d' =700.00- 40.0 x2.0 =620.00 mm

$Ic = \frac{\pi}{64} 700.00^4 + (13.0 - 1.0) \frac{8482.00}{8.00} x 620.00^2$

Ic = 1.6676600000 x 10^{10} mm⁴

Direct Stress's in column = $\sigma cc'$ = 1941795.0 /486629.0 =3.990 N/mm²

Bendings Stress's in column = $\sigma cbc' = \frac{153550 \ x \ 1000}{1.66766 \ x \ 10^{10}}$ =3.22 N/mm²

For the safetys of column's, we have the condition

$$\frac{\sigma cc'}{\sigma cc} + \frac{\sigma cbc'}{\sigma cbc} \leq 1$$

$$\frac{3.99}{1.33 \ x \ 5} + \frac{3.22}{1.33 \ x \ 7} \leq 1$$

0.95 < 1   safe

Use 10.00 mm Ø wire rings of 250.00 mm c/c to ties up the mains reinforcements. Since the columns are of 700.00 mm diameters rise the width of curved beam B2 from 600.00 mm to 700.00 mm

10 DESIGN OF BRACES

The bending moment m1 and extreme value in a brace is governed by step 9

$$\tan(\theta + \tfrac{\pi}{8}) = \tfrac{1}{2}\cot\theta$$

We get $\theta = 24.80°$

$$m1 = \frac{Qw1 \; x \; h1 + Qw2 \; h2}{n\sin\frac{2\pi}{8}} \cos^2\theta\sin(\theta + \tfrac{\pi}{n})$$

For the lowest junction C h1=5.00 m and h2 = 4.00

$$m1 = \frac{245660 \; x \; 5 + 212600 \; x \; 4}{8 \; x \; \sin\frac{2\pi}{8}} \cos^2 24.8°\sin(24.8° + \tfrac{\pi}{8})$$

m1max = 222540.00 Nm

The max. shear force Sbmax in a brace is given by for $= \tfrac{\pi}{8}$

$$Sbmax = \frac{245660 \; x \; 5 + 212600 \; x \; 4}{3.93 \; x \; 8 \; x \; \sin\frac{2\pi}{8}} \; 2\cos^2\tfrac{\pi}{8}\sin\tfrac{2\pi}{8}$$

Sbmax = 112870.00 N

for $= \tfrac{\pi}{8}$ the value of m1 is given by

$$m1max = \frac{245660 \; x \; 5 + 212600 \; x \; 4}{8 \; x \; \sin\frac{2\pi}{8}} \cos^2\tfrac{\pi}{8}\sin(\tfrac{\pi}{8} + \tfrac{\pi}{8})$$

m1max = 221786.00 Nm

Twisting's moments at $\theta = \tfrac{\pi}{8}$ is M' = 0.05 m1

M' = 0.05 x 221786 =11090.00 Nm

Thus, the bracing will be exposed to a combination of max. shear forces and a twisting moments when wind blow parallel to it $= \tfrac{\pi}{8}$

Use M-20 Concrete For Which

σcbc = 7.00 N/mm²   σcc = 5.00 N/mm²

For Steel

σst = 230.00 N/mm²

k = 0.283 j =0.906 and R = 0.897

Depth of NA = 0.283 d = kd

Supposing Asc =Ast = pbd and dc=0.1d

Equating the moment of equal area about NA P=0.00560

Since the brace is endangered to both BM as well as twisting moment we have

Me1 = M' + MT

Where M' =B.M =22250.00Nm

$$MT = T \left(\frac{1 + \frac{D}{b}}{1.7}\right) = MT = 11090.00 \; x \; \left(\frac{1 + \frac{700}{300}}{1.7}\right)$$

MT = 21745.00 Nm

Me1 = 222540.00 +21745.00 = 244285.00 Nm

In order to find the depth of the section, compare the moment of resisting of the section to the external moment

b x n c/2 [d.n/3] + (m-1) Asc.C' (d-dc) = Me1

C = 1.330 x 7.00 = 9.310 N/mm²

mc = 1.50

m =1.50 x 13.00 = 19.5

C' = 9.310 (0.230-0.10)/0.2830 = 6.020 N/mm²

-:300.00 x 0.283 *d x 9.310/2.0 x [1.0-0.2830/3] d + (19.50-1.0) (0.00560 x 300.0*d)*6.02(1.0-0.10) *d=244285.00 x 10³

d = 680.00 mm

Approve D =700.00 mm so that d =700 -25 -10 =665.00 mm

Asc=Ast=pbd =0.0056 x 300.0 x 700.0 =1176.00 mm²

No. of 20 mm Ø bars each at top and bottom

$$100 \; xAs \; /bd = \frac{100 \; x \; 4 \; x \; 491}{300 \; x \; 700} = 0.94\%$$

Mximum Shear = 112870.00 N

$$Ve = V + \frac{1.6 \; T}{b}$$

$$Ve = 112870.00 + \frac{1.6 \; x \; 11090}{0.3}$$

Ve = 172017.00 N

τve = 172017.00 /300.00 x 700.00

τve = 0.820 N/mm²

This is smaller than τcmax but more than τc =0.37 N/mm² -: transverses reinforcements is necessary

$$Asv = \frac{T.Sv}{b1xd1x\sigma sv} + \frac{V.Sv}{2.5xd1x\sigma sv}$$

b1 = 230.00 mm; d1 = 630.00 mm

Using 12.00 mm Ø 2 legged stirrups, Asv =226.00 mm²

$$Asv = \frac{11090 \; x \; 100}{230 \; x \; 630 \; x \; 230} + \frac{112870}{2.5x \; 360 \; x \; 230}$$

Asv / Sv =0.645

Minimum transverse reinforcement is given by

$$\frac{Asv}{Sv} \geq \frac{\tau ve - \tau c}{\sigma sv} x \; b$$

$$\frac{Asv}{Sv} = \frac{0.82 - 0.37}{230} x \; 300$$

$$\frac{Asv}{Sv} = 00.5870$$

Sv = 350.00 mm

However, the space should not exceed the least of X1 , $\frac{X1+Y1}{d}$ and 300 mm

Where

X1 = Short dim stirrip= 230.0+20.0+12.0 =262.0 mm

Y1= Long dime stirrups = 630.0 + 20.0 +12.0 = 662.0 mm

$$\frac{262+662}{4} = 391.00 \; mm$$

-: offer 12.0 mm Ø 2 legged stirrups at 230.0 mm c/c throughout. Since depth of section exceeds 450 mm offer side reinforcement @ 0.1 %

A1 = 0.1/100 x 300 x 700 = 210 mm²

Offer 2 -10 mm Ø bar at each-face giving total

AL = 4 x 78.5 = 314 mm²

Offer 300 mm x 300 mm haunches at the junction of braces with column and reinforce it with 10 mm Ø bar sizes of various components and geometry
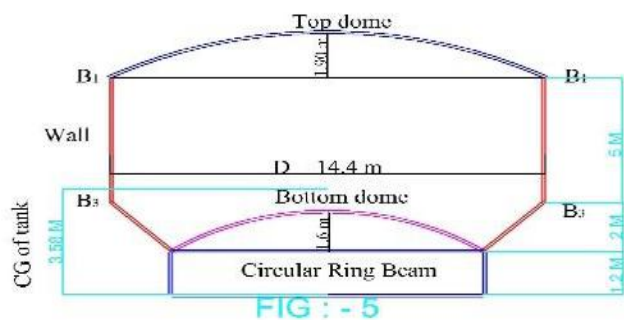
Fig. 5: Component Name

Sizes of various Components are

Top Dome 100 thick

Top Ring Beam B1 400 x 360

Cylindrical Wall 200 thick; Bottom Ring Beam B3 700 x 600

Circular Ring Beam B2 600x1200; Bottom Dome 250to 280 thick

Conical Dome 250 thick: Braces 300 x 700

Columns 700 diameter

Constraints of Spring Mass Model

Total weight of water = 9143.627 Kn.

Volume of water = 9143.627 / 9.81 = 932.072 m3

Mass of water, m = 932072.06 kg.

Inner diameter of tank, D = 14.00 m.

For outcome parameters of spring mass model, an comparable circular container of similar volume and diameter equal to diameter of tank at top level of liquid will be measured.

Let h be the height of equal circular cylinder,

$\pi (D/2)2\ h$ = 932.072

h = 932.072 / [π x (14 / 2)2] = 6.05 m

For h / D = 6.05 / 14 = 0.43   ,[IS CODE 1893 Part II P.No 10]

m_i / m = 0.48; m_i = 0.48 x 932072 = 447394.56 kg

m_c /m = 0.50, m_c = 0.50 x 932072 = 466036 kg

h_s = 18.20 m h_i / h = 0.395 ; h_i = 0.395 x 6.05 = 2.38m

h_i* / h = 0.90 ; h_i* = 0.9 x 6.05 = 5.445 m

h_c / h = 0.60; h_c = 0.60 x 6.05 = 3.63 m

h_c* / h = 0.815; h_c* = 0.815 x 6.05 = 4.93 m.

About 55% of liquid mass is excited in impulsive's mode while 43% liquid mass contributes in convective's mode. Sum of impulsive's and convective's mass is 913430.560 kg which is about 2% less than the whole mass of liquid.

weight of empty container + one third weight of staging,

m_s = (4744.4210 + 1702.19 / 3) x (1,000 / 9.81) = 541465.47 kg.

Time Period's

Time period of impulsive's mode,

$T_i = 2\pi \sqrt{\dfrac{m_i + m_s}{K_s}}$ [IS Code 1893 part 2 pn 16 fig 5

$T_i = 2\pi \sqrt{\dfrac{447394.56 + 541465.47}{132.32 x\ 10^5}}$

T_i **= 1.70 sec**

Time period of convective's mode ,

$T_c = C_c \sqrt{\dfrac{D}{g}}$ [IS Code 1893 part 2 pn 16 fig 5]

$T_c = 3.20 \sqrt{\dfrac{14}{9.81}}$ h/D =0.43   Cc= 3.20

T_c **=3.82 sec**

Design Horizontal Seismic Coefficient

Design horizontal seismic coefficient for impulsive mode ,

$(A_h)i = \dfrac{Z\ x\ I}{2\ x\ R}(\dfrac{Sa}{g})$

Where, Zone = V I = 1.5 R= 2.5

Z = 0.36 (IS 1893(Part 1): Table 2; Zone V)

T_i **= 1.70 sec,**

Site has Medium soil,

Damping = 5%,

-:, $(Sa/g)i$ = 0.9 (IS 1893(Part 1): Figure 2)

$(A_h)i = \dfrac{0.36\ x\ 1.5}{2\ x\ 2.5}$x0.9

$(A_h)i$ **= 0.097**

Design horizontal seismic coefficient for convective mode,

$(A_h)c = \dfrac{Z\ x\ I}{2\ x\ R}(\dfrac{Sa}{g})$

Where, I = 2.5, R = 2.5

Zone = V Z = 0.36(IS 1893(Part 1): Table 2; Zone V)

    T_c =3.82 sec

Damping = 5%

$(Sa/g)c$ = 0.45 x 1.75 = 0.787

Multiplying factor of 1.75 is used to obtain Sa/g values for 0.5%damping from that for 5%damping.

$(A_h)c = \dfrac{0.36\ x\ 1.5}{2\ x\ 2.5}$x 0.787

$(A_h)c$ **= 0.0840**

Base-Shear

Base-shear at the lowermost of staging, in impulsive mode,

$V_i = (A_h)i\ (m_i + m_s)\ g$

V_i= 0.0970 x (447394.56 + 541465.47) x 9.81

V_i= 940.96 kN-m

Similarly, base shear in convective mode,

$V_c = (A_h)c\ m_c\ g$

V_c = 0.0840 x 466036.00 x 9.81

V_c = 384.03 Kn

Whole base-shear at the lowermost of staging by SRSS

$V = \sqrt{V_c^2 + V_i^2}$

$V = \sqrt{940.96^2 + 384.03^2}$

V = 1016.16 kN.

Displacement of tank manual:-

Total displacement = Hs/500 = 16000/500 = 32 mm

Table. 5: Displacement Manual

Node	Displacement (mm)
U5	32
U4	24
U3	16
U2	8
U1	0

Node	Displacement (mm)
U5	32
U4	23.4
U3	15.5
U2	8
U1	0

Design for intz water tank with base isolation: -
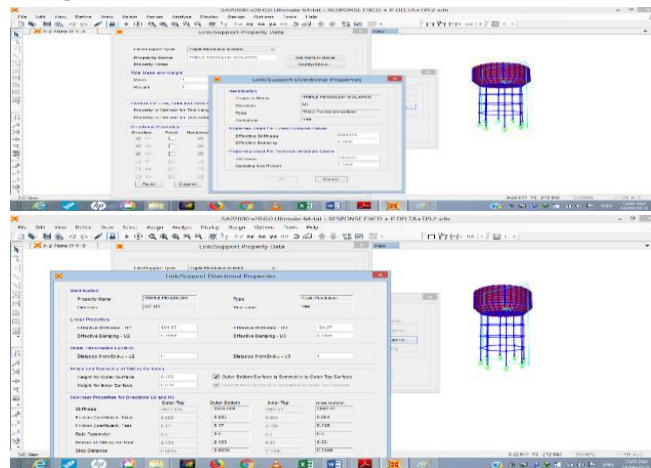
Fig. 7: Finite element model TFPI

III. SOFTWARE DESIGN INTZ WATER TANK

Design of intz water tank by using SAP2000 with fixed base:

The seismic presentation of RCC structures earlier and after the application of flexibility and stiffness-based elements method is to be studied in the present project. In this study we are presenting isolation system as a substitute of conventional technique to get improved performance of elevated water tank through the earthquake. This section offers model geometry evidence, including items such as joint coordinates, joint restraints, and element connectivity.

Fig. 6: Finite element model fixed base.

Seismic Data:

Seismic Zone: V; Soil Type: Medium soil
Beam Dead Load (UDL): 1.500 KN/m
Live load = 1.5000 KN/m; Water pressure: 0.60 KN/m

SAP2000 Analysis

1. Analysis of intz tank is to be performed using Sap2000 for Zone-V.
2. after the analysis is done for fixed base intz water tank is compared with the manual result obtained from manual design and sap2000 design.
3. in this study we have found that base shear and displacement result are equal.
4. but we cannot go for the further manual design of base isolation.
5 So software design by using sap2000 we design structure and compare it with fixed base intz water tank.

Total base shear at the bottom of staging by SRSS
V = 1016.36 kN.

Displacement of tank sap2000: -

Table.6: Displacement sap2000 fixed base.

SAP2000 Analysis

1. Analysis of intz overhead tank is to be performed using Sap2000 with base isolation for Zone-V.
2. we have used the triple friction pendulum isolator at the support at ground level
3. Response analysis is performed for the intz water tank and design is analyized.
4. So software design by using sap2000 we design structure and compare it with fixed base intz water tank and base isolation.

Total base shear at the bottom of staging by SRSS
V = 894.69 kN.

Displacement of tank sap2000 with base isolation: -

Table 7: Displacement Base isolation

Node	Displacement (mm)
U5	5
U4	4
U3	2
U2	1
U1	0

Base shear and displacement analysis are performed with manual and SAP both for both fixed and triple friction pendulum support.

Intz water tank is never been considered under research by researchers with triple friction pendulum

Also, Manual deign is not having option for defining base isolation, still we software defined triple pendulum support in sap2000 to compare with manual fixed base elevated tank.

IV.   RESULT PARAMETER

Parameter for manual: - In this manual calculation of intz water tank with earthquake resistant parameter. We have Design the parameter of base shear and displacement are as follows

A) Base shear value = 1016.16 kn
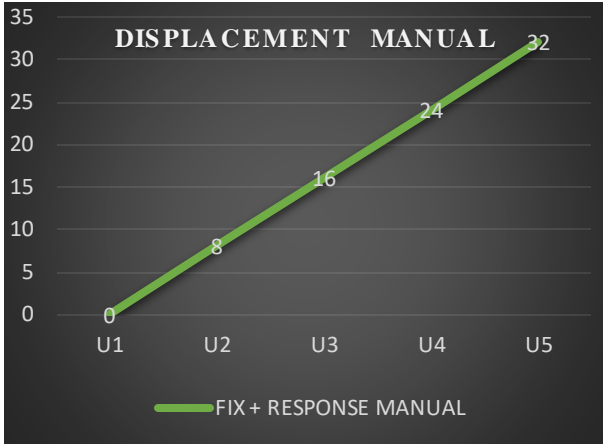
Graph. 1: Displacement

Result parameter for fixed sap2000: - In the sap2000 with fixed base of intz water tank. We have compared the design. we have found Same base shear and displacement as compared to manual design of intz water tank.
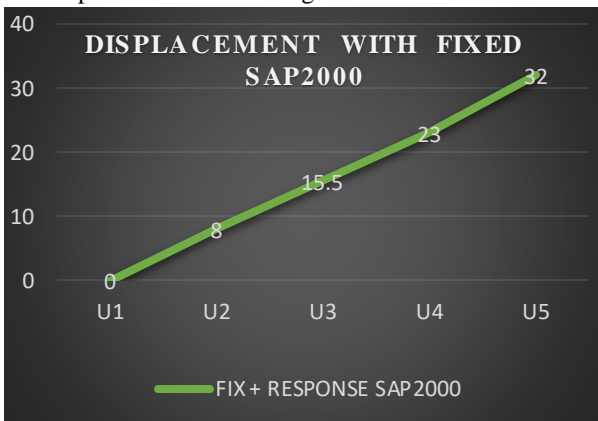
Graph. 2: Displacement sap2000

Result parameter for isolated base sap2000: - In the sap2000 with isolated base of intz water tank. We have found that base shear has been reduced to 12.00 % as compared to manual and base isolation. And also, we have found that there is less displacement as compared to manual with fixed base.
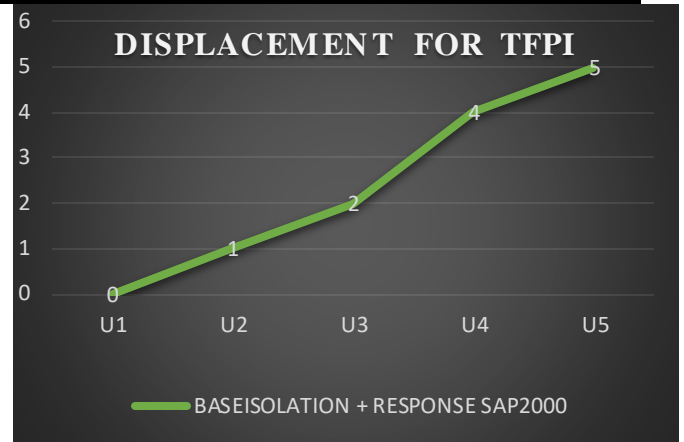
Graph. 3: Displacement base isolation

V.   CONCLUSION

Elevated Water tank is never been considered under research by researchers with triple pendulum isolator. The result which we have obtained for manual fixed base and sap2000 fixed base we found that design for base shear and displacement are quite same. But for the base isolation elevated water tank we have found 2% decrease in base shear and in the displacement up to 90% is decrease with base isolator

Base shear of Zone V because of zone factor same for manual and fixed response reduction factor etc. while considering seismic analysis. And decrease in base shear for base isolation and displacement.
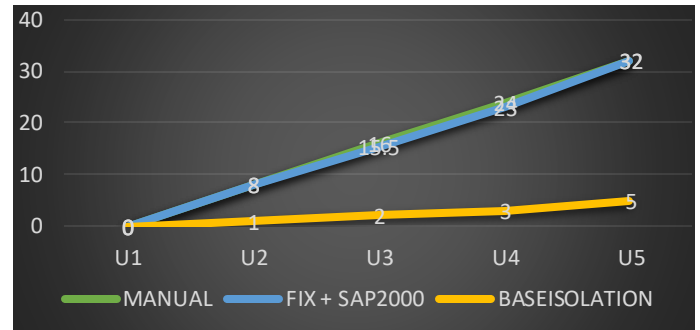
Graph. 4: Comparison of Displacement
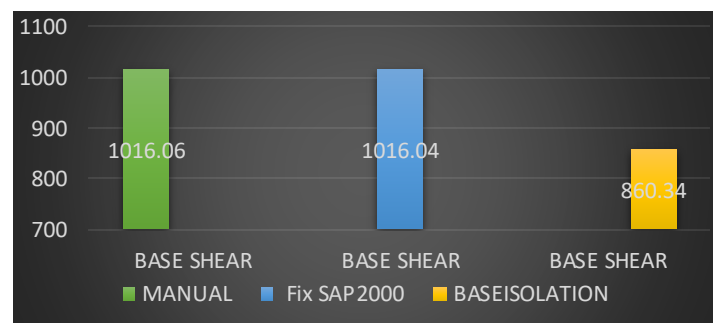
Graph. 5: Comparison of Base Shear

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Analysis of Resilience and its Relationships with Psychological Factors during Successful Aging

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Abstract— The objective of this research was to verify the relationship between resilience, successful aging, wisdom, quality of life, basic psychological needs perception, cognition and depression. The methodological design was quantitative and transversal. 161 elderly people of both sexes living in the city of Ivoti / Brazil participated. The instruments used were the Resilience Scale, Wisdom Scale, Geriatric Depression Scale, and Inventory of Basic Psychological Needs Perceptions for the Elderly, MMSE, and Whoqol-Old. Spearman's correlation analysis identified the relationship between resilience and quality of life variables, basic psychological needs and depression. In the linear regression analysis, we found a model in which the increase of resilience is associated to the personal competence, autonomy, wisdom, cognitive performance and past, present and future activities. We conclude that the resilience association with psychological aspects in the onset of old age is an important protective factor for the maintenance of successful aging.
Keywords—Basic psychological needs, Cognition, Depression, Quality of life, Resilience.

I. INTRODUCTION

It is common that in the period of old age many changes occur in both the social and biological as in the psychological scopes. However, in addition to diseases, limitations and declines, there are also positive aspects and potentialities manifested in a subjective way among the elderly. To promote healthy aging, it is necessary to promote protective factors since they are strong influencers of the ability to adapt to risk factors. This adaptation ability is called resilience. Therefore, this

definition converges to a sum of social and psychic nature processes that allow healthy development even in unfavorable contexts. Considering resilience as a process, it is not possible that it is an attribute of the person or a characteristic acquired throughout development [1].

Thus, in order to preserve the mental health of people in general, it is necessary to prevent risk factors and strengthen protective factors. In this way, the presence of adverse situations is related to the concept of resilience, since it is a situation where the person is exposed to stress, but is able to overcome and find strategies to deal with the situation in a positive way, while conserving [2].

Is important to consider this aspect in the study as the population studied, there is a high chance that the person will be exposed to risk situations for a long time. Thus, the elderly can maintain a positive sense of well-being, even under conditions of functional limitations and disabilities, because like any human being, the elderly activate compensatory mechanisms to deal with these losses.

Therefore, it is important that, with the aging process, the resilience capacity of the elderly is increased, so that adaptive behavior can be maintained, due to the fact that in old age the probability of unpleasant events related to physical health is greater, to the well-being and to the life of loved ones. Knowing what factors are protective elements we will be able to stimulate them, favoring the resilience and consequently the successful aging.

Considering this reality, the living conditions of the elderly have been researched in several scientific areas, mainly after elaboration of the Statute of the

Elderly [3]. However, many fields remain open. Meanwhile, demographic research has been proving, more and more, the growth of the number of elderly in the world and in Brazil. Over the next 50 years, for the first time in history, there will be more people in the world over 60 than under the age of 15. In this way, the aging phenomenon is no longer only problem of developed countries. This topic is very relevant in the 21st century, because it has consequences for all sectors of human life, at the world level [4].

The resilience theme has been considered a challenge for some scholars and is still unknown to many others. Therefore, the two themes, aging and resilience require investigations that take into account, above all, our reality.

Beyond resilience, wisdom is one of the most important and necessary dimensions for the proper qualitative understanding of human behavior, implies a balanced relationship between the cognitive, affective and emotional components. Wisdom appears as the supreme end of human development, especially for old age and can be one of the protective elements capable of fostering resilience and successful aging.

However, it is important to consider the risk factors involved in the aging process and for this, it is also important to deepen our understanding of depression, as they are capable of hindering successful aging. Regarding the age range chosen for this study, it can be stated that among mental disorders, depression is a more frequent disease of emotional suffering in the elderly, and this fact can affect the quality of their life, therefore constituting a problem of public health [5]. In addition, depression is also being considered as a risk factor for dementia processes. Consequently, it can be a life-threatening element, especially of those who have a chronic-degenerative or incapacitating illness. Thus, the presence of depression can be a factor that hinders or even prevents the elderly from achieving a successful aging.

A considerable volume of studies has been devoted to the understanding of the successful aging process and its biological and psychosocial components [6]. Among the many aspects of successful aging, cognitive aging and its biological / psychological bases are one of the primary focuses of research, given the need to identify and differentiate between normal and pathological changes and, if possible, identify targets for intervention in the sense of Prevent or mitigate the effects of pathologies such as vascular dementias and Alzheimer's [7].

Human aging is understood in this study as a phenomenon that is part of a process of development, growth, learning, maturation and human improvement [8]. That is why the elderly need positive attitudes in their lives, so that they can have a successful aging. Thus, the elderly can expand the understanding of themselves, perceiving their qualities, respecting their limits, accepting oneself as a human being and re-meeting with themselves. In this sense, old age can be characterized as a promising period for investigating factors and processes of resilience and vulnerability.

This study aims to verify the relationship between resilience and the variables of successful aging, quality of life, perception of basic psychological needs, wisdom, cognition and depression in the elderly over 60 years living in the city of Ivoti / Brazil.

II. METHOD

The present study has a quantitative and cross-sectional methodological design, and the evaluations were done in a single moment, therefore, there was no follow-up period of the individuals. The research was carried out in the municipality of Ivoti in partnership with the Municipal Council of the Elderly of the municipality and the Secretariat of Health and Social Assistance. This work is part of the larger research entitled Parameters analysis of cognition, body composition, functional capacity, oral health, psychological characteristics and genetic and biochemical markers of response to physiological stress: a study of successful aging in the elderly over 60 years.

The population of this study was composed of elderly residents in the Municipality of Ivoti. The municipality has a population estimated in 2013 of 21,460 people, an area of 63,161 km² and a population density of 314.71 inhabitants per km². The municipality is within the metropolitan region of the State of Rio Grande do Sul, has a predominantly German ethnic identity and a high rate of human development. The total resident population of the elderly over 60 years in the municipality is 1959 persons. In the 60-69 age group, there were 1,165 people, of which 517 were men (421 from urban and 96 from rural areas) and 648 were women (603 from urban and 45 from rural). The population aged over 70 is 794 people, 314 men (284 urban and 29 rural) and 480 women (408 urban and 73 rural) (Brazilian Institute of Geography and Statistics, 2013).

The sample of this study was selected for convenience in five health centers of the city. All the elderly registered were invited to participate and the sample was composed of 161 elderly people in the age group between 60 and 79 years, of both sexes. The mean age was 67.45 years with a standard deviation of 5.57 years. The age groups were divided into two classifications: 60 to 69 years (66%) and 70 to 79 years (34%). In this sample we had 29.9% of males and 70.1% of females identifying the presence of feminization of old age. Inclusion criteria were over 60 years of age, living in

the municipality of Ivoti, not being institutionalized or hospitalized, having mental and health conditions to have independence and autonomy to participate in the study. The exclusion criteria were: to present dementia processes, fragility syndrome, to be hospitalized or institutionalized.

In this study, we evaluated the variables of resilience, successful aging strategies, wisdom, and perception of basic psychological needs, cognitive performance, life quality and depression. The instruments that evaluated the variables described in this study were:

1. Resilience Scale developed by Wagnild and Young [9], used to measure resilience assessed by levels of positive psychosocial adaptation to major life events [10]. The scale is composed of 24 Likert-type items that range from 1 (totally disagree) to 7 (totally agree). Scores range from 24 to 168 and high values indicate high resilience. This scale was adapted by Pesce et al. [10] and considered relevant for Brazilian culture;

2. Wisdom Scale, developed by Alves [11], provides information about how people conceive the wisdom and values they associate with the wise person; Approaches values associated with intelligence, personality and transcendence. Three direct questions related to three factors are associated with the scale, so that more information can be obtained and the existence of significant relations between them can be verified. The scale ranges from 1 (totally at odds) to 5 (fully agree);

3. Geriatric Depression Scale, Brazilian version of GDS-15, offers valid measures for the detection of major depressive episode in the elderly. The scale is scored according to the presence of depressive symptoms, with a cut-off point of 6 symptoms (normal $\leq$ 5, mild depression $\geq$ 6 and $\leq$ 10 symptoms,> 10 severe depression). It presents an easy and quick application, with questions that ask for yes or no, answers according to the perception of how it felt in relation to the last two weeks preceding the evaluation [12,13];

4. Inventory of Perceptions of Basic Psychological Needs for the Elderly is understood as the satisfaction perceived by the individual, considering the Autonomy, Relationship and Competence dimensions, during a given situation. In this inventory, we find statements that describe perceptions of the elderly about their daily routine. It is a 15-item scale, answered by a bidirectional likert scale, graded in 5 points, ranging from "strongly disagree" (1) to "strongly agree" (5) [14]. This instrument was adapted from the Inventory of Perception of Basic Psychological Needs for Athletes validated in the study of the doctoral thesis of Barbosa [14] and later validated by the same researcher for elderly population;

5. SOC Inventory (Selection, Optimization, Compensation) explains the strategies to achieve a successful aging, developed by Baltes et al. [15]. In its original version it contains 48 items, however in this study the reduced version was used, which was described by [16] as more favorable. This version consists of 12 items that evaluate the use of SOC strategies by the elderly. Each item consists of two statements one describing the behavior reflecting the SOC and another offering a reasonable but not SOC option;

6. Mini Mental State Examination (MMSE) is a cognitive screening test widely used in the evaluation of the elderly and was developed by Folstein, Folstein, and McHugh [17] and translated by Bertolucci, Brucki, Campacci, and Juliano [18]. It consists of several questions typically grouped into seven categories, each one designed to evaluate specific cognitive functions: orientation for time (5 points), orientation for place (5 points), record of three words (3 points), attention and calculation (5 points), recall of three words (3 points), language (8 points) and visual constructive capacity (1 point). The items are evaluated by a score ranging from 1 to 5 points, reaching a maximum of 30 points. Schooling was pointed out by Bertolucci et al. [18], Juva, Mäkelä, Erkinjuntti, Solkava, Ylikoski, Valvanne and Tilvis [19] and Almeida and Almeida [13] as a determinant factor for the evaluation presenting differentiated cut points according to the number of study years. The cut-off points were based on the criteria of Brucki, Nitrini, Caramelli, Bertolucci, and Okamoto [20];

7. Whoqol-Old aims to measure the individual's satisfaction with their life and their perception of the influence that illnesses have on their lives. This instrument contains 24 Likert-type items from 1 to 5, divided into six facets. Each facet is composed by four items, assuming a standardized score of 0 to 120. The domains are: Autonomy; Functioning of the senses; Past, present and future activities; Social participation; Death and death; and intimacy [21].

The project was approved by the Research Ethics Committee of the University under number 747.080. The Participants signed a free and informed consent form in accordance with the resolution of the National Health Council of the Ministry of Health that deals with research involving human beings.

After classification and data collection, descriptive, comparative, correlation and multiple stepwise linear regression studies were performed. The correlation study was performed using the Spearman Correlation Coefficient with acceptance level 0,05. For the comparative study of means the Mann Whitney tests were used, with acceptance level also 0,05. For the statistical study, the Statistical Package for the Social Sciences - SPSS - for Windows, v. 22.0.

III.   RESULTS

The psychological variables of resilience, wisdom, depression, basic psychological needs, successful aging as well as quality of life were not significantly different when compared to the variables gender and to the age group divided between 60 and 69 years and between 70 and 79 years (Mann Whitney test). Only the cognitive performance variable, evaluated by the MMSE, presented a significant difference ($p = 0.045$) in relation to the gender variable, demonstrating that men presented better cognitive performance (Table 1).

Table.1: Participants' characterization

	60 - 69 years n=106		70 - 79 years n=55		Total n=161	p
	M n=25	F n=81	M n=17	F n=38		
Resilie.	142,9 ±10	142,3 ±12,9	136,1±30	144,8 ±14,2	142,51 ±14,89	0,974* 0,597**
Wisdo.	4,27 ±0,47	4,27 ±0,38	3,9 ±0,7	4,2 ±0,4	4,30 ± 0,55	0,709* 0,134**
MMSE	25,67 ±2,30	24,62 ±3,3	23,7 ±4,4	22,7 ±4,2	24,27 ±3,61	0,080* 0,045**
GDS-15	0,21 ±0,1	0,20 ±0,16	0,20 ±0,1	0,1 ±0,1	2,91 ±2,36	0,450* 0,771**
Basic psychol.needs	67,40 ±4,7	67,48 ±6,54	63,2 ±8,2	67,8 ±6,5	67,34 ±6,81	0,073* 0,410**
SOC	7,68 ±2,8	7,53 ±2,21	7,4 ±2,2	7,1 ±2,1	7,59 ±2,24	0,352* 0,130**
Quality of life	74,87 ±12	94,56 ±10,2	73,2 ±14	74,7 ±9,8	74,74 ±10,98	0,435* 0,893**

*p of age group

** p of gender

In the general group of participants in our study, we found in Spearman's correlation analysis a significant positive correlation between resilience and quality of life variables (*rho* = -0.475, *p* = 0.000) and basic psychological needs (*rho* = 0.534; *p* = 0.000). We also identified a negative correlation between resilience and depression (*rho* = -0.279; *p* = 0.000), showing that older people who present more resilient conditions have a higher perception of quality of life, less depression symptoms, consider the importance of autonomy, relationships and personal competence during old age.

For the analysis of stepwise multiple linear regression, resilience was tested as a dependent variable. Initially, the following independent variables entered the regression model: depression, quality of life (sensory abilities, autonomy, past, present and future activities, social participation, death and dying, intimacy), wisdom (intelligence, personality, transcendence, Happiness, and religious practice), cognitive performance, basic psychological needs for the elderly (autonomy, relationships, personal competence) and SOC (selection for losses, elective selection, optimization and compensation).

After analysis of the collinearities and adjustments of the stepwise multiple linear regression model, the following independent variables remained in the final model (Table 2): personal competence factor of the basic psychological need, autonomy and past, present and future activities factors of the quality of life, wisdom and cognitive performance (MMSE). The determination coefficient was $R^2 = 0.729$.

Table.2: Multiple linear regression analysis for the dependent resilience variable

Model	Unstand. Coef. B	Std. error	Stand. Coef. Beta	t	Sig.	Collinearity Statistics Toler.	VIF
Constant	20,482	6,810		3,008	,003		
Personal compet.	1,753	,136	,627	12,854	,000	,730	1,369
Auton.	1,143	,337	,179	3,386	,001	,620	1,613
Wisdom	,238	,078	,143	3,038	,003	,780	1,282
Past, present, future activities	,765	,302	,138	2,537	,012	,589	1,697
MMSE	2,737	1,255	-,092	-2,180	,031	,977	1,023

Considering the dependent variable resilience within the two age groups from 60 to 69 years and from 70 to 79 years (Table 3), there is a $R^2 = 0.653$ and $R^2 = 0.838$. The predictors for the model of participants in the

60-69 age group are: psychological need for personal competence, autonomy factor of quality of life, depression (GDS-15) and intelligence wisdom. In the model of older people, 70 to 79 years old, we identified the predictors of psychological need for personal competence, quality of life autonomy factor, and strategies for selection, optimization and compensation (SOC).

Table.3: Multiple linear regression analysis for the dependent variable resilience in the age groups of 60 to 69 and 70 to 79 years

	Model	B	Std. error	Beta	t	Sig.	Tol.	VIF
							Collinearity Statistics	
Age	Constant	49,298	9,836		5,011	,000		
	Personal Compet.	1,458	,168	,568	8,663	,000	,792	1,263
60-69 years	Auton.	1,308	,352	,231	3,711	,000	,876	1,142
	Depres.	-13,0	4,841	-,175	-2,70	,008	,815	1,227
	Intellig. wisdom	3,310	1,600	,132	2,069	,041	,840	1,190
	Constant	6,782	8,946		,758	,452		
	Personal Compet.	2,424	,192	,776	12,62	,000	,840	1,191
70-79 years	Auton.	,074	,018	,248	4,065	,000	,854	1,171
	SOC	,978	,480	,117	2,037	,047	,957	1,045

The coefficient of determination of $R^2 = 0.885$ and of $R^2 = 0.669$, respectively, was obtained by analyzing the multiple linear regression of the dependent resilience variable in relation to the male and female sex study participants (Table 4). For the male analysis, we had the psychological need predictors for personal competence and relationship, as well as life quality. For the female group, the psychological need predictors for personal competence, the quality of life autonomy factor,

and the selection, optimization and compensation strategies (SOC) were part of the model.

Table 4: Multiple linear regression analysis for the dependent variable resilience in the male and female

Model	B	Std. error	Beta	t	Sig.	Tol.	VIF
						Collinearity Statistics	
Constant	2,71	9,729		,279	,782		
Personal Compet.	1,59	,187	,618	8,525	,000	,579	1,728
Relations	2,19	,455	,315	4,823	,000	,712	1,404
Life Quality	5,97	2,238	,179	2,670	,011	,675	1,481
Constant	24,0	7,841		3,063	,003		
Personal Comp.	1,99	,166	,664	12,03	,000	,945	1,058
Auton.	1,71	,325	,292	5,286	,000	,944	1,059
SOC	1,08	,327	,179	3,324	,001	,993	1,007

The elderly participants in our study in order to develop resilience need to stimulate personal competence, relationships, and quality of life. For the elderly be resilient, they had to develop personal competence as well. Regarding quality of life, the elderly need only the autonomy factor and use the strategies of selection, optimization and compensation that enable a successful aging process. Being, therefore, resilience in women related to successful aging strategies.

IV. DISCUSSION

Brazil, as a developing country, faces new challenges in the social area, as the rapidly ageing of the population. Once people live longer, a new field of interest opens up in studies that seek to understand the aging process, which should serve as a basis for public policies seeking an advanced age with life quality. In this context the lifespan meta-theory of lifelong development has emerged as one of the most relevant in the search for and understanding of successful aging. This approach indicates that, in order to achieve successful aging,

individuals need to seek the balance between the gains and losses arising from this process and, for that, they must use internal mechanisms called selection, optimization and compensation (SOC). This fact was identified in our study in the age group of 70 to 79 years and in the women.

Although we did not identify in our sample differences in relation to the variables studied in relation to sex or age, except in relation to the cognitive performance that was shown to be higher in men, we can observe that the variables when associated to resilience show a significant result.

Papalia and Feldman [22] explain that older people show considerable plasticity (modifiability) in cognitive performance and may benefit from training. Some aspects of memory appear to be almost as effective in older adults as in younger ones, but other aspects (notably the ability to operate memory and the ability to recall specific events or newly acquired information) are often less efficient, Problems with coding, storage and retrieval. Baltes [23] proposes a dual process model: the mechanics of intelligence often decline, but the pragmatics of intelligence (practical thinking, knowledge and specialized skills and wisdom) can continue to grow.

In the correlation analysis, we identified a relation between the increase of resilience capacity and the positive perception of the quality of life and the basic psychological needs, as well as the reduction of the symptoms of depression.

Alaphilippe and Bailly [24] and Vilela [25] describe that the elderly are not prepared to face this period of life and end up confronted with life boredom. Lack of occupation, especially in the case of men, is one of the main reasons for the onset of depression symptoms, with tendencies to develop hypochondriacal concerns and masked depressions associated with feelings of sadness, helplessness and hopelessness. This picture of depression can progress to a vegetative lifestyle, considered by the authors as a social death, until biological death, or anticipated by suicide. Studies have shown that women are more affected by symptoms of depression and anxiety than men [26]. In Brazil, the latest National Health Survey [27] shows a higher prevalence of depression in women (10.9%) compared to men (3.9%). One way to counterbalance depressive and anxiety symptoms is through self-pity, because with it there is the understanding that suffering (error, failure, pain, inadequacy) is part of the shared human experience. Self-pity in women is related to self-esteem, self-efficacy and socio-demographic aspects [28].

Although the literature indicates differentiated conditions for aging in general, we can note that in the sample of this study, the relationship of resilience with other variables within the context of successful aging in the same way as approached by Baltes [23]. The results demonstrate that coping with the stressful events typical of the aging process has represented a suitable condition for the development of resilience within a context of satisfactory perception of life and concomitant reduction of the symptoms of depression.

Koller et al. [29] report that resilience reveals how people live their lives, since resilience is a strategy that facilitates development and expands the possibilities of a successful quality-of-life aging.

When thinking about the aging process, it is very common that the expected losses that come with age, together with the difficulties associated with them, are referred in first place. However, considering that the aging process is currently irreversible, it must always be taken into account that the most important is how the elderly manages to deal with the losses related to old age, in order to maintain their functional capacity and quality adequate to levels of life. This aspect is strongly related to the way the elderly person perceives their life and with the subjective characteristics related to an aging with quality of life [30]. In this way, the association of resilience with the variables identified in the studied population regarding personal competence, autonomy, wisdom, as well as the recall of past activities and the accomplishment of present activities and the planning of future activities and the cognitive performance as factors are justified Essential for aging to be characterized as successful.

In the present study, the quality of life facet - past, present and future activities was identified as a predictor of resilience. It is known that regardless of the age group in which the individual is, during his development, the environment and habits developed throughout life play a preponderant role; When we refer to the elderly, we can not separate them from their social context and life history [21].

The personal competence, autonomy, absence of depression and the wisdom of intelligence as elements necessary for the manifestation of resilience were identified for the participants in the age group of 60 to 69 years. In older people, from 70 to 79 years old, the association of resilience appears again with personal competence and autonomy. As a differential in relation to the younger age group we find the strategies of selection, optimization and compensation (SOC) that define the successful aging process.

In a study carried out by Camargo, Contarello, Wachelke, Morais and Piccolo [31], the results presented a panorama that indicated the association of several variables, including social ones and configurations of representational thinking about what was perceived as

aging. Some variables, such as sex and age group, were contextualized in cultural conditions which were associated with representational products that explained and gave meaning to the challenges and new phenomena that people had to deal with in everyday life, adapting to practical demands. The same process occurred with the present study, where depending on the age range the need to be or not resilient was modified.

Our study found that for men develop resilience and achieve successful aging, it is necessary a good perception of life quality and the basic psychological needs for personal competence and relationship. Women also demonstrate that the development of resilience is associated with personal competence, but instead of the relationship they demonstrate the importance of autonomy and, in return for the perception of quality of life, point to successful aging strategies.

This difference can occur because older women, regardless of social class, tend to attend spaces to remain active as elderly groups, recreational associations, which allows them to affirm their participation, independence and autonomy to manage their lives; women are still more involved than men are by social factors [32]. Women in our sample have always had the family and social interpersonal relationship as a principle, unlike men who retire when they need to look for new relationships in order to maintain their capacity for resilience. However, autonomy tends to occupy a prominent role for women in old age, as they manage to become more independent and autonomous through age and especially widowhood, defining their resilience through the exercise of autonomy. Autonomy is a characteristic exercised by men from the youth, not interfering in the development of resilience.

Considering both age groups (60 to 69 years and 70 to 79 years) and the male and female elderly, we identified that the basic psychological need for personal competence is constant, and is therefore a fundamental element for the development of resilience in people of the study. Quality of life factors were also evidenced in the different age groups and in both sexes.

The absence of depression proves to be important only for the elderly in the age group of 60 to 69 years, as well as the wisdom of intelligence. But successful aging strategies were more specific for women and for the 70-79 age group.

Laranjeira [33] points out that successful aging is measured not only by the absence of problems, but by indicators of subjective well-being, such as satisfaction with life, happiness, morality, contentment, quality of life perceived or other negatively related measures such as depression and anxiety.

It can be seen that injuries of all kinds can occur with the age advancement; the deaths (of the spouse, of relatives, of friends) become more and more frequent. Loss of social utility and disease can cause serious disturbances in the elderly. For all these aspects, aging could be considered as a risky context; however, the elderly react in very different ways. Some may develop a behavior classified as resilient, so that normal and expected events of life become a source of expressiveness rather than threats to the continuity of the self [34].

V. CONCLUSION

From the analysis and discussion of the data obtained in this study, it can be concluded that the resilience variable did not present significant difference when analyzed under the aspect of different age and sex ranges. The studied sample presents, in a general way, great psychological conditions that were evaluated through the strategies of selection, optimization and compensation, the perception of the basic psychological needs, the resilience, the wisdom and the quality of life and the absence of depression.

Since conception, adaptive processes of acquisition, maintenance, transformation, and wear are involved in the psychological and functional structures. In this perspective, development is understood as a continuous, multidimensional and multifactorial process of modifications, influenced by genetic-biological and sociocultural issues, of a normative and non-normative nature, marked by gains and losses and by the interaction between the individual and the culture.

In order to respond to the objective proposed in this study, it was identified that there is an association between resilience and variables of basic psychological needs, quality of life, depression, wisdom and cognitive performance when analyzed in relation to the sample as a whole.

These results demonstrate that the aging process is complex, ranging from biological aging to social aging, which allows each individual to shape psychologically. This adaptation implies the use of new strategies of thinking and problem solving to compensate for losses when resources tend to decrease. The losses suffered during the life span increase with more lived years, as well as the probability of the appearance of diseases, the reduction of the autonomy and even the death.

We concluded that the variable resilience is related to the basic psychological needs, the absence of depression and the quality of life and it is understood that the present work contributes to the understanding of how this specific population, through resilience and quality of life, crosses this life cycle.

Although several analyzes still need to be performed due to the complexity of the variables presented in this study we can trace some research paths. First, the relationship between social, psychological and physical aspects in the successful aging process is clear. Secondly, it should be noted that the group studied presents ideal conditions for the development of successful aging, and therefore can not represent a parameter for the aging of the Brazilian population.

It is considered, therefore, that the resilience during the old age is marked by many intervening variables, besides the fact that the aging is also subjective, sufficient elements so that many studies still need to be conducted so that the functioning of the resilience in the aging process as well explained in its entirety.

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The Effectiveness of Scientific Reasoning-Based Physics Module to Train the Students' Multirepresentation Ability at Physics Learning in High School

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Abstrak— *Module is a printed media written with the aim that students can learn independently or with the guidance of a teacher. The module based on scientific reasoning is a learning module that contains material, methods, boundaries, and ways to evaluate that are systematically designed with a scientific approach. This study aims to analyze the effectiveness of students' learning outcomes and multirepresentation abilities by using a module based on scientific reasoning. This research is a quasi-experimental research conducted at SMAN Pakusari. Based on the results of research that has been carried out, then the effectiveness of students' learning outcomes and multirepresentation using the scientific reason-based module has increased.*

Keywords— *Module, Scientific Reason, multirepresentation, Learning Outcomes.*

I. INTRODUCTION

The development and progress of a nation is closely related to education. In Javanese, education is defined as pengulawentah, which means processing, so cultivating the soul is maturing the feelings, thoughts, will and character of the child (Alfandi, 2011: 97). Education is applied in teaching and learning activities. The essence of the teaching and learning process is the process of communication, namely the delivery of information from sources of information through certain media to the recipient of information. The teaching and learning process requires learning models, teaching methods and learning media which are all interrelated and play an important role. Teaching materials are one example of media commonly used in educational institutions. Teaching materials in physics learning are materials that are systematically arranged which are used by teachers and students. (Ministry of National Education, 2009: 12). In addition, according to Mahardika (2012: 10) teaching material is a set of materials that are arranged

systematically which aims to create a supportive atmosphere for students to learn.

The use of teaching materials in the learning process has an important role. According Belawati (2003: 1.4 1.9) the role includes the role for teachers, students, in classical learning, individual, or group. The role of teaching materials in the education process occupies a strategic position and also determines the achievement of educational goals, in living (Mahardika, 2011). Modules can also stimulate students to think more critically, because modules are widely used independently, and for critical thinking a student needs good thinking reasoning skills, beside that the module can also be used as an effective teaching guide for educators as well as material for training for participants learners in self-assessment (Prastowo, 2015: 109). According to Purwati et al. (2016: 482) the greater the ability of students' scientific reasoning, the greater the ability to understand students' physical concepts. Scientific reasoning and understanding of the concept are both at the stage of cognitive development, so they will be interconnected. Then, it is recommended for high school teachers to get used to the concept of scientific reasoning in addition to conceptualization ability, because scientific reasoning supports good results in understanding the concept of physics. Scientific reasoning is an important thing to be applied as a pedagogical framework in the process of learning Physics. So that there is a need for development to improve scientific reasoning in solving problems in various kinds of representation, according to Markawi (2013: 23) reasoning has a positive effect which results in an increase in learning outcomes in Physics. Reasoning also has a positive effect which results in an increase in problem solving abilities (Maryani, 2012). The module using the Scientific Reasoning approach to physics learning that can improve the ability of multi representation in students needs to be used because it will

have an impact on students' learning outcomes. The purpose of this study was to determine the effectiveness of physics-based physics reason modules to train students' multirepresentation skills in physics learning in high school.

II. METHODOLOGY

This type of research is quasi-experimental research. It was held at SMU Pakusari in the 2017/2018 academic year consisting of 36 students. Based on the impact analysis, the module is based on scientific reason to train the multirepresentation skills used by students. Data collection techniques used in this study are observation, pre-test, posttest, and documentation. Data collection techniques used in measuring students' learning outcomes are in the form of written tests on 10 post test essay questions, while the data analysis technique was the N-Gain Test to determine the effectiveness of improving students' multirepresentation ability.

III. RESULT

Data of students' learning outcomes is used to find the value of effectiveness by using the N-Gain Test during teaching and learning activities using a scientific reason-based module obtained from the results of the pre-test and post-test. Students' learning outcomes using the N-Gain test with scientific reason-based module can be seen in table 1.

Table.1: Test scores of students' multirepresentation ability (pre-test and post-test) t in cycle 1, cycle 2, and cycle 3

Average Score					
Cycle 1		Cycle 2		Cycle 3	
Pre-test	*Post-test*	*Pre-test*	*Post-test*	*Pre-test*	*Post-test*
24,22	76.30	25.89	79.54	27.70	82.32

Table 2. N-gain for each cycle

N-gain					
Cycle 1	ategory	Cycle 2	ategory	Cycle 3	ategory
0,69	Medium	0,72	High	0,76	High

N-gain					
Cycle 1	Category	Cycle 2	Category	Cycle 3	ategory
0,69	Medium	0,72	High	0,76	High

Multirepresentation ability is the ability to understand physics problems with various representations, such as being able to understand what is taught in a particular problem or situation. The ability of multirepresentation can be divided into 4 representations, namely verbal, graphical, mathematical and image representations. In this

study analysis of 4 representations. Multi representation ability is measured through post-test activities which was carried out at the last meeting. The analysis of students' multirepresentation ability after using a module based on the N-gain value of students' learning outcomes.

IV. DISCUSSION

The effectiveness of physics modules based on seicentific reasoning is assessed by an analysis of the improvement of students' multirepresentation abilities. Based on data from the results, the development of the students' multirepresent ability from the first cycle to the third cycle has increased.
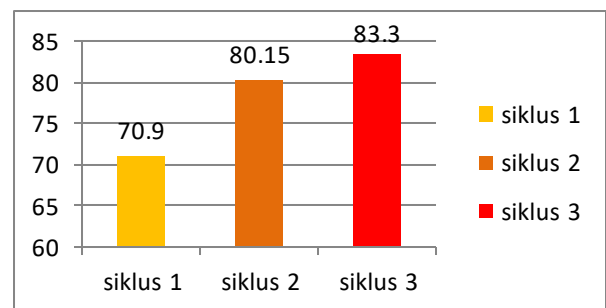
4.1 Graph development test cycle

The data of students' rmultirepresentation ability in the first cycle shows that 70.9% have low multirepresentation ability in each representation. Reflection on the module is done to achieve better results in the next cycle. In the second cycle data, the students' multirepresentation ability increased by 80.15% and increased in the third cycle with a percentage of 83.3%. So that it can be concluded that the module used can be used or effective to train students' multi representation ability. Learning is said to be effective if the level of learning success is at least in the high category. These results also show the consistency of students' learning outcomes after learning with a physics-based seicentific reasoning module.

Data analysis of students' multirepresentation ability is also used in determining the effectiveness of physics modules based on seicentific reasoning. The level of students' multirepresentation ability in the first cycle can be known through the analysis of the value of the pre-test and post-test by using N-gain. The ability of multirepresentation is divided into four indicators, including verbal, graphic, drawing and mathematical. The average pre-test and post-test scores have increased in each cycle.

The first cycle of learning resulted in an analysis of the pre-test and post-test values using N-gain in the medium category so that to achieve the high category it needs improvement in the second cycle. In the second cycle After analyzing the N-gain the ability of students' multirepresentation has increased but there are still some

things that are classified in the medium category. Furthermore, to achieve the expected category in the high category, some improvements were made in the third cycle.

After being analyzed, N-gain analysis thinking skills in cycle 3 obtained an average value of 0.76 so that it was in the high category. Based on the N-gain value which shows a high category in the analysis of multi representation ability, it can be concluded that the developed physics module can improve students' multirepresentation ability and be effective to use, so that it does not need to be tested again in the next cycle.

Empirical validation data in the form of multirepresentation test data at the deployment stage is also used in assessing the effectiveness of physics modules based on scientific reasoning. The distribution was carried out in three classes from three different schools. The first class is class X MIPA at MA Wahid Hasyim. Students' representation ability score data in this class shows 80% mathematical representation ability, verbal representation 81.83%, 78.8% graphical representation and 83.3% image representation with an average of 80.98% with the number of students who have classical completeness by 88%. This means that the level of students' multirepresentation ability is in the very high category. The level of multirepresentation ability tested was analyzed by N-gain showing the average multi representation ability of 0.70 and showing a high category.

The same analysis is carried out at the dissemination stage in other classes. The second and third distribution was carried out in class X Mipa at MA Al-Qodiri 2 Gumukmas and class X at Al-Qodiri Health Vocational School. Learning outcome score data in each class shows the average value of students' multirepresentation ability of 79.03% and 83.57% of classical completeness of 88%. This means that the level of multirepresentation ability of students is in the very high category. The level of multirepresentation ability based on N-gain analysis on the pre-test and post-test scores produces values of 0.73 and 0.72 indicating a high category.

The consistency of the trial results can also be assessed through the deployment stage. The results of the data analysis of the deployment stage carried out in different classes with the same majors showed the level of multirepresentation ability of students in the very high category. The level of students' multirepresentation ability also shows consistent results, namely in the high category. These results indicate that physics modules based on secientific reasoning are effectively used to train students' multirepresentation skills in physics learning in high school. This is in line with the opinion of Yuntawati

and Aziz (2018), the developed module is said to be effective if it meets several aspects, among others, 1) the ability of the teacher in managing the learning, 2) the activities of students and teachers, and 3) completeness of learning.

The development of modules as teaching materials also participates in supporting the development of the learning process and the demands of the 2013 curriculum at this time, where a teacher acts as a facilitator, so that the teacher facilitates the needs of his students as much as possible. The material in physics is never separated from the scientific reasoning approach and multirepresentation ability. That is, the basic ability of scientific reasoning is needed in understanding the concepts of physics in various representations.

V.   CONCLUSIONS AND SUGGESTIONS
Based on the research objectives and the results of the research that has been done, it can be concluded that the use of scientific reasoning based physics modules can improve students' multirepresentation ability with classical completeness about 82% with a high enough category. This has an effect on the results of the students' multirepresentation ability analysis after using the module with N-gane of 0.76.

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A Review and an Approach of Water Pollution Indication using Arduino Uno

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Abstract— *Drinking water is critical for the wellbeing and prosperity of all people and creatures because water play major role in all living beings and most danger disease are caused by water and it is our duty to provide clean and safe water and also to monitor the pollution level in water it is additionally essential for farming utilization for good product yielding and natural way of life linkage wellbeing issues. With over 200 children dying per day due to unsafe water, drinking water crisis is ranked one on the global risk by World Economic Forum, 2015. This paper presents an easy and comprehensive methodology is microcontroller sensor based system continuous observing and pollution recognition for both drinking and non-drinking water dissemination frameworks and in addition for customer locales.*

Keywords— *Water Pollution Indicator, Arduino Uno, Water Monitoring, pH sensors, Turbidity sensors, Oxidation-Reduction Potential sensors, Temperature sensors, Conductivity Sensor.*

I. INTRODUCTION

Clean drinking water is critical resource, important for the health and well-being of all humans. several experimental studies indicate need for continues online water monitoring efficient patio-temporal resolution and demonstrate that the conventional reagent-based water quality methods fail to satisfy this requirements due to higher labor and operational cost it is critical for accurate real-time water quality observing frameworks than the current lab based techniques, which are too ease back to create operational reaction and don't give a level of general wellbeing security continuously conventional strategies for water quality checking and control include the manual accumulation of water test at different areas and at diverse time trailed by research centre scientific procedures keeping in mind the end goal to portray the water quality the main conclusion was that many of the chemical and biological contaminants used have an effort on many water parameters monitored including Turbidity (TU), oxidation Reduction Potential (ORP),Electrical conductivity(EC) and Ph. Thus it is easy to monitor and infer the water quality by detecting the changes in such parameters.

Necessity of Water Monitoring
In the 21st century, there were lots of inventions, but at the same time were pollutions, global warming and so on are being formed, because of this there is no safe drinking water for the world's pollution. Nowadays, water quality monitoring in real time faces challenges because of global warming limited water resources, growing population, etc. Hence there is need of developing better methodologies to monitor the water quality parameters in real time.

II. LITERARURE REVIEW

This chapter presents the critical analysis of existing literature which is relevant to water Pollution Indicator using Arduino Uno. Though, the literature consists of a lot many research contributions, but, here, we have analyzed around eight research and review papers. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the database used for experimentations and the performance evaluation parameters. Their claims are also highlighted. Finally, the findings are summarized related to the studied and analyzed research papers. Chapter concludes with the motivation behind identified problem.

Table 1: Literature Review

Sr. No.	Ref. no. Concerned Author(s) and years	Concept used	Performance evaluation parameters	Database used	Claimed by concern authors (s)	Our findings
1	Vaishnavi V. Daigavane and Dr. M.A Gaikwad (2017)	Interfacing pH sensor, turbidity sensor, flow sensor, temp. Sensor with arduino uno and IOT base	Not mentioned	Not mentioned	Low cost, good flexibility,	No ORP detection, No de solved salts detection
2	Prof. SUMATHI.K, Prof. CHRISTINA DALLY.E, Prof.ASHWINI G.V, SAIGOKUL.s	Uses GSM modul sensor with arduino uno	Not mentioned	Not mentioned	Not mentioned	No practical data given, Performance not evaluated,
3	Nidhi Gautam, Sumit Shringi, Ajay Pratap Singh Rathore	Uses electrical conductivity sensor with arduino uno	Not mentioned	theoretical model of electrical conductivity were given	Quick and accurate	Only determine the moisture level, pH and other parameters not determines
4	Nikhil Kedia	A Senso cloud base project	Not mentioned		feasible in all aspect	Good work
5	Akanksha Purohit, Ulhaskumar Gokhale	Water Quality Measurement System based on GSM	Not mentioned	Not mentioned	Versatile and economical	Good work

III. PROBLEM FORMULATION

This chapter presents the formulation of the identified problem, which base representation of Water Pollution Indicator using Arduino Uno. All the Reviews on theoretical approaches involving the same common terminology.

In the earlier system there was various sensors are use such as flow sensor, pH sensor, and the Wi-Fi module which makes it more expensive but with the less features such as no ORP sensor, no detection of salts present in the water. To overcome these drawbacks we are introducing new sensors in the earlier mechanism. To use the system more efficiently and to get more parameters from the water to identify the problem regarding to water Pollution and to apply control measures the system were introduced.

IV. COMPONENTS USED

This chapter is subdivided into 6 sections wherein the report presents the detailed working of automatic overhead water tank cleaning system that is incorporated in our work along with our approach. Section 4.1 includes the information about the main components used in the project. The platform use for the programming and the hardware use is in point 4.2. Working of system is explained in Section 4.3 with the aid of flowchart. Our proposed approach is introduced in Section 4.4 provides detailed working of the proposed approach.

MAIN COMPONENTS:

A) pH Sensor :

The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and

values below 7 would indicate an acidic solution. It operates on 5V power supply and it is easy to interface with arduino. The normal range of pH is 6 to 8.5.

Fig.1: pH Sensor

B) Temperature Sensor:

Temperature is the most often-measured environmental quantity. This might be expected since most physical, electronic, chemical, mechanical, and biological systems are affected by temperature. Certain chemical reactions, biological processes, Water Temperature indicates how water is hot or cold. The range of DS18B20 temperature sensor is -55 to +125 °C. This temperature sensor is digital type which gives accurate reading.

Fig.2: Temperature Sensor

C) Turbidity Sensor:

Turbidity is a measure of the cloudiness of water. Turbidity has indicated the degree at which the water loses its transparency. It is considered as a good measure of the quality of water. Turbidity blocks out the light needed by submerged aquatic vegetation. It also can raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight.

Fig.3: Turbidity Sensor

D) Conductivity Sensor:

EC meter measures the electrical conductivity in a solution. It uses to monitor the amount of nutrients, salts or impurities in the water. An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. It is commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

Fig.4: Conductivity Sensor

E) ORP (Oxidation-Reduction Potential) Sensor:

The Oxidation-Reduction Potential (ORP) Sensor measures the ability of a solution to act as an oxidizing or reducing agent. Use the ORP Sensor to measure the oxidizing ability of chlorine in water or to determine when the equivalence point has been reached in an oxidation-reduction reaction.

Fig.5: ORP (Oxidation-Reduction Potential) Sensor

F) Display:

A liquid crystal display (commonly abbreviated LCD) is a thin, flat display device made up of any number of colour

or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery- powered electronic devices because it uses very small amounts of electric power. Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each other. With no liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer. The surfaces of the electrodes that are in contact with the liquid crystal material are treated so as to align the liquid crystal molecules in a particular direction. This treatment typically consists of a thin polymer layer that is unidirectional rubbed using, for example, a cloth. The direction of the liquid crystal alignment is then defined by the direction of rubbing.
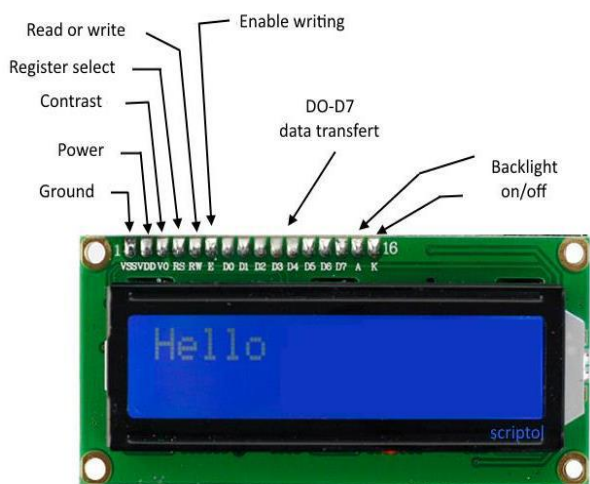
Fig.6: Display

ARDUINO UNO:

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. The board has the following new features: pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the

shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that uses the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin that is reserved for future purposes.
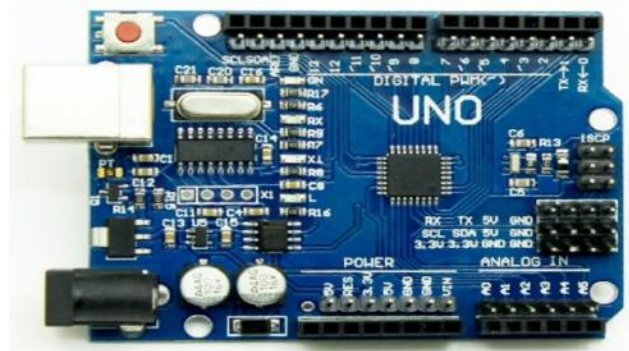
Fig.7: Arduino Uno

Uno means one in Italian and is named to mark the upcoming release of Arduino 1.0.
Microcontroller ATmega328 Operating Voltage 5V Input Voltage (recommended) 7-12V Input Voltage (limits) 6-20V
Digital I/O Pins 14 (of which 6 provides PWM output)
Analog Input Pins 6 DC Current per I/O Pin 40 mA
DC Current for 3.3V6 Pin 50mA Flash Memory 32 KB SRAM 2KB (ATmega328)
EEPROM 1KB (ATmega328) Clock speed 16MHz

WORKING FLOWCHART:
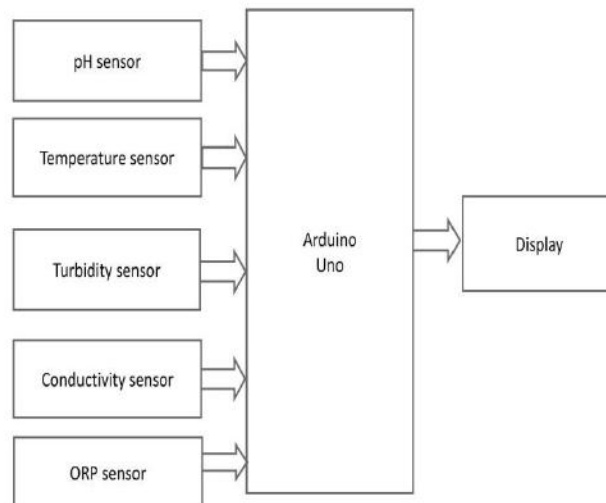
Fig.8: Interfacing various sensors with the Arduino Uno

V. PROPOSED APPROACH

A) Circuit Diagram and Working
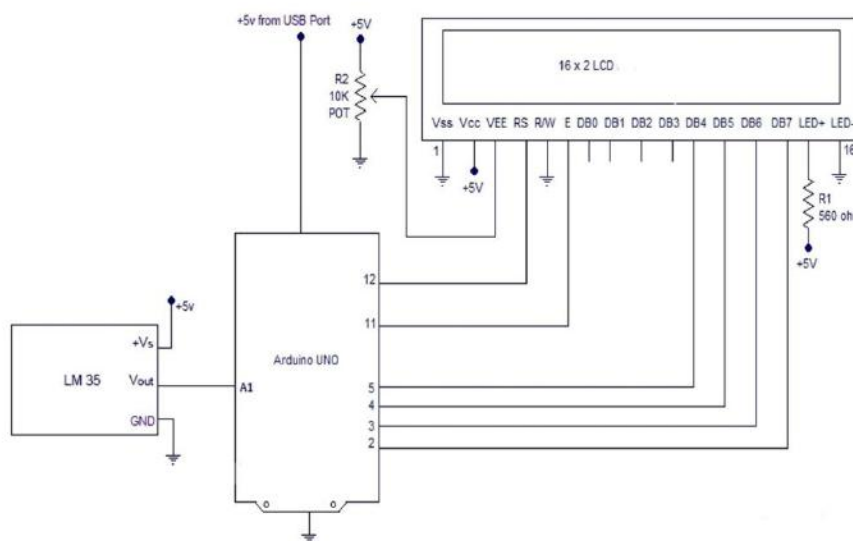
Fig.9: Circuit Diagram

The whole design of the system is based mainly on Arduino Uno which is newly introduced concept in the world of development. There is basically two parts included, the first one is hardware & second one is software. The hardware part has sensors which help to measure the real time values, another one is Arduino atmega328 converts the analog values to digital one, & LCD shows the displays output from sensors, in software we developed a program based on embedded c language. The PCB is design at first level of construction and component and sensors mounted on it. The parameters of water are tested one but one and their result are given to the LCD display.

B) Proteus Simulation:
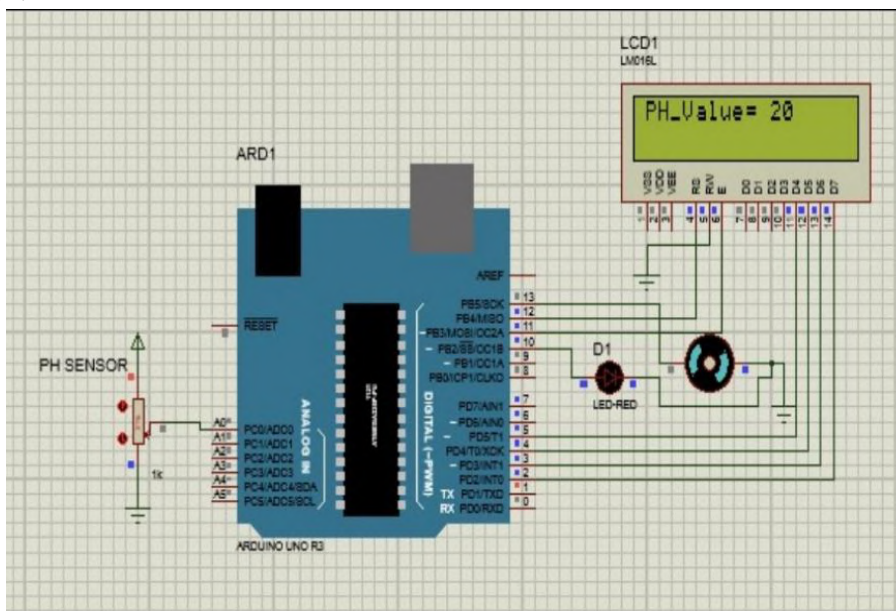
Fig.10: Hardware Simulation

VI. EXPERIMENTAL RESULTS

We have identified a suitable implementation model that consists of different sensor devices and other modules, their functionalities are shown in figure. In this implementation model we used ATMEGA 328 with versions sensors. Sensors are connected to Arduino UNO board for monitoring, ADC will convert the corresponding sensor reading to its digital value and from that value the corresponding environmental parameter will be evaluated. After sensing the data from different

sensor devices, which are placed in particular area of interest. The sensed data will be shown on the display.

VII. CONCLUSION AND FUTURE SCOPE

This chapter presents the conclusions drawn from the evaluation and comparison of experimental results. The chapter concludes with future scope.

Conclusion:

Monitoring of Turbidity, PH & Temperature of Water makes use of water detection sensor with unique advantage. The system can monitor water quality automatically, and it is low in cost and does not require people on duty. So the water quality testing is likely to be more economical, convenient and fast. The system has good flexibility. Only by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters. The operation is simple. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value. By keeping the embedded devices in the environment for monitoring enables self protection (i.e., smart environment) to the environment. To implement this need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, we can bring the environment into real life i.e. it can interact with other objects through the network. Then the collected data and analysis results will be available to the end user through the Wi-Fi.

Future Scope:

- In future we use IOT concept can be used
- Detecting the more parameters for most secure purpose
- Increase the parameters by addition of multiple sensors
- By interfacing relay we control the supply of water

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Propargyl alcohol as a corrosion inhibitor for AISI 304L stainless steel in hydrochloric acid

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Abstract— Hydrochloric acid solutions (at concentrations of 5 to 28%) are used to acidify or acid-stimulate a rock-reservoir, increasing productivity of an oil well and removing calcareous deposits that lodge inside the carbon steel pipes. Typically, AISI 304 L stainless steel is used to manufacture various components, such as valves, adapters, rings, connectors, and rotors of pumps that are used in these acidifications. In order to guarantee the protection of both the carbon steel and the AISI 304 L, propargyl alcohol can be used as a corrosion inhibitor. The results of mass loss (gravimetric) and electrochemical tests (polarization curve) show a good efficiency of propargyl alcohol as a corrosion inhibitor for AISI 304 L stainless steel in concentrations of 5% (by volume) and 10% (by volume) of hydrochloric acid.

Keywords — AISI 304 L stainless steel, corrosion, corrosion inhibitors, propargyl alcohol, hydrochloric acid.

I. INTRODUCTION

One of the many uses of AISI 304L stainless steel is manufacturing components and equipment for the petroleum industry. Petroleum represents the largest component of the industrial energy matrix and is key in developing the global economy. Corrosion is one of the most harmful challenges encountered in the oil and gas sector. The study of corrosion is therefore fundamental due to its great impact in the oil industry. In fact, corrosion control expenses are estimated to be greater than 3.0% of the gross national product. As a result, new studies that aim to minimize costs of corrosion control expenses are of paramount importance to society [1, 2].

Matrix acidizing is a widely used technique to stimulate the productivity of an oil well that becomes inefficient over time. The main purpose of this process is to remove wellbore formation damage, promoting the dissolution the reservoir rock and consequently increasing the permeability of rock to the passage of oil and gas. Hydrochloric acid (HCl) is the most used in the stimulation operations due to its ease of dissolution of carbonate rocks as limestone ($CaCO_3$) and dolomite

($CaCO_3 . MgCO_3$). The formation of soluble salts ($CaCl_2$ and $MgCl_2$) occurs when HCl penetrates the reservoir rock [3, 4]. The chemical reaction for limestone and dolomite is written, respectively as:

$2\ HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$

$4HCl + CaCO_3.MgCO_3 \rightarrow CaCl_2 + MgCl_2 + 2CO_2 + 2H_2O$
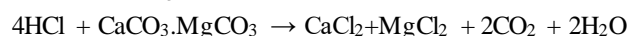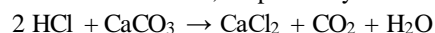
An oil and gas production system made from carbon steel tubing (Figure 1) may include some equipment such as valves, adapters, rings, connections and rotors of special pumps that can made from AISI 304L austenitic stainless steel. Corrosion inhibitors are designed to protect such carbon steel tubing during the HCl stimulation process, without taking into consideration other materials that need anticorrosion protection [5-7].
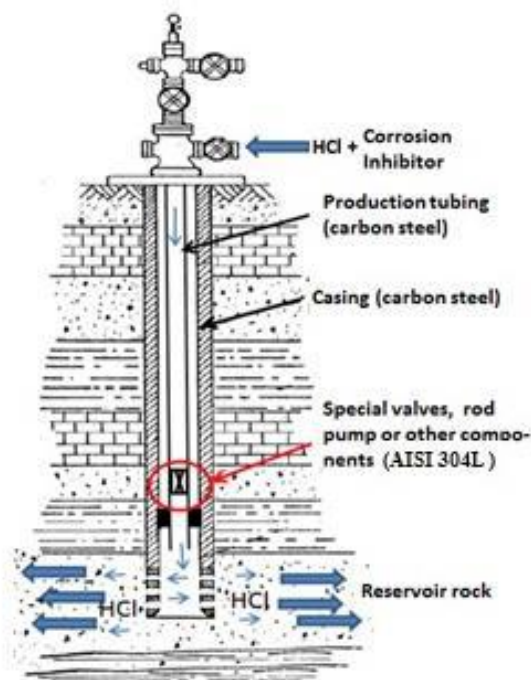
Fig. 1: Acid stimulation of reservoir rock

The application of corrosion inhibitors is commonly employed to combat corrosion damage; these inhibitors have a high efficiency in protecting the material of carbon steel pipes in the oil industry. The oil and gas industry has used the technique of using corrosion inhibitors to prevent the corrosion of carbon steel. Corrosion inhibitors are

defined as chemical substances that add to the corrosive medium to form a barrier on the metal surface (via adsorption or chemisorption), thus preventing or reducing corrosive actions. Corrosion inhibitors made from propargyl alcohol have demonstrated good performance in the protection of carbon steel from HCl solutions [5].

Generally, corrosion inhibitors are built with carbon steel, as carbon steel dominates more than 90% of materials used in the oil industry. Another important point is that the initial cost of stainless steel equipment is 15 to 20 times higher than that made of carbon steel (these costs do not consider manufacture technologies).

Although AISI 304L is classified as stainless steel, it can be corroded, depending on its exposure to certain conditions. Acids such as HCl, sulfuric (H_2SO_4) and hydrofluoric acid (HF) are reducing agents, producing hydrogen (H_2) when reacting with metals or alloys. These acids also can remove the passive oxide layer or passive film that forms on the steel surface. On the other hand, nitric acid (HNO_3) does not damage the passive oxide layer because of its oxidizing properties, thus preventing acid attack. Considering these factors, it is important to protect stainless steel with the addition of corrosion inhibitors [8 -10].

The petroleum industry uses AISI 304L stainless steel in their manufacturing; equipment made with this product is thus susceptible to corrosion via reducing acids. This paper analyses the effectiveness of propargyl alcohol in inhibiting the corrosion of HCl on AISI 304L.

II. MATERIALS AND METHODS

Disks of AISI 304 L stainless steel were made with a 2.5 cm diameter and a 2 mm thickness. The elemental composition of AISI 304 L stainless steel is shown in Table 1. The metal surface was abraded with silicon carbide (SiC) paper ranging from a 100 to 600 grit size, followed by cleaning in deionized water. Subsequently, surfaces of the disks were degreased in ethanol by using ultrasonic cleaning. They were then dried with hot air.

Table 1. The chemical composition of AISI 304L austenitic stainless steel.

C (%)	Mn(%)	Si(%)	Cr(%)	Ni(%)	Fe(%)
0.030	1.80	0.35	18.30	8.60	Balance

The corrosive media used were 5% and 10% volume solutions of high purity HCl. The concentrations of the corrosion inhibitor, propargyl alcohol (2-Propyn-ol-1), were fixed at 0.05 and 0.1 % volume.

Gravimetric assays (measuring weight loss) were performed in 100 mL glass containers. The corrosion coupons were completely immersed in 80 mL of acid solution, leaving the remaining headspace in the container for the evolution of hydrogen (H_2) that resulted from the

acid attack. The jars were maintained at temperatures of 25°C, 40°C and 55°C in a thermostatically controlled bath. The testing times were fixed at one, two, and three hours of exposure. The mass loss tests were conducted in triplicate.

Immediately after completion of the test, coupons were removed from the corrosive medium. Every deposit was rinsed first with deionized water, then with ethanol and subsequently dried quickly with hot air. The deposits were then re-weighed with the same accuracy so that the weight loss could be determined according to ASTM G 31-72 [11].

In the electrochemical tests, specimens were cut to a 0.25 cm^2 exposed area and encapsulated in polyester resin. The specimens were initially abraded longitudinally with 600-grade emery paper, degreased with acetone, washed in distilled water and dried under air. The electrochemical cell test (Figure 2) consisted of a three-electrode arrangement; a saturated calomel reference electrode, a platinum plate as the counter electrode and the 304L austenitic stainless steel sample as the working electrode. The test was conducted on a Type III Autolab potentiostat by varying the potentials at intervals of 60 mV/min over a range of −300 mV to +300 mV, with respect to an open circuit potential by a desk top computer.
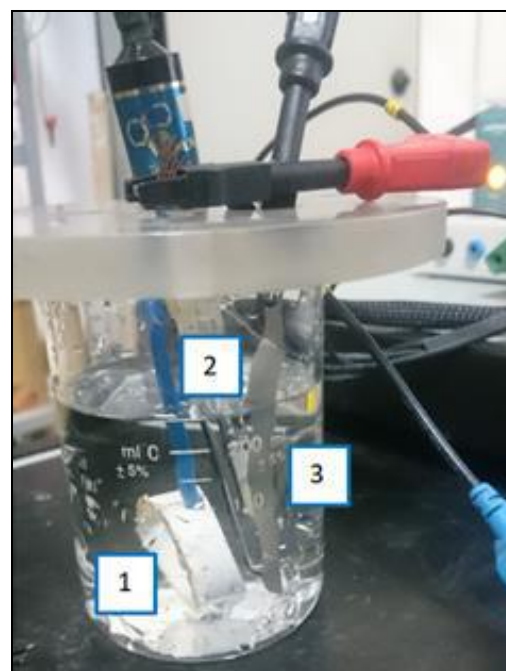
Fig. 2: The polarization cell used in this experiment: (1) the working electrode AISI 304L, (2) the platinum counter electrode, and (3) the saturated calomel reference electrode.

III. RESULTS AND DISCUSSION

The experimental conditions and results of the mass loss tests of AISI 304L stainless steel in the two HCl solutions

in the absence or presence of the two concentrations of propargyl are in Figures 3 and 4. The results show that mass losses are relevant when the corrosion inhibitor is not used, in particular in the three hour experiments. In addition, the mass loss at 10% HCl is the triple that of 5% HCl.
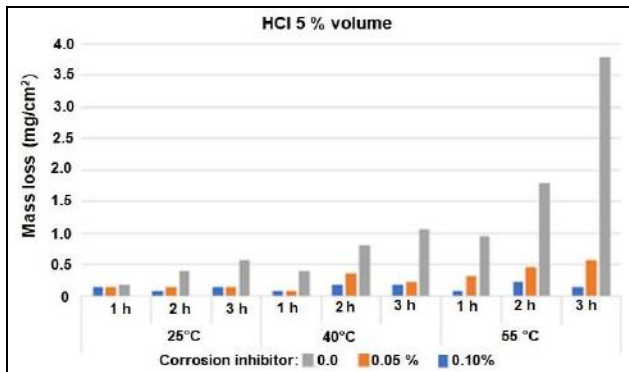
Fig. 3: Results of the mass loss tests of AISI 304L stainless steel in 5% HCl solution with and without corrosion inhibitor.
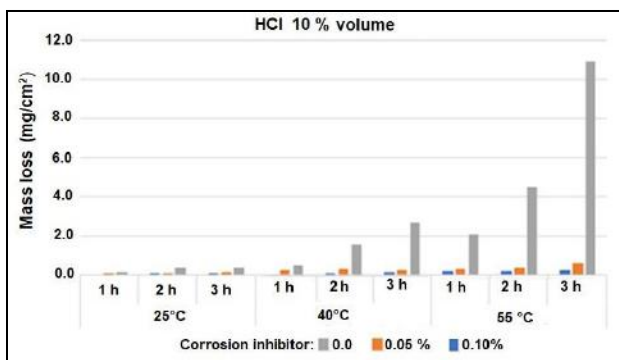
Fig. 4: Results of the mass loss tests of AISI 304L stainless steel in 10% HCl solution with and without corrosion inhibitor.
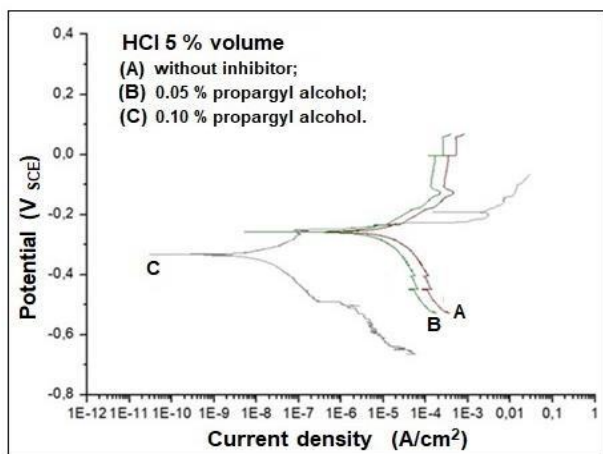
Fig. 5: Polarization test results for 5% HCl at 25°C, with and without inhibitor.
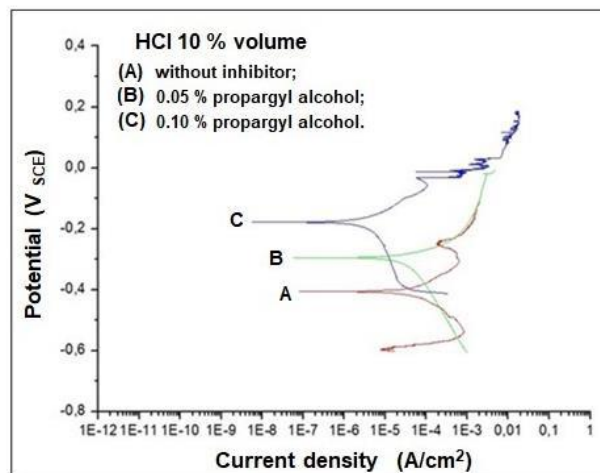
Fig. 6: Polarization test results for 10% HCl at 25°C, with and without inhibitor.

The polarization resistance (Rp), the current density (I_{cor}) and the corrosion potential (E_{cor}) for each polarization curve with varying concentration and temperature are shown in Tables 2 and 3. The following equations show the efficiency of the corrosion inhibitor under the tested conditions:

Effic. % $= 100 \ (I_o - I_{inhib}/ I_o)$, where

Effic. % = corrosion inhibitor efficiency; I_o = current density without addition of corrosion inhibitor, and $I_{inhib=}$ current density with addition of the corrosion inhibitor.

Table 2. Electrochemical parameters of the polarization curves of AISI 304L steel exposed to a 5% HCl solution with and without the propargyl alcohol corrosion inhibitor.

Inhib. (%)	I_{cor} (A/cm^2)	E_{cor} (V)	R_p (Ω)	Effic. (%)
0	0.9 x10^{-4}	-0.260	2.9 x 10^3	----
0.05	1.5 x10^{-6}	-0.300	3.0 x 10^5	98.33
0.10	9.2 x10^{-7}	-0.350	3.8 x 10^6	98.97

Table 3. Electrochemical parameters of the polarization curves of AISI 304L steel exposed to a 10% HCl solution with and without the propargyl alcohol corrosion inhibitor.

Inhib. (%)	I_{cor} (A/cm^2)	E_{cor} (V)	R_p (Ω)	Effic. (%)
0	8.1 x10^{-4}	-0.410	5.1 x10^2	------
0.05	1.2 x10^{-5}	-0.310	2.6 x10^4	98.51
0.10	1.1 x10^{-6}	-0.290	2.7 x10^5	99.86

The polarization curves and the tables for the electrochemical parameters (Figs. 5-6, Tables 2-3) support the following findings:

- The polarization curves show a significant reduction in current densities (I_{cor}) as the corrosion inhibitor is added to the acid solution.
- The increased polarization resistance (R_p) indicates the protective action of the corrosion inhibitor on the metal surface.
- There is a systematic parallelism between the polarization curves with the displacement of these curves to the right upon greater corrosive attack.
- The current passing through the system is reduced with increasing inhibitor concentration. This phenomenon is because the increase of inhibitor molecules near the surface of the steel forms a resistance barrier to the passage of current, thus reducing the corrosion of stainless steel. The protonation of propargyl alcohol in the acid medium facilitates adsorption on the metal surface [12].
- The increase in the concentration of the inhibitor molecules leads to an increase in the density of inhibitor molecules adsorbed on the metal surface [13].

IV.   PROPOSED CORROSION MECHANISM FOR AISI 304 L STEEL IN HYDROCHLORIC ACID IN THE PRESENCE AND ABSENCE OF A CORROSION INHIBITOR

The corrosion of AISI 304L in hydrochloric acid and the protection exerted by corrosion inhibitor (propargyl alcohol) is explained by a proposed model (Figure 7). The corrosion reactions and the competition between the migration of H^+ ions and the adsorption of propargyl alcohol are divided into three steps.
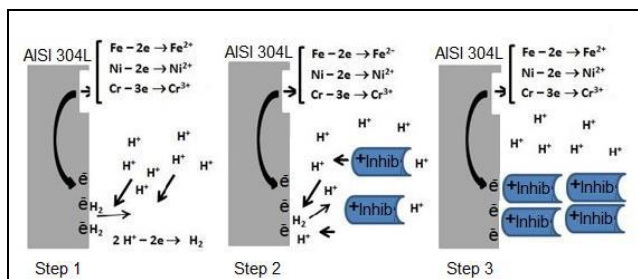
Fig. 7: Proposed mechanism to explain both the corrosion and protection exerted by the corrosion inhibitor in an acidic environment.

In the first step, AISI 304L stainless steel is attacked by hydrochloric acid, destroying the passivated layer and forming the Fe^{2+}, Ni^{2+} and Cr^{3+} ions, which migrate to the acid solution. At the same time, the H^+ ions migrate to the steel surface (cathodic area), forming both atomic (H) and molecular (H_2) hydrogen. These anodic and cathodic reactions are:

Anodic reactions:
$$Fe - 2e^- \rightarrow Fe^{2+}$$
$$Ni - 2e^- \rightarrow Ni^{2+}$$
$$Cr - 3e^- \rightarrow Cr^{3+}$$
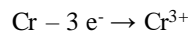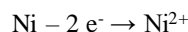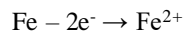
Cathodic reaction:
$$2 H^+ + 2 e^- \rightarrow 2H \rightarrow H_2$$
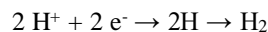
In the second step, protonation occurs. With the addition of the corrosion inhibitor to the hydrochloric acid solution, H^+ ions react either totally or partially with the inhibitor molecules. This process causes the positively charged organic molecules to migrate towards the cathodic surface. The protonation of propargyl alcohol in acidic media described in this study is based on the work developed by Bartos and Hackerman [14] and Feng et al. [15].

Finally, in the third step, adsorption of the inhibitor molecules occurs, forming a barrier on the steel surface. This process acts to prevent or delay the approach of H^+ ions, which would then pick up electrons from the metal surface (cathodic area), ultimately inhibiting the development of anodic reactions.

V.   CONCLUSIONS

The following conclusions were made based on the experiments conducted in this study:

- The gravimetric tests showed that the loss of mass of AISI 304 L austenitic stainless steel increases with increasing HCl concentration, temperature and immersion time. In the absence of the corrosion inhibitor, with a three hour immersion time and a temperature of 55 °C, the loss of mass of stainless steel at 10% of HCl is three times the loss of mass at 5% HCl.
- The addition of propargyl alcohol to HCl solutions reduced the mass loss of stainless steel under all test conditions, suggesting excellent corrosion protection.
- In the electrochemical tests, the polarization curves showed that the propargyl alcohol increased the corrosion resistance of the AISI 304L steel by creating a barrier of adsorbed molecules that resisted the passage of electric current, thus reducing the corrosion of the metal surface. These results showed that the current density decreases and the polarization resistance increases as the concentration of the corrosion inhibitor rises.

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A Review and an Approach of Flying Electric Generators as Alternate Source of Energy

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***Abstract*—** *This paper presents a review of flying electric generators which are used to harness kinetic energy in powerful, persistent high altitude winds. It has been found that FEGs could give individual output of up to 40MW. It is a lighter wind turbine that rotates about a horizontal axis in response to wind, generating electrical energy. This electrical energy is transferred down for immediate use, or to a set of batteries for later use, or to the power grid. This paper presents the critical analysis of existing literature which is relevant to flying electric generator Though, the literature consists of a lot many research contributions, but, here, we have analyzed some important research and review papers. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the database used for experimentations and the performance evaluation parameters. Their claims are also highlighted. Finally, the findings are summarized related to the studied and analyzed research papers. Paper concludes with the motivation behind identified problem.*

***Keywords*—** *Flying Electric Generator (FEG), Wind Turbines, Alternate Source of Energy, Energy Harvesters, Magenn Air Rotor System (MARS).*

I.   INTRODUCTION

Flying electric generator are proposed to harness kinetic energy in powerful, persistent high altitude winds. At 1500ft (4600m) and above, tethered rotorcraft, with four or rotors mounted on each unit, could give individual output of up to 40MW. Flying Electric Generator (FEG is one of the recently found energy source. FEG is a lighter wind turbine that rotates about a horizontal axis in response to wind, generating electrical energy. This electrical energy is transferred down for immediate use, or to a set of batteries for later use, or to the power grid. Helium (an inert non-reactive lighter than air) sustains the Air Rotor which ascend to an altitude for best wind and

its rotation also causes the Magnus effect. This provides additional lift, keeps the device stabilized, and keeps it positioned within a very controlled and restricted location. This is the latest technology in Energy sector and cheaper than other techniques and Eco friendly.

The propeller turbine on the flying device or the flow induced rotational motion of the complete device drives on-board generators from where the electrical energy is transmitted to the ground by a conductive tether A good example of this category is the balloon concept developed by Magenn Power Inc. namely Magenn Air Rotor System. In this concept, a balloon filled with helium stationary at a height of 200 m to 350 m altitude rotates around a horizontal axis connected to a generator. The electrical energy produced is transmitted to the ground by a conductive tether for consumption or to a set of batteries or to the power grid. The Magenn Air Rotor System rotation also generates the "Magnus effect" which provides additional lift, keeps the rotor system stabilized and positions it within a very controlled and restricted location [4]. Flygen concept takes advantage of this principle by mounting small turbines on a wing or an array of turbines on a multi-wing structure that itself acts like the tip of a traditional turbine blade. The FEG is filled with helium gas, which is inert and non-flammable.

II.   LITERARURE REVIEW

This chapter presents the critical analysis of existing literature which is relevant flying electric generator Though, the literature consists of a lot many research contributions, but, here, we have analyzed some important research and review papers. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the database used for experimentations and the performance evaluation parameters. Their claims are also highlighted. Finally, the findings are summarized related to the studied and

analyzed research papers. Chapter concludes with the motivation behind identified problem.

Table.1: Literature Review

Sr. No.	Ref. no. Concerned Author(s) and years	Concept used	Claimed by concern authors (s)	Our findings
1	Mr.Sankaran Nampoothiri Ms. Dhanya G2, Harvester, Apr-2016	Lifting mechanism using helium gas filling	Lifting is very simple by this mechanism	Complexity Is More In This Volume
2	ODoherty, R. J., Roberts, B. W. Res.Institute, Feb 1982	Upper Wind data in One Design of Tethered Wind Energy System. Solar Energy	Air pressure is very important While designing the mars system	Very helpful in designing of mars system
3	CH.Uday kiran reddy - Y.Dasarath- 2009	Lifting mechanism using helium gas	Helium gas is most suitable for lifting	Helium gas properties is given which are very helpful
4	kamini n. shelke December- 2012	This concept is used magenn air rotor system is used	none	Magenn air rotor system is described very simply
5	Rakesh chaudari april 2015	Electrical Energy generation by mars	a high torque less speed is of very small in size	Good performance

III. PROBLEM FORMULATION

There are many ways to generate electricity such as nuclear, thermal, diesel, solar, hydropower based generation system. In nuclear based generation there is always risk of nuclear radiation accident also it requires high initial cost and impacts on human life. In thermal based generation there is a huge production of CO2 in atmosphere and it depends on availability of coal as fuel. In diesel based generation running charges are more due to high cost of diesel and also cost of lubrication. These are the problems that occurs in generation of electricity

In flying electric generator there is no need non-renewable fuel. Also it does not have any impact on environment or human life. There are various problems that are overcome by flying electric generator

IV. PROPOSED APPROACH

A) Working

The Turbine Filled with Helium is deployed with the help of a tether made from a Vectra and high performance multifilament yarn spun from liquid crystal polymer, which is stronger than Steel with high Strength to Weight Ratio. The Flying Electric Generator (FEG) is an innovative lighter-than-air tethered device that rotates about a horizontal axis in response to wind, efficiently

generating clean renewable electrical energy at a lower cost than all competing systems. This electrical energy is transferred down the tether to a transformer at a ground station and then transferred to the electricity power grid.
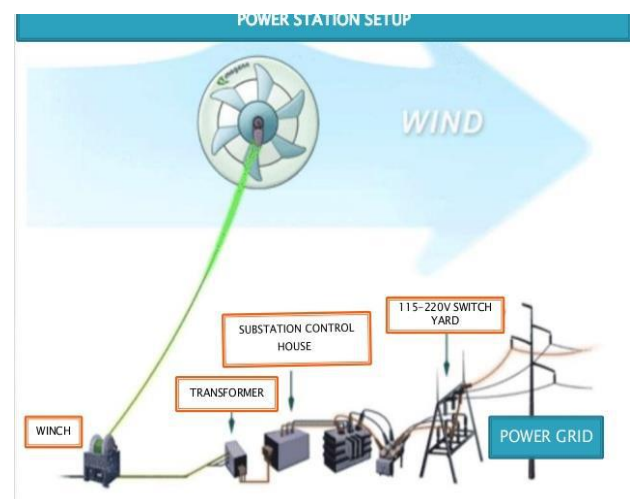
Fig.1: Functional Block Diagram

- As the rotor of the electric generator rotates due to high velocity wind it produces very high torque. u
- There is a step-up gear box which connects the low-speed shaft to the high-speed shaft and increases the

rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1200 to 1500 rpm. u

- The electrical energy thus produced is transferred down the tether for consumption, or to a set of batteries or the power grid.
- It is a windmill similar to a conventional one in its working principle but here the rotor and generator will be floating in air just like a hot air balloon.
- The generator will be enclosed in an inflatable structure and this structure is held by a Tether and tied to the ground.

B) Lifting Mechanism
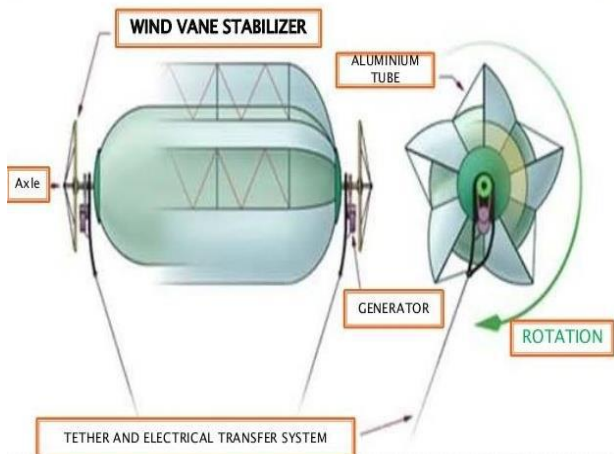
Fig.2: Magenn Air Rotor System

The helium filled MARS is a buoyant turbine made of vectran – a bulletproof material that is stronger than steel of the same thickness – and is connected to the ground by an insulated conductive tether. The unit can rise to a height of 300 to 1,000 feet to take advantage of more constant and higher wind speeds at higher altitudes that conventional wind turbines are unable to reach. While in the sky, the MARS turbine spins in the wind, generating electricity. The current is transferred down the tether for consumption, battery storage or transmitted to a power grid.

The MARS units will have an internal bladder system to maintain pressure. Helium leakage is not an issue under normal conditions; excess air turbulence and gusting might present a small risk but this craft has been designed to withstand challenges. Unlike in a child's balloon, helium leaks at a rate of only half of a percent per month in these designs.

Helium is a light inert gas and the second most abundant element in the universe. Helium provides extra lift and will keep MARS at altitude in very low winds or calm air. It is also plentiful, inexpensive and environmentally safe. Helium's inert quality over other lifting gases makes it very acceptable.

MARS will be constructed with composite fabrics used in airships today. The fabric will be either woven Dacron or Vectran with an inner laminated coating of Mylar to reduce porosity and an exterior coating of Tedlar which will provide ultra-violet protection, scuff resistance and color.

Over speed controls are built into the design of MARS. On the larger MARS units, excessive speed is controlled by moderating tether height. Pressure is constantly monitored and controlled. Rotation speed, wind speed, and generator functions are also monitored. Depending on size, either DC or AC generators will be used, with rectification as necessary.

MARS units must and will have lighting every 50 feet, and the lights must flash once per second. All MARS units must and will have a mechanism to quickly deflate in case a unit gets detached from its tether.

Fig.3: Helium Gas Filling

The Magenn Air Rotor System (MARS) is the next generation of wind turbines with cost and performance advantages over existing systems. MARS is a lighter-than-air tethered wind turbine that rotates about a horizontal axis in response to wind, generating electrical energy. Helium sustains the Magenn Air Rotor System, which ascends to an altitude as selected by the operator for the best winds. Its rotation also generates the "Magnus" effect. This aerodynamic phenomenon provides additional lift, keeps the MARS device stabilized, positions MARS within a very controlled and restricted location, and finally, causes MARS to pull up overhead to maximize altitude rather than drift downwind on its tether

C) Arrangement of Mars
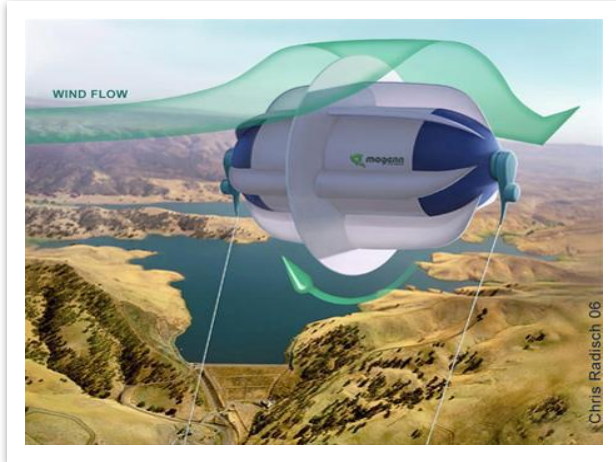
Fig.4: Arrangement

Helium is not the only thing that keeps the object aloft. Combined with its shape, the spinning generates lift using what is called the Magnus effect, which also tends to keep the craft overhead on its tether, rather than drifting downwind. The bigger the MARS unit, the easier it is to build heavier stronger structures, envelopes, and generators. As an example, the largest MARS units planned (100' x 300') will have tens of tons of buoyant (helium) lift. This is well in excess of the overall Air Rotor system weight.

Due to the inherent elegance of the design, the Magenn Air Rotors will always weather-vane properly. Regardless of wind direction, the deflection disk will ensure MARS units will automatically rotate toward the wind, with the Magnus aerodynamic effect creating additional lift.

V.   EXPERIMENTAL RESULTS
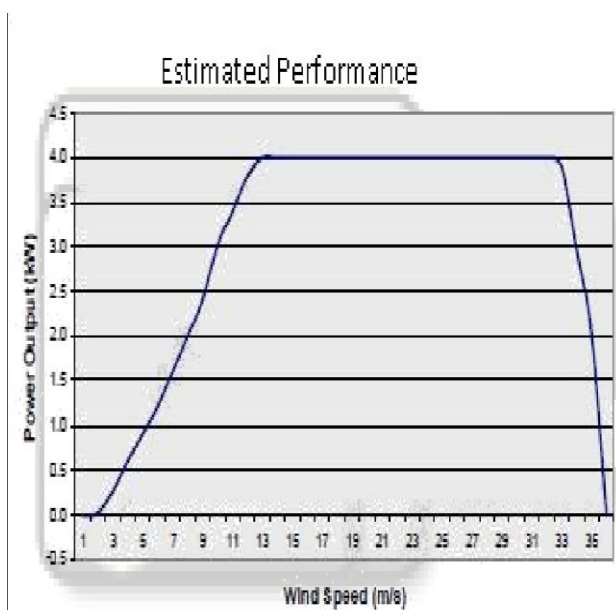
Fig.5: Graph showing estimated performance

From the graph it is verified that the power output of the floating air balloon increases exponentially as the wind speed increases. As the flow of wind is considerably high at higher altitude.

VI.   CONCLUSION AND FUTURE SCOPE

This section presents the conclusions drawn from the evaluation and comparison of experimental results. The section concludes with future scope.

Conclusion:

FEG technology will be applied off-grid and combined with diesel power for developing nations, island nations, farms, remote areas, cell towers, exploration equipment, oil and gas wells, mining sites, offshore drilling stations, and backup power & water pumps. FEG could also be used for on-grid applications for farms, factories, and remote communities. We know that Wind energy is a CLEAN Energy i.e. Pollution-free and eco-friendly. Also wind energy is a renewable energy. This paper presents the critical analysis of existing literature which is relevant to flying electric generator Though, the literature consists of a lot many research contributions, but, here, we have analyzed some important research and review papers. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the database used for experimentations and the performance evaluation parameters. Their claims are also highlighted. Finally, the findings are summarized related to the studied and analyzed research papers. Paper concludes with the motivation behind identified problem.

Future Scope:

- Uses: Charging batteries and using them to light up the streets, etc.
- Suitable for parking at multiplexes, malls, toll booths, signals etc.
- Such speed breakers can be designed for heavy vehicles, thus increasing input torque and ultimately output of generator
- More suitable and compact mechanism to enhance efficiency

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A taxonomy of tasks in dam cracks surveillance for augmented reality application

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Abstract — *Augmented reality is an advanced computational visualization technology that alters how users in the real world can perceive the virtual information. The use of this technology for EAC/FM is being widely investigated. In the scope of dam safety, the constant analysis of concrete behavior is mandatory, searching for clues of pathologies such as cracks. Cracks are relatively common in concrete structures, nevertheless they need to be surveilled due to the risks they offer. The surveillance of cracks involves exhaustive tasks, and for dams, it consists in the execution of a set of complex tasks that demands access to accumulated data and information. Augmented reality can contribute with the visualization process of this information, diminishing the mental workload demand. This paper defines a hierarchical taxonomy of the tasks that are needed in this domain, using Berliner´s taxonomy to classify the tasks, enhancing the understanding of the points where the augmented reality can be used with better results.*
Keywords— *augmented reality, task-analysis process, crack surveillance, dam crack, taxonomy.*

I. INTRODUCTION

Augmented reality is an advanced interaction and visualization technology that has been widely used in a variety of domains, including entertainment, tourism, and help with task execution. This technology improves your perception of the environment around. In EAC/FM, augmented reality has been widely used in all phases of the enterprise life cycle. It can help by presenting, in a contextualized way, project information, schedule, planning, historical data, allowing the user to keep his attention on the task he is doing, avoiding context change. Computer systems that use augmented reality technology offer advanced means of interaction and visualization. They seek to expand the human perceptual system by combining virtual information in the real environment so

that it contributes to improving the conditions for accomplishing the tasks. Systems development is guided by an HCI project, resulting from a user-centered analysis. A good augmented reality system needs to know the environment where the tasks will be performed, the tasks and the users who will perform the tasks.

For the success of the employment of augmented reality in AEC/FM it is important to identify the tasks and understand the information, perceptual and cognitive process required. The proposed taxonomy seeks to aid this.

Employing augmented reality in the context of crack surveillance can help technicians to better perform the tasks required in the context. This article details the scope of the tasks, identifies and classifies them using Berliner taxonomy in order to map the perceptual, motor and cognitive components involved.

II. AUGMENTED REALITY IN AEC/FM

The use of augmented reality in the AEC/FM is being investigated approximately two decades ago. Much of the scientific work describes the development and use of prototypes and evaluates users' satisfaction with the experiences provided [1–14]. Some augmented reality prototypes focus on aiding in the monitoring or inspection of environments during construction [1,2,4–6,9]. Others for assembling aid [10,15–17], maintenance [18], for the execution of tasks that present uncertainties [19], for training [8,14,20], for remote execution of tasks [21]. Some scientific works have investigated the contributions of augmented reality in the management of a building [3,4,6], others assert that augmented reality may favor communication [6,10,22] and the safety of workers in the construction environment [6]. Several of these works already mentioned use the augmented reality in conjunction with the BIM - *Building Information Model*. There are also papers highlighting the benefits gained

from the use of augmented reality to explore the structured information of BIM [11], there are those who point out that it allows the information about the building, designed in the office, to be accessed at the construction site, in a contextualized way.

Research indicates that the adoption of augmented reality in the area is an extended version of BIM because the technology addresses one of the key issues currently investigated in BIM: effective and efficient means to exploit highly integrated and organized information [11,23].

This set of scientific papers proves that the technology has a positive impact on the practices of the sector and that can help in solving existing difficulties in many ways. Among the studies analyzed there were descriptions of the use of augmented reality in the infrastructure sector. The system proposed by Fujiwara: ARLINER, uses the technology to assist the construction of containment dams, in hazardous access places (active volcano slopes), through the remote operation of machines [21]. Hammad, Garrett e Karimi defined a class of augmented reality applications called MARSIFT – *Mobile Augmented Reality System for Infrastructure Field Tasks* [24]. This paper presents, in a descriptive way, utilities of mobile augmented reality in the accomplishment of the necessary activities in the infrastructure constructions. The use of augmented reality to guide the movement of professionals to specific locations, to present evolution information related to monitoring or inspection activities, to communication between teams and to identify specific positions of interest through accurate tracking techniques is cited. The work of Zhou, Luo and Yang describes a case study for quality inspection in tunnels [25]. A model is retrieved and used to establish a virtual line that overlaps in the real environment allowing the assessment of structural safety through the measurement of differences between the model and the real environment view.

The use of augmented reality in conjunction with BIM seeks mainly to [26]:

• Reduce discrepancies between planned and executed solutions.

• Reduce inefficiency in communication among professionals involved in activities.

• Improve the perception and cognition of the professionals involved in decision making.

• Facilitate access to information related to activities.

• Improve the concentration and attention of the professional in the execution of the activities. This set of work shows that augmented reality is a technology with great potential in AEC/FM. It has proved adequate to enable access and sharing of information by the team of professionals who cooperate with each other. However,

there are few studies that explore the use of augmented reality in infrastructure construction.

III. CRACKS MONITORING

The safety of a dam is maintained when its structural and operational integrity is preserved so that it satisfies behavioral requirements that seek to avoid failures in operation, dam and reservoir [27,28].

In the operation phase of a dam it is essential to carry out a periodic surveillance and maintenance program [29]. A hierarchical classification of dam safety processes can be seen in the Fig. 1.
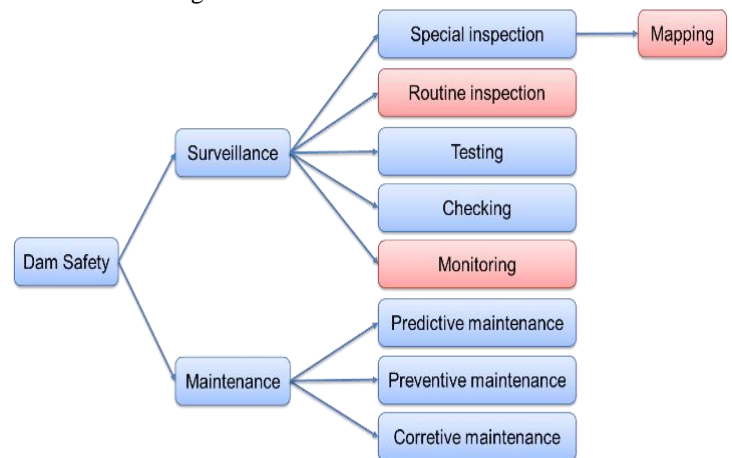
Fig. 1: Hierarchical classification of dam safety processes

Concrete behavior analysis occurs in the surveillance program; it investigates, among other things, the relationship of cracks with other dam events [30]. The presence of cracks in the structure is perceived during visual inspections (special, periodic or routine); however, in addition to identifying them, it is necessary to map them in order to understand the causative mechanism and the risks they pose to safety. Crack mapping consists of a thorough and exhaustive observation of the surfaces, in order to visually identify, record the shape and the relative location of cracks, according to some convention established by the organization. In addition, it is important to photograph and characterize cracks, building a historical record of its evolution over time. The records generate conditions to determine the cause and age of cracks [30].At each new mapping, a new set of individual data is collected. Although crack detection can occur in any type of inspection, it usually occurs only in special ones, where mapping is recommended. When a crack is identified, it has occurred some time ago. So it is not a simple task to make notes and estimates of the cause and age of the crack, but it is important to guide decision making. The data collected in the mappings need to be maintained to allow monitoring of evolution over time. The result of the mappings consists of internal and global reports, required by regulatory authority in the sector.

They present the current condition and evaluate the behavior of cracks by comparison with previous results, which support recommendations and decisions regarding maintenance and installation of instruments to monitor the behavior of active cracks[30]. In addition, the set of information resulting from the mapping is necessary for conclusions about the security offered by the structure.

Although mapping inputs and outputs are well defined, there are several ways to do this, and their establishment in each organization considers, among other things, the size of the dam and the level of technology used in the context. The technologies employed directly interfere in the efficiency and in the effectiveness of the mapping.

IV. HIERARQUICAL TAXONOMY

Taxonomy is a term derived from the Greek (*taxis* - order and *nomy* - law, norm, rule) introduced by Candolle, in 1813 [31,32]. Initially, they were used to classify living beings in a logical and scientific way; but is currently a method used in varied contexts as a resource to organize and classify conceptual units [31].

In the context of information processing models, Berliner et al. [33], have proposed a taxonomy that determines elementary units of behavior in relation to perception, mediation , motor and communication processes.

The elementary units of behavior are declared by means of 32 verbs classified according to the type of activity performed. Although this taxonomy has been proposed more than 50 years ago, it is still used to determine human behavior and assist in describing operational procedures [34].

According to Eurocontrol [35] the classification proposed by Berliner et al. is useful to explain the behaviors that are common in tasks that require some type of interaction. The elementary units of behavior classified according to the processes are shown in Fig. 2.

Fig. 2:Berliner's taxomony [34]

In the AEC/FM, taxonomies are used to classify the knowledge about the work required in the context so as to provide the means for the development of specific analyzes. Everett proposed a hierarchical taxonomy of construction-related tasks to analyze tasks and point out the most suitable ones for automation [36]. Everett's taxonomy is composed of nine *levels*: Industry, Sector, Project, Division, Activity, Basic Task, Motion, Orthopedics and Cell.

In order to analyze the tasks identified in the construction context, Everett took into consideration that humans are better able to perform tasks with predominance of improvised actions, or that have uncertain information and that require judgments based on experience and perception of complex stimuli. While machines are suitable for storing and retrieving information and performing repetitive jobs in a short time, without being distracted by external factors.

Dunston and Wang proposed another hierarchical taxonomy for the context of the AEC/FM [37]. In this case the operations and tasks were categorized. The main objective was to provide the conditions to analyze them on issues related to the use of mixed reality. According to the authors, the taxonomy provides the following benefits:

- It facilitates identifying the opportunities to explore the mixed reality in the AEC/FM.

- Establishes methodologies for mapping technology to context tasks.

- Identifies the core tasks of the AEC/FM.

This taxonomy proposed by Dunston and Wang is composed of five categories: Application Domain, Application specific operation, Operation specific activity, Composite tasks and Primitive tasks, as shown in Fig. 3.
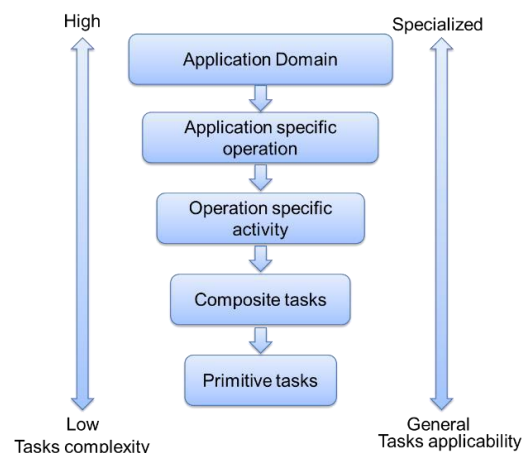
Fig. 3: Hierarchical taxonomy of AEC tasks and operations [37]

According to the authors, the level of composite tasks is appropriate to assess the suitability of mixed reality technology and taxonomy evidences the needs of the practice required in the context, at different levels of complexity, by fostering the means to study them individually, and relating them to technology alternatives.

4.1. The proposed taxonomy

The proposed hierarchical taxonomy classifies the required work in the field of crack surveillance at five levels: Domain, Process, Activity, Sub-activities and Tasks, as shown in Fig. 4. It represents all the operational work required in the domain, which is composed of processes made through activities that are divided into subactivities; subactivities are composed of tasks performed to meet the needs of the domain.

Cracks surveillance is carried out through processes already consolidated in the context of dam safety, required by norms and laws that regulate and supervise the practices. The subset of the processes for surveillance of concrete dams that includes, among other things, the suveillance of cracks are: *Mapping*, *Periodic inspection* and *Monitoring*, as highlighted in Fig. 4.

Mapping is handled by the activities C*rack detection, Crack Characterization, Crack survey, Validate* and *Analyze behaviour*. On the other hand, the periodic inspection comprises the activities *Analyze Document, Anomaly detection, Crack Characterization, Crack survey, Analyze behavior* and *Validate*. Lastly, Monitoring occurs by means of activities: *Read instrument, Validate* and *Analyze behaviour*.

The proposed hierarchical taxonomy also has an intermediate level between the level of activities and the level of tasks, called Sub-activities. The sub-activities required in the activities are: *Surface inspection, Crack registration, Acquire location, Locate, Acquire openess, acquire length, acquire depth, Direction registration, Acquire image, Appearance registration, Age estimation, Cause estimation, Data examination, Data processing, Document examination, Advise, Send review, Develop report, Acquire reading, Routine inspection, Register event, Repeat reading, Check reading.*

At the last level of the taxonomy are the tasks to meet sub-activities: *Draw, Move to, Observe, Recognize, Photograph, Detect, Measure, Indicate, Annotate, Search, Research, Select, Prepare, Inform, Compare.*

The relationship between the elements of the taxonomy can be seen in Fig. 4. The links represented by dashed lines represent works that depend on specific facts to be performed.
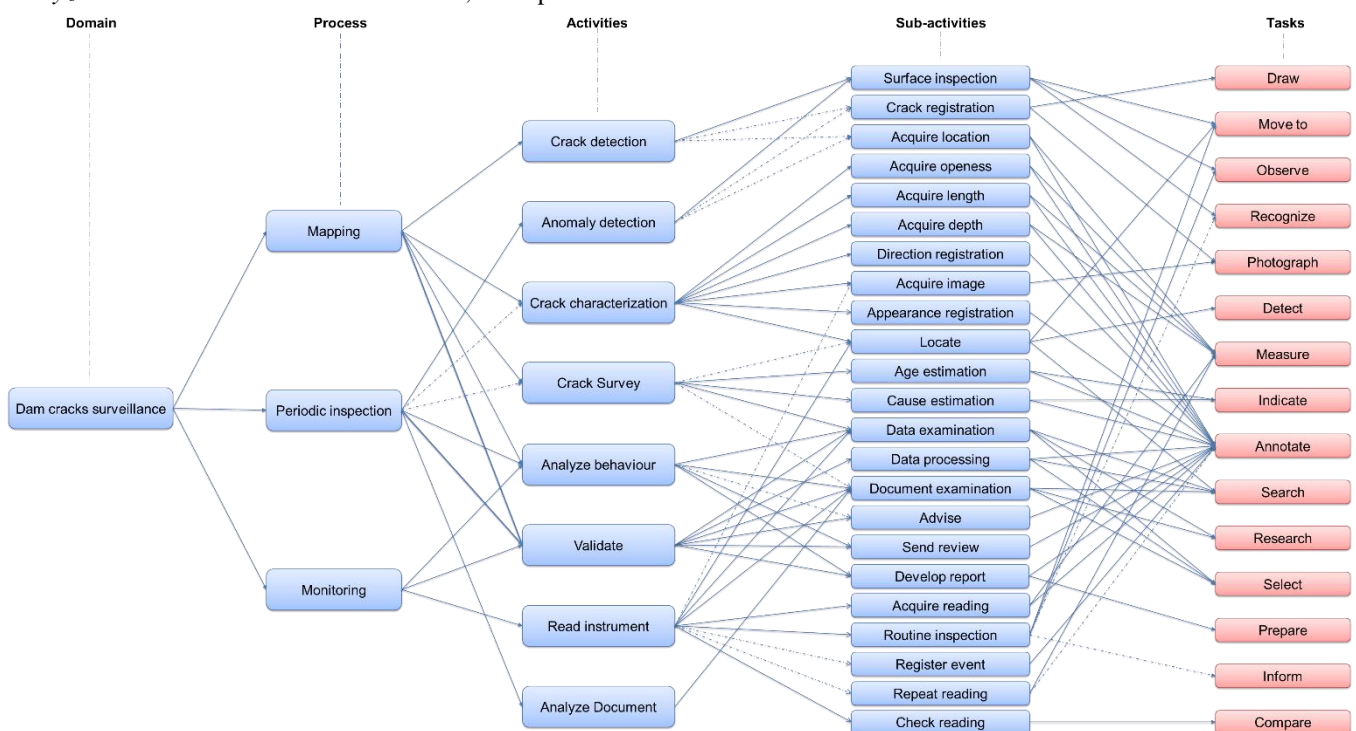
Fig. 4: Hierarchical taxonomy of tasks of the surveillance of cracks in concrete dams

4.2. Classifying tasks

Task is the smallest unit of work considered in the proposed taxonomy. It represents a portion of the physical work (interactions with the environment) and mental (internal interactions involving the perceptual and mediational system) that the user needs to perform in a sub-activity.

The way in which the work happens depends on several extrinsic factors, such as characteristics of the environment where the task is performed and resources available to help the user execute them. The way the work happens depends also on factors intrinsic to the user, such as skills, experience and knowledge, among others. The tasks of the domain were classified according to the units of behavior of the taxonomy of Berliner et al., as shown in Table 1.

Table 1: Classification of the tasks of cracks surveillance in concrete dams on Berliner´s taxonomy

Tasks	Behavior	Process type
Draw	Register	Communication
Photograph		
Annotate		
Inform	Informs	
Move to	Moves	Motor
Observe	Observes	Perceptual
Research	Inspects	
Recognize	Identifies	
Detect	Locates	
Search		
Measure	Calculates	Mediational
Indicate	Verify	
Select	Chooses	
Prepare	Verify	
Compare	Compare	

V. CONCLUSION

There are several studies demonstrating the potential for augmented reality in the AEC / FM area. Existing solutions already explore augmented reality functions to optimize the activities in which they are applied. However, there is still room for research that seeks to broaden the understanding of both augmented reality technology and the domain to which these interfaces will be applied. The proposed hierarchical taxonomy and classification of tasks regarding Berliner taxonomy provides resources to identify the tasks with the greatest impact by using the technology. Since augmented reality is a technology that allows information access and visualization, it is concluded that structuring the knowledge about the perceptive, cognitive and motor workload of the tasks of the domain, allows the application of technology in a more conscious way, increasing the contributions provided by the augmented reality, favoring the successful application of the technology in the surveillance of cracks in concrete dams.

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Automatic Overhead Water Tank Cleaning System: A Review and an Approach

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Abstract— *Aim of this paper is to develop a mechanical system for cleaning domestic cylindrical water tank. The mechanical system includes two main mechanisms which are rack and pinion gear mechanism and reciprocating four bar linkage mechanism. The rack and pinion arrangement is used to move whole mechanical system up and down for cleaning the cylindrical tank. The rack is fixed on the motor and the four-bar mechanism is attached to the motor shaft. PVC brushes are attached to the ends of the four-bar linkage. Four bar linkage is made in such a way that it can be adjusted according to inside diameter of the tank. When the motor is started the linkage rotates and with the help of brushes, cleaning of wall and base of tank takes place. The purpose of this project is to reduce the human efforts and to avoid the chemical influence on health of person entering the tank for cleaning.*

In this modern world, cleaning of overhead tanks manually is a tedious job. To overcome this we have aimed at tackling the disadvantages of cleaning overhead tanks, so an automatic system overhead tank cleaning is designed to provide high safety, high efficiency, less time for cleaning and to avoid environmental pollution problems. Purpose of this paper is to clean domestic cylindrical water tank with the help of mechatronics system. The mechatronics system consists of a grooved gear rod attached to two arms with brushes at ends. The two arms are connected to the gear rod by nut. By rotating the gear rod, the up and down motion of the two arms is achieved. The gear rod is rotated with the help of a D.C gear motor. The main grooved shaft is powered by an A.C motor. The motor and the shaft are connected by a rubber belt. The clockwise rotation of the main shaft will make the arms move and vice versa. The whole operation is controlled by a circuit consisting of relay switches, buttons, and PIC microcontroller. The number of times for the operation to repeat can be fed into the circuit. The achievement of this project is reduction of cost and

manual labour because there will be harmful diseases for the person who will go inside and it will affect the health as well as the other human being who consumes water from the tank.

Keywords—*Water Tank Cleaning, Cylindrical water tank, four bar linkage, motor shaft, rack and pinion, PVC brush.*

I. INTRODUCTION

In recent studies it has been found that no automation based machine used in cleaning of overhead tank. This is because of the irregular shape and various heights of the tank locations. With previous survey made an attempt to make a machine by automation process for cleaning tank. An alternate solution has made a plan to solve this problem. In India, the usage of sintex tanks by the people is approximately 71% After studies made the information that have faced a lot of difficulties like continuous work in the dirty places, irregular payment and other various reasons. Continuous work and irregular payment may also be the major reason for this attempt. So came to a conclusion that cleaning the overhead tank using automation process can be useful to solve all these problems. In this case, machine has the capability to clean the tank easily and quickly. Designing of our machine is based on the survey report conducted.

1.1 Necessity of Cleaning Water Tank

Every day we use the tank water for brushing and bathing, for cleaning and moping, for washing clothes and in other household chores. With the passage of time, sediments scale and algae get deposited on the walls, ceiling and floor of the water tank. This deposition contaminates the water and makes is unfit for use. With time algae and bacteria grow and breed in this water infect it and could make us fall sick eventually. Hence water tank cleaning is very important.

1.2 Methods of water tank cleaning.

Manual scrubbing in which wall and floor of tank are scrubbed to remove dirt, sediments, fungus and stains, but this method is more tedious and time consuming. The water tank can also be cleaned by using chemicals to remove the dirt and sediments. The chemicals used may affect the human health. Pressurized water can be sprayed on the walls of the tank which will remove the dirt from the tank surface. These methods are time consuming and require more efforts for cleaning. To find such an approach, there is need of studying the existing approaches and algorithms that had already been used for automatic overhead water tank cleaning system. This motivates us for the literature review.

The organization of this paper is as follows. In Section 2, systematic presentation of the literature review is done; which involves the list of the related approaches along with the summary of the related work that is more relevant to developed approach. Section 2 concludes with our findings from the literature review and motivation behind identified problems. Section 3 focuses on the

formulation of the identified problems. Section 4 is dedicated to the proposed approach. Section 5 emphasizes on the experimental results. Section 6 addresses the conclusions along with the future work.

II. LITERARURE REVIEW

This section presents the critical analysis of existing literature which is relevant to overhead water tank cleaning system and its mechanisms. Though, the literature consists of a lot many research contributions, but, here, we have analyzed around eight research and review papers. The existing approaches are categorized based on the basic concepts involved in the mechanisms. The emphasis is on the concepts used by the concerned authors, the database used for experimentations and the performance evaluation parameters. Their claims are also highlighted. Finally, the findings are summarized related to the studied and analyzed research papers. Section concludes with the motivation behind identified problem.

Table.1: Literature Review

Sr. No.	Ref. no. Concerned Author(s) and years	Concept used	Claimed by concern authors (s)	Our findings
1	Thonge Suraj , Shelke Prasad, Wakte Vaibhav , Thonge Sharad , Prof. Shinde ,(2017)	A mechanical system which clean the tank mechanically using brush, rack and pinion , bar linkage and motor.	The authors observed that the Cleaning is done more effective than the conventional methods.	Adjustment of the system inside the tank is difficult.
2	S. Abhishek, D. Kiran, P. Praveen and Dr. K. L. Senthilkumar (2017)	A mechanical system which clean the tank mechanically using brush, rack and pinion , bar linkage and motor.	The authors observed that the Cleaning is done more effective than the conventional methods.	Cleaning of the tank using this system is not effective.
3	Prayosha innovative (2017)	Sedimclean water tank cleaning machine which clean sediments in the tank. It is a vacuum cleaner type system which clean the tank without removing the water from the tank.	Sedimclean water tank cleaning machine which clean sediments in the tank. It is a vacuum cleaner type system which clean the tank without removing the water from the tank.	Only clean the sediments in the tank not the scale and algae inside the tank.
4	Brown J. A (1989)	vacuum tanker for cleaning storage tanks which is an vaccine cleaning system for cleaning the water tank and also acts as a water pump to force water.	Powerful technology to clean Big water tank more efficient and in very less time.	Very expensive
5	M.S.Triantafillou and G. S. Triantafyllou, (2003)	An efficient swimming vehicle is a mechanical system to clean the swimming pool using	Fish-like underwater micro robot which clean the swimming pool effectively.	Good working

		motor, mechanical arrangements, brush and floss.		
6	W. S. N. Trimmer and K. J. Gabriel (1987)	Design considerations for a practical electrostatic micro-motor	A high torque less speed motor of very small in size.	Good perform-ance
7	Dr.R.K.Bansal (2011)	Kinematics of machine.	None	Good study
8	Shubham Shrivastav, Hari Om Kumar (2016)	Design and Development of Cylindrical Water tank cleaner.	Easy to use and effective cleaning of the water tank is done	It is large in size and heavy in weight.

III. PROBLEM FORMULATION

This section presents the formulation of the identified problem, which based representation of an overhead water tank cleaning system. All the reviews on theoretic approaches involve the same common terminologies.

The problem of cleaning the water tank by the conventional can be formulated as:

All methods of cleaning water tank as discussed above are time consuming and require more human efforts. So the alternate method is required for cleaning purpose which will overcome the drawbacks of all other methods. Therefore, we are developing water tank cleaning equipment which requires less time and human efforts for cleaning.

There are many ways to generate electricity such as nuclear, thermal, diesel, solar, hydropower based generation system. In nuclear based generation there is always risk of nuclear radiation accident also it requires high initial cost and impacts on human life. In thermal based generation there is a huge production of CO_2 in atmosphere and it depends on availability of coal as fuel. In diesel based generation running charges are more due to high cost of diesel and also cost of lubrication. These are the problems that occurs in generation of electricity

In flying electric generator there is no need non-renewable fuel. Also it does not have any impact on environment or human life. There are various problems that are overcome by flying electric generator

IV. PROPOSED APPROACH

This section is subdivided into 5 sub-sections wherein the report presents the detailed working of automatic overhead water tank cleaning system that is incorporated in our work along with our approach. Sub-section A includes the information about the main components used in the project. The material and methods is mentioned in Sub-Section B. Working of system is explained in Sub-Section C with the aid of flowchart. Our proposed approach is introduced in Sub-Section D. Sub-section E provides detailed working of the proposed approach.

A) Main Components
Gear Motor

Fig. 1 Gear Motor

Gear motor is used to produce high torque with low speed. Motor used has specifications as single phase 220V, 15A which produces power of 0.35 HP and frequency of 50 Hz and the shaft speed is 75 rpm.

Four Bar Linkage

Fig. 2 Four bar linkages

A plane linkage consisting of four links pinned tail to head in a closed loop with lower or closed joints. It is a plane mechanism consisting of four links that form rotating kinematic pairs. The four bar linkage is arranged in such a way that it adjusts the inner diameter of the tank.
Rack and Pinion

Fig. 3 Rack and pinion arrangements

A rack and pinion is a type of linear actuator that comprises a pair of gears which converts rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack". Rotational motion applied to the pinion causes the rack to move relative to pinion. Thus the motor attached to the rack is moved in vertical direction along the guide way with the help of handle attached to the pinion.

Shaft

Fig. 4 Motor shaft

Shaft made up of mild steel of diameter 15mm is used to transmit rotary motion from motor to the four bar linkage. Holes provided on the shaft, adjust the four bar linkage according to the diameter of the tank.

Brush

Fig. 5 Brushes

The brushes are made up of Poly Vinyl Chloride (PVC) polymer. Brushes attached to the ends of four bar linkage revolve due to rotation of motor shaft to clean the inner surface of the tank.

B) Materials and methods
Selection of Materials
The machine setup is considered. The rows and columns of the machine are of mild steel material. The DC Motor are used to move the shaft from starting to end position of the brushes and the brushes rotates continuously based on the input power which it receives from the AC Motor to clean the overhead tank. The two types of rotary brushes are used to clean the overhead tank in horizontal and vertical positions. A shaft is used to hold the brushes in side view and bottom positions in which the adjustable springs with tension are used in between the brushes to adjust the size of the side view brushes as per the tank's space requirement. The 0.25 horse power electrical type single phase Ac motor is used to run the machine. The up and down motion of the shaft can be controlled with help of the microcontroller. The Microcontroller is used to set the total number of rotary motion of the shaft which is used rotate the brushes at the two ends of the machine. It is operated in a supply voltage range of (0-12) V ac. The vertical shaft is about length of 3.5 feet and the horizontal shaft is about length of 3 feet which is eight in number. The setup stand is made up of mild steel such that all the components are easily made to fix upon it. A series of brushes are placed in shaft of the rotor in which the pulley gives the required speed, such that the distance between each brush from center is exactly 40cm.

Selection of Motor
Two motors are used in the machine. The 0.25 horse power electrical type single phase Ac motor is used to run the rotatory brushes. Another 12V horse power DC motor is connected to the shaft to run the brushes and it is connected to the connecting rod to transfer the rotary motion into linear motion by means of reciprocating motion is achieved. This is used for up and down motion of the shaft which is the last step carried in the machine. The mechanism used is spring compression mechanism.

Selection of springs
A spring is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. There are a large number of spring designs; in everyday usage the term often refers to coil springs. Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after fabrication. Some non-ferrous metals are also used including phosphor bronze and titanium for parts

requiring corrosion resistance and beryllium copper for springs carrying electrical current (because of its low electrical resistance).When a coil spring is compressed or stretched slightly from rest, the force it exerts is approximately proportional to its change in length (this approximation breaks down for larger deflections). The rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. That is, it is the gradient of the force versus deflection curve. An extension or compression spring has units of force divided by distance, for example lbf/in or N/m. Torsion springs have units of torque divided by angle, such as N•m/rad or ft•lbf/degree.The inverse of spring rate is compliance, that is: if a spring has a rate of 10 N/mm, it has a compliance of 0.1 mm/N. The stiffness (or rate) of springs in parallel is additive, as is the compliance of springs in series.

Selection of Screw

A screw is a mechanism that converts rotational motion to linear motion, and a torque (rotational force) to a linear force. It is one of the six classical simple machines. The most common form consists of cylindrical shaft with helical grooves or ridges called threads around the outside. The screw passes through a hole in another object or medium, with threads on the inside of the hole that mesh with the screw's threads. When the shaft of the screw is rotated relative to the stationary threads the screw moves along its axis relative to the medium surrounding it for example rotating a wood screw forces it into wood. In screw mechanisms, either the screw shaft can rotate through a threaded hole in a stationary object, or a threaded collar such as a nut can rotate stationary screw shaft. Geometrically, a screw can be viewed as a narrow inclined plane wrapped around a cylinder.

Selection of Nut

A nut is a type of fastener with a threaded hole. Nuts are almost always used in conjunction with a mating bolt to fasten two or more parts together. The two partners are kept together by a combination of their threads' friction, a slight stretching of the bolt, and compression of the parts to be held together. The most common shape is hexagonal, for similar reasons as the bolt head - 6 sides give a good granularity of angles for a tool to approach from (good in tight spots), but more (and smaller) corners would be vulnerable to being rounded off. It takes only 1/6th of a rotation to obtain the next side of the hexagon and grip is optimal. However polygons with more than 6 sides do not give the requisite grip and polygons with fewer than 6 sides take more time to be given a complete rotation. Other specialized shapes exist for certain needs, such as wingnuts for finger adjustment and captive nuts (e.g. cage nuts) for inaccessible area. A wide variety of nuts exists, from household hardware versions to specialized industry-specific designs that are engineered to meet various technical standards. Fasteners used in automotive, engineering, and industrial applications usually need to be tightened to a specific torque setting, using a torque wrench. Nuts are graded with strength ratings compatible with their respective bolts.

C) Working

Firstly, whole water is removed from the tank. Detergent is then sprayed on the inner wall of the tank for easy removal of dirt. The whole system is inserted in retracted position into the tank. The four bar linkage is then adjusted according to the tank diameter in such a way that brush at end of the shaft touches the bottom of tank. Now the motor is switched ON. The four bar linkage starts rotating along with the shaft. This causes scrubbing of inner wall of tank by the brush attached to the ends of linkage. For cleaning upper portion of the tank the whole mechanism is reciprocated along the guide ways with the help of handle connected to the rack and pinion arrangement. In this way the tank gets cleaned within minimum time.
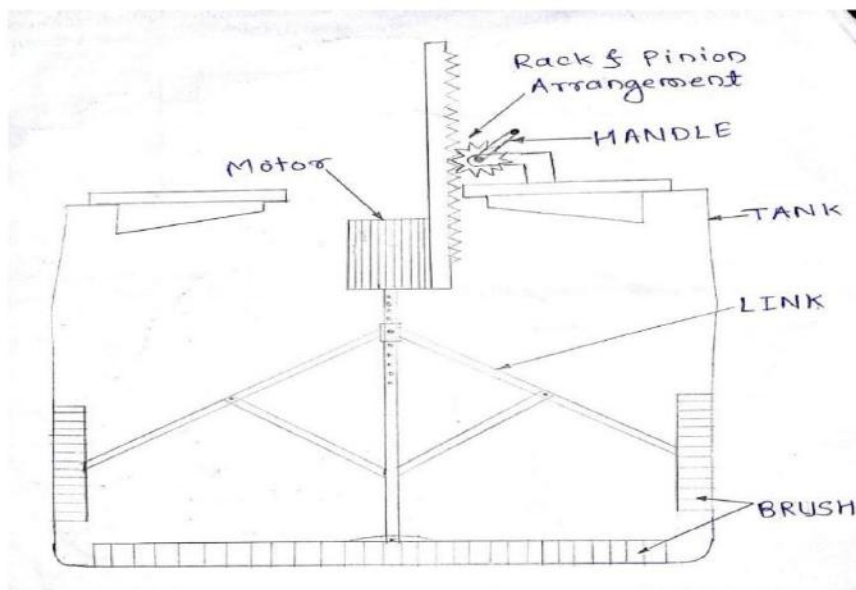
Fig. 6: Automatic overhead water tank cleaning system
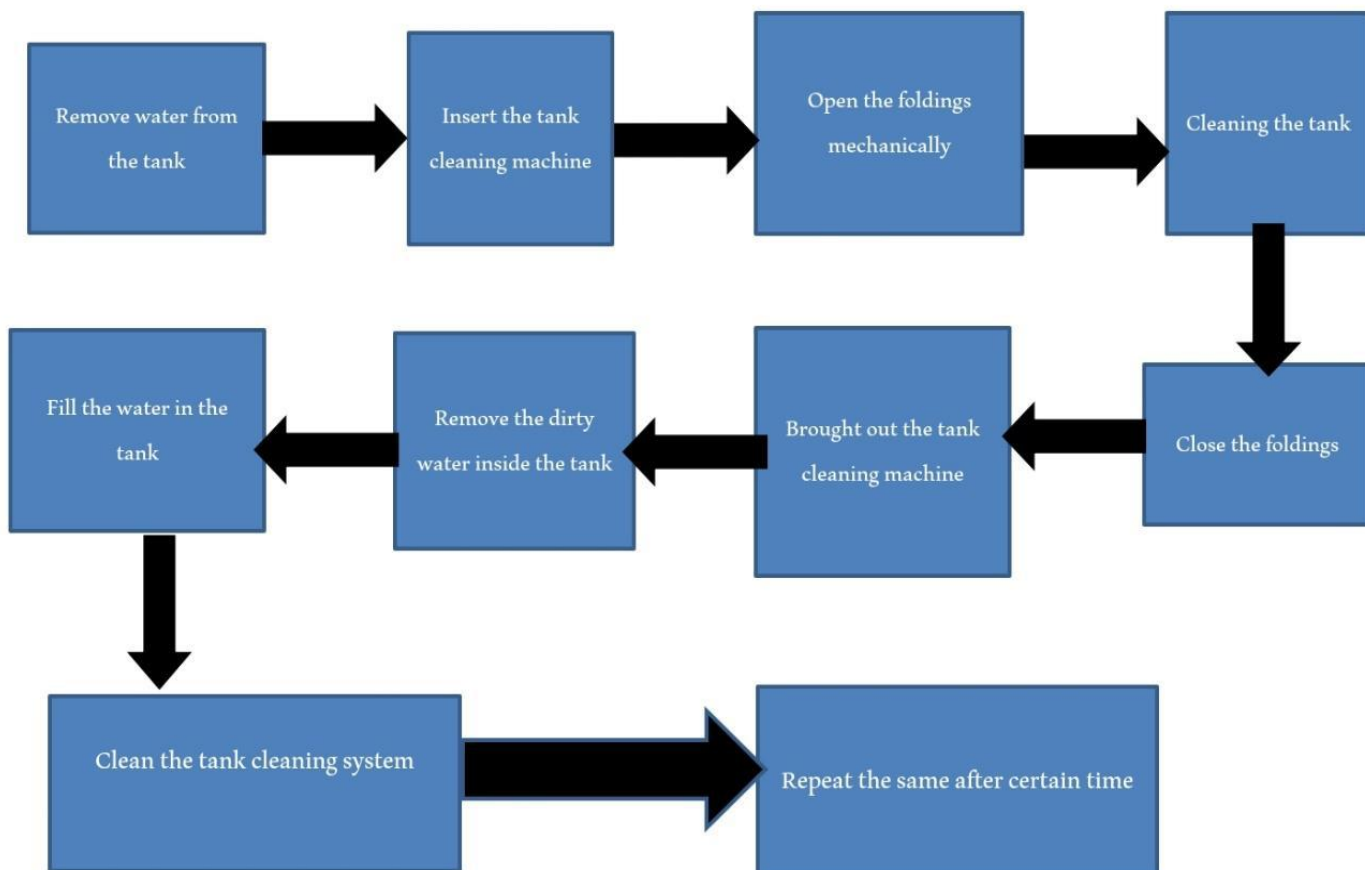
Fig. 7: Working flowchart

D) Proposed Approach

Software View

An animated design of the prototype has been made with the Solid works and Creo 2.1.0 version software's. An automated tank cleaning machine is a machine used to clean the overhead tanks such those found to store the water. Tanks must be cleaned from time to time for various reasons. The main reason is to clean the tank is allow to gets fungus. Thus the tank is to be inspected or maintenance to be performed regularly
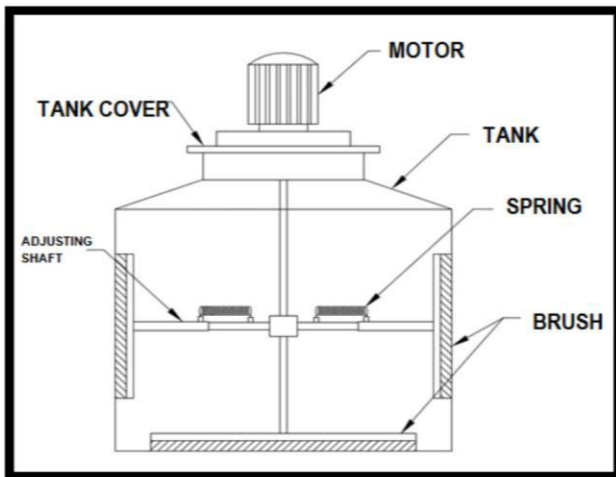
Fig. 8: Design of prototypes
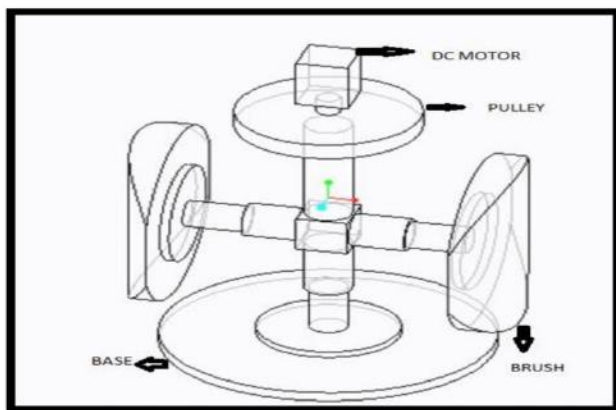
Fig. 9: The prototype

E) Details

Fabrication and Testing

Automated tank cleaning machines work in a manner similar to a wall cleaner. A D.C motor of about 12V which runs at 60rpm is used in this project to move the side shafts up and down continuously. An AC motor of about 0.25HP which runs at 1440rpm is used for rotating the shaft at the fixed speed. The shaft is mounted on the motor in the T- shape rod. The machine is attached at the top of the tank. Then the brushes are mounted at the three end of the shaft through a surface of the tank. A PIC Microcontroller and LCD display Timer is used to set the number of rotation times of brushes and movement of shaft.

After the complete setup, the motor rotates and the brushes rotate at the surface of the tank. A spring compression is mechanism is attached between the brush and shaft. Finally the water gets drain by the outlet of the tank. Portable water washing systems are widely used, but tanks that are cleaned frequently may have a fixed system installed.

V. EXPERIMENTAL RESULTS

An automated tank cleaning machine is a machine used to clean the overhead tanks such those found to store the water. Tanks must be cleaned from time to time for various reasons. The main reason is to clean the tank is allow to gets fungus. Thus the tank is to be inspected or maintenance to be performed regularly.

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VI. CONCLUSION AND FUTURE SCOPE

This section presents the conclusions drawn from the evaluation and comparison of experimental results. The section concludes with future scope.

Conclusion:

The water tank cleaner was used to clean the water tanks by using rotating brushes. This method was more effective and safe than the conventional methods. This method is capable to clean water tanks within less time and human efforts

Advanced model for tank cleaning system is cleaning the tanks thus making the operation user friendly. The working prototype is promising both in terms of imparting cleanliness and avoiding excess manpower. The future scope of the project is to extend it with auto feeding mechanism by which the manpower involved in feeding gets removed. Through the help of the auto feed mechanism it is easy to clean the tanks without excess man power. The project can be even extended to increase the cleanliness of the tank by insulating the frame and other components using stainless steel.

Future Scope:

- This system is user friendly and time saving also the cost is less hence it can be used in the future water tank cleaning purpose.

- In future the advance system may also be invited like the vacuum cleaner type system that can clean the tank without removing the water from the tank.

- The system could be more compact and light weighted and more user-friendly and efficient by improvement in the design and using some other advance equipment.

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Aspectos filosóficos e metodológicos da Pesquisa Operacional: a evolução de uma área interdisciplinar

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Resumo— *A Pesquisa Operacional se insere na história dos grandes acontecimentos tecnológicos e científicos do século XX. Sua influência no surgimento de outras ciências e aplicações, cujos desdobramentos no período pós-guerra contribuíram para o aumento da racionalização da sociedade moderna são evidentes. Diante deste contexto, este artigo tem como objetivo traçar uma reconstrução analítica sobre os aspectos filosóficos e metodológicos que marcam a história da pesquisa operacional. Tal reconstrução será realizada por meio do método histórico utilizando bibliografia e documentos. O aperfeiçoamento das técnicas da Pesquisa Operacional foi um fator determinante para o seu sucesso e seus aspectos metodológicos e filosóficos reverenciaram pensadores como John Dewey, Churchman e Capra, que são referências para entender o pensamento do homem moderno. Verifica-se que a Segunda Guerra Mundial foi determinante para a ciência de modo geral e mais especificamente para o grande avanço da pesquisa operacional. As conquistas obtidas pela PO, em grande parte, decorrem da formação de grupos multidisciplinares que permitiram a evolução da área em diversas direções, propiciando um diálogo interdisciplinar.*

Palavras-chave— *Pesquisa Operacional; PO; Grupos multidisciplinares; Segunda Guerra; Acontecimentos tecnológicos e científicos.*

Philosophical and methodological aspects of Operations Research: the evolution of an interdisciplinary area

Abtract— *Operations Research fits into the history of the great technological and scientific events of the twentieth century. Its influence on the emergence of other sciences and applications, whose developments in the post-war period contributed to the increased rationalization of modern society are evident. Given this context, this article aims to trace an analytical reconstruction on the philosophical and methodological aspects that mark the history of operations research. Such reconstruction will be developed based on a historical method using bibliography and documents. The refineme nt of Operations Research techniques was a determining factor for its success, and its methodological and philosophical aspects have revered thinkers such as John Dewey, Churchman, and Capra, who are references to understand modern men's thought. It turns out that World War II was determinant for science in general and more specifically for the great advance of operations research. The achievements of the OR, largely, result from the formation of multidisciplinary groups that allowed the evolution of the area in several directions, providing an interdisciplinary dialogue.*

Keywords— *Operations Research; OR; Multidisciplinary groups; World War II; Technological and scientific events.*

I. INTRODUÇÃO

Os acontecimentos da Segunda Guerra Mundial criaram um mundo de circunstância adversa para os praticantes da ciência, que se viram envoltos com problemas de natureza desconhecida. O homem "dialoga com as coisas, com os seus semelhantes e, muitas vezes,

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consigo mesmo, procurando um ajuste intelectual com o contorno - ajuste indispensável para o bem viver. Esse diálogo mantido com a circunstância requer uma linguagem" (HEGENBERG, 1975, p. 1).

A linguagem indispensável com que se depararam os cientistas durante o período de guerra foi a da interpretação dos acontecimentos e das indagações a respeito da natureza das coisas, das suas relações com as outras, e das suas qualidades. Tudo isso resultou em um sistema estritamente ligado a números e medidas. Assim, mensurar era atribuir número a um objeto obedecendo a certas restrições pré-estabelecidas e cuja intenção era explicar e prever os acontecimentos. A linguagem com essas características foi traduzida em um conjunto de métodos, denominado Pesquisa Operacional (PO), pois era "preciso um método de natureza sistemática, para salvaguardar as operações pelas quais nos movemos de fatos a ideias e de ideias a fatos que as provarão" (DEWEY, 1959, p.167).

Para Miser (1993), os modelos ou métodos da ciência são descrições aproximadas da realidade, de que fazem parte todos os fenômenos do universo que envolve a natureza, o homem, os artefatos do homem e suas interações. Os fenômenos trabalhados pela PO, a princípio, causaram estranheza pela sua natureza, porém foi possível construir modelos que os representassem.

É um esforço descobrir a regularidade de um fenômeno e associar essa regularidade com outro conhecimento, a fim de que o fenômeno possa ser modificado ou controlado, justamente como fazem outras pesquisas científicas. A diferença decorre dos fenômenos que são estudados, da matéria em análise. Em vez de estudar o comportamento dos elétrons, dos metais, do motor a gasolina, dos insetos ou dos homens, individualmente, a pesquisa operacional vê o que se passa, quando um complexo de homens e equipamentos executa o trabalho que lhe foi confiado. Um batalhão de soldados, uma esquadrilha de aviões, uma fábrica ou uma organização de vendas é mais do que um conglomerado de homens e máquinas: é uma atividade, um modelo de operação. Essas operações podem ser estudadas, suas regularidades determinadas e relacionadas com outras regularidades; podem eventualmente, ser entendidas e, então modificadas e aperfeiçoadas (MORSE, 1966, p. 117-118).

Os problemas eram submetidos à análise pelas vias dos processos mentais e dos métodos, os quais estavam associados aos trabalhos de pesquisa das equipes envolvidas. O especialista tentava, por meio de um processo de indução, encontrar um modelo que explicasse o fenômeno e, por dedução, procurava determinar qual seria o comportamento do sistema que mais se aproximava do seu objetivo, baseando-se na análise quantitativa para auxiliar o processo de decisão.

A realidade tecnológica apresentada ao homem do século XXI, da qual ele se tornou tão dependente, acelerou a ordem racional presente nos métodos e modelos da PO e refletir sobre esse tema levando em conta seus aspectos matemáticos faz com que se transite a partir de alguns aspectos da metodologia científica constantes na PO à Filosofia Matemática, com o objetivo de compreender o fruto desse convívio.

Diante deste contexto, objetiva-se, de modo geral, traçar uma reconstrução analítica sobre os aspectos filosóficos e metodológicos que marcam a história da pesquisa operacional, de modo a compreender como esta vem se configurando ao longo do tempo.

II.   PESQUISA OPERACIONAL: CIÊNCIA, METODOLOGIA E FILOSOFIA

Os sucessos das aplicações de PO se devem, de acordo com Miser (1993), às habilidades das equipes em relação à análise e avaliação de dados, ao estabelecimento das relações quantitativas e à constituição de hipóteses testáveis. Essas habilidades foram relevantes para o seu sucesso e potencializadas em decorrência da diversidade na formação das equipes. Para apoiar os comandos operacionais na resolução de problemas, foram criados grupos multidisciplinares, compostos de matemáticos, físicos, engenheiros, cientistas sociais, e outros.

O uso de equipes interdisciplinares disponibiliza um arsenal maior de técnicas de investigação e ajuda a construir a ligação entre a teoria e a prática. Os grupos que trabalharam com PO tinham representantes de quase todas as áreas e podemos citar como exemplo os biólogos. Por estarem habituados a lidar com diferenças individuais em grande volume de casos e por terem controle de situações experimentais, tiveram uma contribuição significativa nos grupos de pesquisa (MISER, 1993).

Com relação ao trabalho científico, Miser (1993) chama atenção para o fato de que a maioria da literatura sobre ciência faz o trabalho científico parecer que é produzido por espíritos desencarnados, deixando de falar sobre os variados repertórios de que se apropriam os pesquisadores para realizarem suas produções científicas. Esse aspecto raramente é incorporado a livros e artigos científicos.

O período da Segunda Guerra Mundial foi um divisor de águas para a prática da ciência. Para Mirowski e Sent (2002) tudo mudou drasticamente com o advento da Segunda Guerra Mundial. Não só foram renovadas as estruturas de financiamento e organização das ciências físicas, como também as concepções econômicas foram

irreversivelmente transformadas. Essa renovação da definição da ortodoxia econômica americana iniciou-se a partir do momento em que físicos e matemáticos inovaram um conjunto de técnicas e ferramentas para modelagem de problemas de comando, controle, comunicação e transmissão de informação sob a rubrica de PO. Vários economistas neoclássicos foram influenciados por estas técnicas e ferramentas, as quais foram cruciais na definição da forma da teoria econômica do pós-guerra.

A PO lida com problemas complexos do mundo real e, muitas vezes, depara-se com a necessidade de estimar as incertezas em suas previsões. Essas podem ser resultantes do comportamento humano, de modificações do meio ambiente ou de ações e reações de concorrentes. Mesmo em situações vulneráveis, o ato de pensar possibilita a escolha de meios alternativos eficazes.

As especulações filosóficas da PO vão ao encontro daquelas que o homem faz antes da realização de um ato, que é pensar reflexivamente, pois só assim poderá produzir a melhor ação. Pensar reflexivamente é uma capacidade que pode emancipar o ser humano da ação rotineira, ou seja:

> [...] o pensamento faz-nos capazes de dirigir nossas atividades com precisão e de planejar de acordo com fins em vista ou propósitos de que somos conscientes; de agir deliberada e intencionalmente a fim de atingir futuros objetos ou obter domínio sobre o que está, no momento, distante e ausente. Trazendo à mente as consequências de diferentes modalidades de ação, o pensamento faz-nos saber a quanta andamos ao agir. Converte uma ação puramente apetitiva, cega e impulsiva em ação inteligente (DEWEY, 1959, p. 26).

A filosofia é a investigação crítica e racional dos princípios relacionados ao mundo e ao homem e melhorar a condição humana, por meio do planejamento,

é um dos seus objetivos. Para Ackoff[3], as práticas da PO e os debates teóricos dos quais participou contribuíram para a formação da sua base filosófica, pois eles desenvolveram princípios que favoreceram a sua prática reflexiva, constituindo um quadro para a sua prática profissional. Ele estava entre ciência e filosofia e foi na filosofia pragmática que encontrou essa sintonia.

Considera-se o artigo de Charles Sanders Peirce[4] intitulado "*How to make our ideas clear*", publicado em 1878, como o primeiro esboço de uma teoria pragmática. O verdadeiro florescimento do pragmatismo como sistema e como método filosófico data do início do século XX e seus fundadores foram Charles Sanders Peirce, William James[5] e John Dewey[6]. As nuances nessa visão filosófica podem ser atribuídas às divergências intelectuais dos seus fundadores.

Peirce dedicou grande parte da sua vida às questões ligadas à ciência, principalmente matemática e lógica. Em 1898, William James inaugurou o novo movimento pragmático em um discurso intitulado *Philosophical Conceptions and Pratical Results* (Concepções Filosóficas e Resultados Práticos) e, coube a Dewey conceber um pragmatismo ligado à pesquisa das questões sociais, de ordem moral e política.

O pragmatismo nasce como uma teoria relativa à prática da ciência, ou seja, propõe que o raciocínio seja guiado por métodos semelhantes ao da ciência, que incluem a observação do fenômeno, a formulação de hipóteses, testes e a revisão de teorias. Para Dewey (1959), a observação no trabalho científico não é somente para verificar uma ideia, mas também para criar um problema e, por meio deste, formular hipóteses. As observações não são consideradas como uma finalidade em si mesma, mas sempre como um meio de atingir um objetivo final.

Meios e fins são dois termos de uso corriqueiro no senso comum e Dewey (1978, p.77) os analisa primariamente como:

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[3] Russell Ackoff Lincoln (Filadélfia, 12 de fevereiro de 1919 - 29 de outubro de 2009), arquiteto e filósofo americano. Foi um teórico organizacional e professor emérito de Ciência da Administração na Wharton School, Universidade da Pensilvânia. Ele foi um pioneiro no campo da pesquisa operacional e professor de pesquisa operacional no Instituto Tecnológico Case, a primeira instituição de ensino superior a oferecer um curso de PO, de 1951 a 1964.

[4] Charles Sanders Peirce (Cambridge, 10 de setembro de 1839 – 19 de abril de 1914) licenciou-se em Ciências e doutorou-se em Química, em Harvard. Considerado um dos mais originais pensadores norte-americanos, Peirce deixou contribuições em múltiplas áreas do conhecimento: lógica, semiótica, astronomia, geodésia, matemática, teoria e história da ciência, econometria e psicologia.

[5] William James (Nova Iorque, 11 de janeiro de 1842 – 26 de agosto de 1910) foi um psicólogo e filósofo americano, com formação em medicina. Ele escreveu livros inflentes sobre psicologia, tendo como um de seus principais interesses o estudo científico da mente humana em um tempo em que a psicologia estava se constituindo como ciência.

[6] John Dewey (Burlington, Vermont, 20 de outubro de 1859 – 1 de junho de 1952) foi um filósofo e pedagogo americano que influenciou educadores de várias partes do mundo. Dewey é o nome mais célebre da corrente filosófica que ficou conhecida como pragmatismo, embora ele preferisse o nome instrumentalismo – uma vez que, para essa escola de pensamento, as idéias só têm importância desde que sirvam de instrumento para a resolução de problemas reais.

[...] meios e fins aplicam-se primariamente à posição ocupada pelos diferentes atos no curso do desenvolvimento de uma atividade, e só secundariamente a coisas ou objetos. O fim, efetivamente, não é mais do que a última fase, o período terminal de uma atividade; os meios são as primeiras fases ou as fases que se têm de atravessar para que a atividade chegue ao seu termo final.

Parece lícito afirmar que a ciência se apoia em pressupostos racionais, que sempre envolve comparações entre os meios alternativos e os fins almejados e, certamente, terá a eficiência como produto final. Racionalidade ou razão significa relação, adequação entre meios e fins. Para Dewey (1978), meios e fins são uma constante em qualquer processo; para ele, os fins indicam uma direção e, isto significa que todo fim é experimental e posto à prova na prática.

A relevância do pragmatismo para Churchman, Ackoff, Emery e Beer é ser uma corrente filosófica coerente, pois estabelece um princípio organizador e racional para as abordagens contemporâneas do pensamento sistêmico e da teoria geral dos sistemas. Os princípios do pensar e agir do homem são temas que foram abordados por vários filósofos. Um deles foi Spinoza, que escreveu sobre a maneira de pensar em seu livro intitulado "A Reforma do Entendimento Humano". John Dewey enriqueceu a literatura mundial com algumas prescrições para o ato de pensar (CAPRA, 2006).

Daí a necessidade de buscar a razão das coisas, e de não aceitar passivamente a resposta do costume e da autoridade política. Que fazer? Desenvolver um método de pesquisa e de prova racional, que assentasse em base sólida os elementos essenciais das crenças tradicionais: desenvolver um método de pensar e de conhecer que a um tempo purificasse a tradição e lhe preservasse, inalterados, os valores morais e sociais; mas ainda que, purificando-os, lhes incrementasse o poder e autoridade (DEWEY, 1959, p. 55).

Churchman, em seu livro "Introdução à Teoria dos Sistemas", chama atenção para o fato de que o modo de pensar em nosso século é movido por uma psicologia diferente da que outrora animou a humanidade. "A nova visão da realidade, de que vimos falando, baseia-se na consciência do estado de inter-relação e interdependência essencial de todos os fenômenos –físicos, biológicos,

psicológicos, sociais e culturais. [...] a concepção sistêmica vê o mundo em termos de relações e de integração" (CAPRA, 2006, p. 250- 260).

A palavra sistema criou modismo, a partir da segunda guerra, e pode-se pensar que "os sistemas são constituídos de conjuntos componentes que atuam juntos na execução do objetivo global do todo" (CHURCHMAN, 1972, p. 27). Em contraposição ao pensamento cartesiano que visava à fragmentação, o sistêmico a transcende e inclui a interdisciplinaridade:

A concepção sistêmica vê o mundo em termos de relações e de integração. Os sistemas são totalidades integradas, cujas propriedades não podem ser reduzidas às de unidades menores. Em vez de se concentrar nos elementos ou substâncias básicas, a abordagem sistêmica enfatiza princípios básicos de organização (CAPRA, 2006, p. 260).

A evolução de uma sociedade está atrelada às mudanças no sistema de valores, que serve de base a todas as suas manifestações, daí decorre a sua suprema importância para todas as ciências sociais, pois:

Os valores que inspiram a vida de uma sociedade determinarão sua visão de mundo assim como as instituições religiosas, os empreendimentos científicos e a tecnologia além das ações políticas e econômicas que a caracterizam. Uma vez expresso e codificado o conjunto de valores e metas, ele constituirá a estrutura das percepções intuições e opções da sociedade para que haja inovação e adaptação social (CAPRA, 2006, p. 182).

Para a PO, as organizações são vistas como sistemas humanos compreendidos por componentes interativos como subsistemas, processos e estruturas organizacionais. Essa estrutura estabeleceu um forte vínculo com a comunidade de negócios, auxiliando-a na tomada de decisões, o que a torna dependente desses sistemas de valores. Como afirma Capra (2006), qualquer análise dita isenta de valores dos fenômenos sociais baseia-se no pressuposto tácito de um sistema de valores existente que está implícito na seleção e interpretação de dados.

Como o pragmatismo, a PO fundamenta-se em fenômenos consequentes, com a possibilidade de ação, onde o mundo das ideias é o cerne para organizar as observações e as experiências futuras. Para ambos, o futuro "não é uma mera palavra onde teorias, noções gerais, ideias racionais têm consequências para a ação: a razão,

necessariamente, tem uma função construtiva" (DEWEY, 2008, p. 125-126).

III. CONSIDERAÇÕES FINAIS

Todos os estudos gerados durante a Segunda Guerra Mundial foram produzidos sobre o mesmo molde, com tentáculos tecnológicos e processos constituídos de uma racionalidade algorítmica, cujas soluções podem ser planejadas ou mecanizadas. A Pesquisa Operacional é fruto dessa prática da ciência. A história registra o movimento de como esse domínio da matemática evoluiu por meio das interações entre resolução de problemas práticos e pesquisa.

Uma característica da PO, possível de ser constatada por meio de sua história e que a distingue das primeiras atividades de pesquisa, durante a Segunda Guerra Mundial, é a sua abrangência sistêmica. Destaca-se ainda o fato de que o contexto e as necessidades surgidas durante esse período de guerra propiciaram o ambiente para o desenvolvimento desse conhecimento de cunho interdisciplinar. A PO é uma ciência de característica interdisciplinar, assim como todas as outras que surgiram, ou evoluíram durante a Segunda Guerra, sob o patrocínio militar, tendo como base a pesquisa científica. A Segunda Guerra Mundial leva o crédito como propulsora dessa ciência interdisciplinar, uma vez que o contexto do período gerou necessidades de encontrar soluções para problemas complexos que não seriam resolvidos sob uma perspectiva disciplinar e não sistêmica.

É assim que a PO é apresentada nos documentos contemporâneos e em alguns relatos históricos desse tempo e, em vez de considerá-la como parte da matemática, uma caracterização melhor seria pensar que alguns matemáticos foram recrutados durante a Segunda Guerra Mundial para trabalhar em unidades interdisciplinares, comandados pelos físicos e conduzidos a participar das mais diversas atividades, agrupadas sob a rubrica PO.

Outro fator preponderante na história da PO eram questões relativas às mudanças provocadas pelo conhecimento científico, em especial o matemático, nas organizações sociais e militares durante e no período pós Segunda Guerra. Essas mudanças aliadas à transferência de tecnologias de esforço militar para o planejamento social após a guerra mudou o curso da história. Pode-se dizer que essas inovações são decorrentes de novas formas de conceber e utilizar o conhecimento, mas que, no entanto, tem suas bases nas mais antigas discussões filosóficas sobre o agir humano. Como já dizia Dewey (1959, p.26) o pensamento reflexivo "converte uma ação puramente apetitiva, cega e impulsiva em ação inteligente"

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Suction, Water Retention Capacity and Permeability Assessment of Compacted and Unsaturated Cover Layer

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Abstract— *This paper exposes characteristics from an evaluated cover layer (0.6 m height) from the experimental Muribeca landfill of Urban Solid Residues (SUR), located in Jaboatão of Guararapes, Brazil. Through laboratory experiments of suction, grain size distribution, and permeability, those parameters were analyzed based in the existing technical standard Brazilian for this procedure. The soil was studied by the division of a cover layer, after 5 years from its completion, of 0,6m, in depth the upper half (0.1 m to 0.3 m) and lower half (0.4 m to 0.6 m), looking for differences of leaching through the upper to lower part. Therefore, the consequences to be presented from the leaching of the materials, after 5 years of finalization of the landfill, making its permeability increase. Concerning its water retaining, it is the most retained in the upper part, which comprises the compost, with a difference in the order of 7 per cent the superior half to inferior half, retaining the least suction from the surface. Leaching was detected through permeability procedure of worthless difference between upper and lower part of the cover layer. Nevertheless, results revealed the efficiency of the cover layer in retaining the rainwater, offering this layer as an alternative solution for the appropriate waste disposal.*
Keywords— Landfill, Water retaining, Permeability, Suction, Cover layer.

I. INTRODUCTION

The daily solid waste generation is inherent to the development of the human begin activities and if there is no proper disposal of this waste, pollution is generated.

Therefore, the disposal of solid waste generated should be a society priority, aimed at preserving the environment and the maintenance of healthy conditions of life.

The landfill has main function to protect the population around the Muribeca Landfill with habitations from distance of about 300 meters. Besides, the cover layer has a fundamental importance, prevent infiltration of rainwater (which into contact with the waste occurs an increase of gas production and leachate, toxic to the population) and the migration of the gases generated by the waste into the atmosphere; it is a way to improve pollution control and to protect neighborhood.

There is a search for alternative materials for the cover layer system with geotechnical and chemical aspects of coherent with layer's goal. In the occurrence of difficulty in finding materials available with the appropriate parameters, it is necessary to look for an alternative cover layer. Thus, there are layers of soil mixed with sludge from water and sewage treatment plants, shredded tires, rubber-sand, organic compost, among others. (e.g., Ahmed and Lovell 1993; Bernal *et al*. 1996; Bressette 1984; Reddy et. al., 2010; Jun He et. al.,2015)

Brazilian standards ABNT (1997) for the design, implementation and landfill operation does not present any technical specification regarding the geotechnical properties of the cover layers in general, only an upper limit to its permeability to the landfill.

Therefore, this article was accomplished to evaluate the cover mixed layer to improve its use and certify if the cover layer still work as it is intend to be after 5 years of its closure. The soil mixed with organic matter from

municipal solid waste (oxidative layers) were in depth studied by Maciel (2009), Maldaner (2011), Lopes (2011), Santos et. al. (2014). It was evaluated the geotechnical behavior of the experimental landfill covering layer, performed in 2010, of Muribeca, Jaboatão of Guararapes – PE, supported of the Group of Solid Residues (GSR), located at Pernambuco Federal University.

The maximum retention for this layer was evaluated by Lopes (2011) with 49%. Santos et.al. (2014) exposed for the same layer, 48%.

For this, the study of the interaction of the covering layer with the environment will be present in respect to their loss of tightness and increased permeability of two orders of magnitude due to leaching of particles larger layer to lower layers.

The objective of this work to expose characteristics from an evaluated cover layer from the experimental Muribeca landfill of Urban Solid Residues through of laboratory tests such as: suction, grain size distribution, and permeability, based on standard Brazilian procedures.

II. MATERIALS AND METHODS

Laboratory tests were developed in Group of Solid Residues (GSR) oxidative covering layer on its upper (top - 0.1 - 0.3 m) and lower (base - 0.4 - 0.6 m) part, assessing the Environmental Geotechnical features and the Soil Physics.

The oxidative covering layer studied was from the experimental cell of the landfill Muribeca, after 5 years of the landfill finalization. This layer had formed by 0.3 m of the compacted soil followed by 0.3 m of compacted layer soil in a ratio of 75 % soil (clay) and 25 % compost as Fig. 1.

The study can determine the influence of leaching within 5 years on soil behavior of the covering layer, so that the permeability is affected and the impermeability of the landfill could turn on inefficient cover layer.
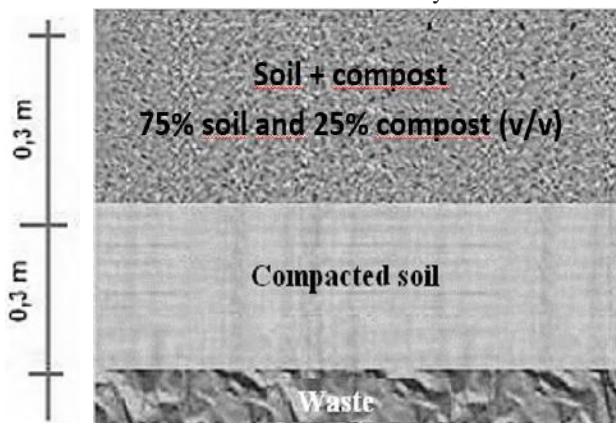
Fig.1: Sketch of assessed oxidative layer, where V/V means volume proportion.

2.1 Climate Data

Climatological data from Muribeca were obtained by the weather station located nearby to the landfill. Once the evaluation has performed based on the local microclimate the obtained parameters have a good accuracy for the necessary analyzes. There were collected rainfall data for the years 2009 to 2014, arranged with averages of each month for those years of analysis.

The region where Muribeca is located has two climatological characteristics of wet and dry conditions. Rainfall is abundant throughout the year and precipitation become of irregularly over time.

2.2 Soil Characterization

From the experimental cell of Muribeca where been taken undisturbed samples at two points (hole 1 and hole 2), illustrated in Fig. 2. Each sample had of approximately 0.2 m height. Disturbed samples for characterization with about 2000 g in desired depths were taken (on the cover layer). Three characterizations have performed as follows:

1. Characterization of the clay deposit;
2. Characterization of the layer in depth from 0.1 to 0.3 m into hole 1 and 2;
3. Characterization of the layer in depth from 0.4 to 0.6 m into hole 1 and 2.
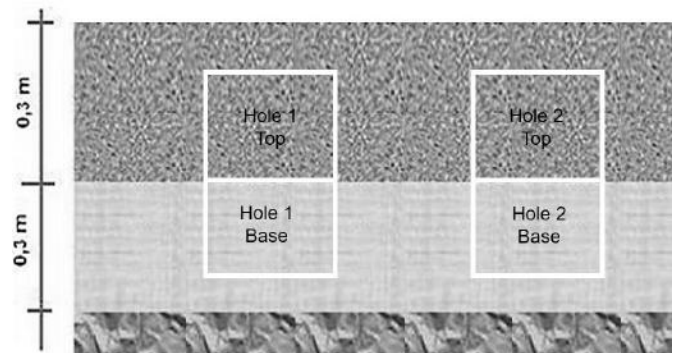
Fig. 2: Undisturbed samples from hole 1 and hole 2.

The laboratory tests, in turn, performed in accordance with the standards of the Brazilian Association of Technical Standards (ABNT) such as for particle size analysis (ABNT (1984b) Solo), determination of the liquid limit (ABNT (1984c) Solo), and determination of the plastic limit (ABNT (1984d) Solo).

To verify grain density two tests were conducted for the two soil depths studied in 2014, with the pycnometer 50 ml of capacity, placed approximately 10 g of each soil sample after had been sieved with a sieve # 200, according to DNER-ME 093/94.

It was possible to verify the porosity of the soil (n) according to the void ratio (e) calculated as given by:

$$e = Hv/Hs \qquad Hs = W / (d * A) \qquad (1)$$

Where:

e = Void ratio;

Hv = Specimen height (m);

Hs = Solids height (m);

W = Dry sample weight (kg);

d = Actual density of the grains (kg/m³);

A = The sample area (m²).

The porosity (n) was given by:

$$n = e / (1+e) \qquad (2)$$

Santos et. al. (2014) showed that the same cover layer analyzed in this article had 42% of porosity behavior in 2014.

Analyzing voids ratio, was observed capacity of water raining retention, was given by:

$$L = n*H \qquad (3)$$

Where:

L = Rainwater lamina;

H = Specimen height;

n = Sample porosity.

2.3 Soil water retention

To carry out the Retention Curve test were used the undisturbed samples collected from the oxidative layer from the depth of approximately 0.1 to 0.3 and 0.4 - 0.6m. From these undisturbed samples two steel rings of 20-mm in height and 60-mm in diameter were molded in the laboratory for suction tests.

To acquire the moisture equilibrium between soil and filter paper, the essay took seven (07) days for moisture homogenization.

The suction curve was obtained from the determination of the moisture from the filter paper on each side of each sample and the suction of the respective samples by using the equations proposed by Chandler et. al. (1992).

The tests were done 5 times for a successive loss of 6% water content started in around 45% water content until specimen present a residual water content, reaching 5 weeks of registered test.

2.4 Permeability (determination of hydraulic conductivity)

To perform this test were collected two soil samples on PVC cylinders with the characteristics of 0.15 m in diameter and 0.2 m in height depths from 0.1 to 0.3 m and 0.4 - 0.6 m each studied hole.

To perform the test have been taken in Tri - Flex 2 with imposition of a upflow hydraulic with 30kPa of pressure gradient and verify the time the water takes to percolate 5cm³ through the sample.

The procedure was done 3 times to obtain an average of readings of time ranging +/-5%.

Water permeability coefficient (Ksat) was calculated by equation 4.

$$K_{sat} = V \times L / \Delta P \times t \times A_{cp} \qquad (4)$$

Where:

K_{sat} = Saturated permeability to water flow (m/s);

V = Volume of percolated liquid (m³);

L = Sample height (m);

ΔP = Pressure Variation (kPa);

t = Percolation time 5 cm³ (s);

A_{cp} = Area of the sample (m²).

Then the sample was taken out to dry in the air, after verified its moisture performed an air permeability test. The test procedures were similar to saturated permeability assay, but instead of water, the fluid inside the sample was air.

Then three flow readings were recorded in a flowmeter with a maximum capacity of 30 NL/h, because the 10 NL/h does not allow checking the permeability, since the sample had a high porosity material, adopting the average of the readings in the flowmeter.

According to Darcy's law (Eq. 5), the intrinsic permeability of the fluid, valid for incompressible fluids only, is:

$$K_{int} = v \times \mu \times L / \Delta P \qquad (5)$$

Where:

K_{int} = Intrinsic fluid permeability (m²);

v = Darcy's speedy parameter (m/s);

μ = Dynamic fluid viscosity (Pa.s);

L = Soil sample height length (m);

ΔP = Inlet and outlet pressure gradient (Pa).

For the air permeability analysis was sought another methods of assessing permeability of compressible fluids, in which Ignatius (1999) developed an equation (Eq. 6), made from Darcy's law, considering the effect of compressibility:

$$K_{ar} = 2 \times v \times \mu \times L \times P_s / (P_e^2 - P_s^2) \qquad (6)$$

Where:

K_{ar} = Permeability of compressible fluids (m/s);

v = Percolation fluid velocity - Darcy (m/s);

μ = Dynamic viscosity of the air = 1,837 x 10⁻⁵ Pa.s ;

L = Specimen length (m);

Pe = Inlet pressure (Pa);

Ps = Outlet pressure (Pa).

III.   RESULTS AND DISCUSSION

The climate was analyzed through graphs of temperature and rainfall and drought chart to relate the rains with the soil water holding capacity of oxidative layer of 0.3m to 0.6m thick.

It is illustrated in Fig. 3 average precipitation and temperature data for the years 2009 to 2014; in Fig. 4 the average water deficit of the years 2009 to 2014. These data were collected from the weather station installed in Muribeca - PE.

It is clear, in that in the months from April to September, in which is located the wet condition, the rains are more intense, with positive water deficit reaching 108 mm in average. These data confirmed by the low temperature in these months, reaching a minimum average of 27,4ºC on June, accordingly, the maximum average 296 mm of rain in the same month.
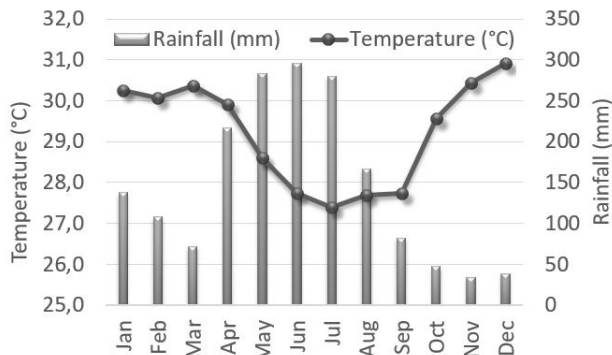
Fig.3: Climatological average data of temperature and rainfall in millimeters the years 2009-2014.
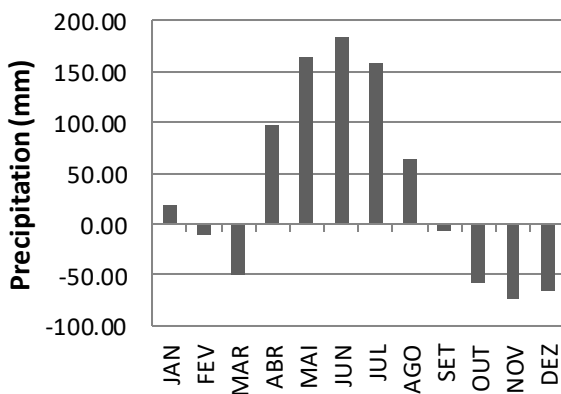
Fig.4: Water deficit for the years of 2009 to 2014

In the months of October to March settles the dry conditions, with negative water deficit reaching 41 mm in average. Through those months, the highest average temperature was found on December, with 31ºC and the minimum average rainfall was in November, with 34.38 mm of rain.

From the samples collected were performed a characterization of the materials collected as shown in Fig. 5 and Table 1.

On the base, the landfill was compacted with sandy clay soil of the deposit, it was hoped, therefore, the behavior of hole 1 base and hole 2 base (LL, LP, gradation curve and classification by Unified System of Classification of Soils (USCS)) similar to the sandy clay soil deposit, but it has not happened.

Fig. 5 and Table 1 showed that the sandy clay soil of the deposit is a Clay with Low Plasticity (CL - USCS), but the soil from the hole 1 and hole 2, after 5 years of leaching and erosion has behaved like Silt (ML - USCS), similar with the topsoil.

The results from characterization showed that the topsoil and base were very similarly, however, different from the deposit of clay. It exposes that the clay of the base has leached, loosing particles of soil. It was realized clearly in Table 2, where can be seen how the Ksat (permeability to water flow using the Eq. 4) and Kar (permeability to air flow using the Eq. 6) are close in average, but far from Lopes (2011) results.

Table 4 shows the porosity of a cover layer, with the porosity and voids of the evaluated holes between 0.3 and 0.6-m. These pores could been analyzed in terms of water accumulation capacity, in this case, regarding the porosity of the soil, the maximum capacity of water accumulation occupying all empty voids of the soil. Thus, the topsoil has, on average, 7% higher porosity/voids than the base, then afford the topsoil (soil + compost) absorbed about 7% more water than the base (clay).
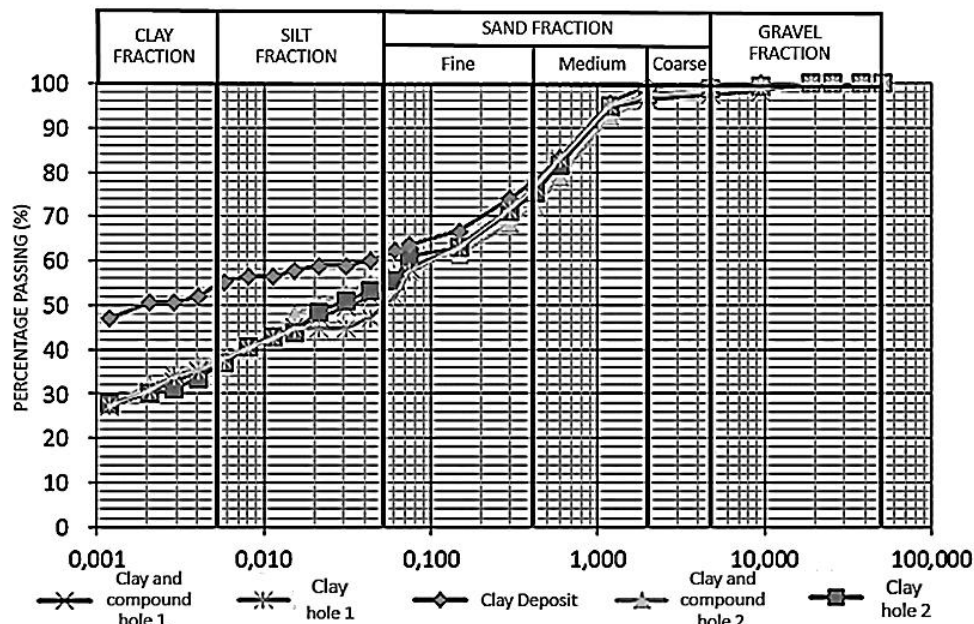
Fig.5: Particle size test hole 1 and 2 and the clay deposit.

Table.1: Parameters for Unified System of Classification of Soils (USCS)

Parameter	Clay Deposit	Clay and compost (hole1-top)	Clay (hole1-base)	Clay and compost (hole2-top)	Clay (hole2-base)
LL (%)	46%	52%	47%	47%	42%
LP (%)	32%	33%	33%	29%	23%
IP (%)	14%	19%	14%	18%	19%
USCS	CL	ML	ML	ML	ML

Table.2: The top Permeability (0,1-0,3m) and base (0,4-0,6m).

Permeability	Clay and compost (hole1-top)	Clay (hole1-base)	Clay and compost (hole2-top)	Clay (hole2-base)
Ksat (m/s)	2,8E10^{-07}	1,7E10^{-08}	3,4E10^{-07}	5,6E10^{-07}
Kar (m/s)	7,6E10^{-07}	5,6E10^{-07}	4,1E10^{-07}	4,0E10^{-07}

Lopes (2011) showed that in 2010 for the topsoil K_{sat} and K_{ar} as presented in table 3:

Table.3: The top (0,1-0,3m) and base (0,4-0,6m) Permeability.

Permeability	Clay and compost (topsoil)	Clay (base)
Ksat (m/s)	1,5 x 10^{-09}	9,2 x 10^{-08}
Kar (m/s)	4,4 x 10^{-08}	3,7 x 10^{-07}

Autor: Lopes (2011)

Table 4 showed higher porosity results than Lopes (2011), as the same way in current work (Eq. (8)), with 10% more porous.

Analyzing the Table 4, comparing with the sample porosity (n), and the Table 5, supposed specimen height (H), Eq. 9, in terms of water accumulation on voids in the soil, a layer of clay of and thickness of 0.3-m could retain excess 140-mm of water approximately. While a layer of the same thickness of soil mixed with compost a ratio of 3:1, could retain 160-mm. As for a layer 0.6-m thick, the clay could retain water 290-mm surplus, while the soil mixed with compost could retain around 315-mm, on average.

The maximum retention for the soil concerning porosity was evaluated from 48% to 40 % on the top and the base respectively, as shown in Table 4 and Fig. 6.

Table.4: Porosity

Sample	Porosity(n)
Hole 1 top	49%
Hole 1 base	48%
Hole 2 top	56%
Hole 2 base	49%

Table.5: Supposing Hight of 0,3 m and 0,6 m for a layer with soil from each hole.

Soil	Supposing Voids in H = 0.3 m (m³/m²)	Supposing Voids in H = 0.6 m (m³/m²)
Hole 1 top	0,15	0,29
Hole 1 base	0,14	0,29
Hole 2 top	0,17	0,34
Hole 2 base	0,15	0,29
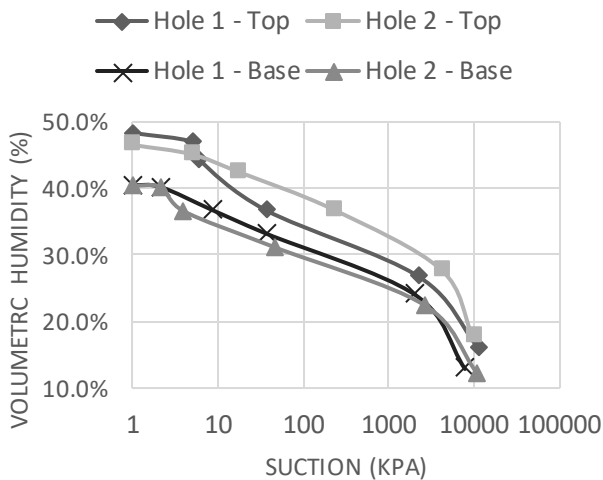
Fig.6: Suction curve holes 1 and 2 x Volumetric Water content.

Fig.7: Suction Curve x Saturation Degree.

Tabel.4: Retention (C)

Samples	C
Hole 1 – Top	6,4%
Hole 1 - Base	5,0%
Hole 2 – Top	5,2%
Hole 2 – Base	5,2%

Analyzing void ratio, calculated by Eq. 7, in the samples studied, was observed that the samples had small changes and that the topsoil had obtained a greater variation of voids compared to the base, Fig. 8**.**
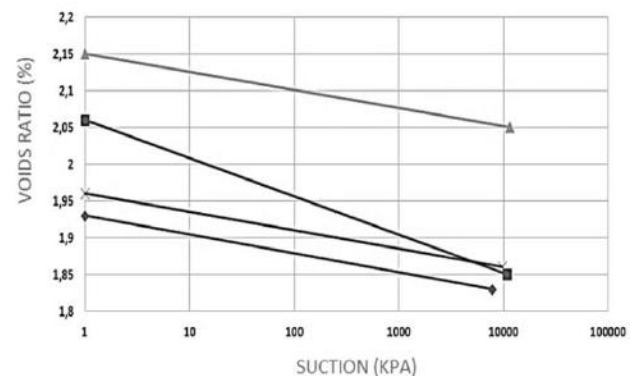
Fig.8 : Suction curve x Voids ratio

Suction on inlet point (GAE) is an important parameter of air inlet through the landfill, which oxygen atmosphere causes methane oxidation. Therefore, the GAE has to be to prevent this air inlet.

In Fig. 7 it could be seen the suction on inlet point (GAE) 3200kPa evaluated for the clay (base) with degree of saturation of 49% and 5,500kPa to soil mixed with compost (topsoil) with degree of saturation of 63 %. This decrease of the degree of saturation is closely linked to leaching and the increased porosity of the topsoil.

Analyzing the behavior of each soil sample from the moisture variation (Δw) and suction ($\log \Delta S$), was been obtained the expected soil retention for the first stage (before the GAE point) usin the physical indexes (C = $\Delta w / \log \Delta S$; Table 4). It was observed on average that the topsoil (soil mixed with compost 1:3) possesses higher water holding capacity (5.8 %) than the base (5.1%).

Analyzing Fig. 8 on average for both samples, the base scores a variation of 0.10% of voids ratio, while the topsoil 0.16%. This behavior of the variation of voids in the soil and the moisture reduction, which was set in particle size test from the soil, is common for a low compressibility soil, characteristics that a soil from a landfill should have to maintain the sealing of the cover layer (Ignatius, 1990).

IV. CONCLUSIONS

In granulometry test, was observed that there is no sensitivity in the test for detecting the occurrence of leaching from the upper layer to the lower layer after a

period of 5 years of landfill closing, in a final cover layer of 0.6 m height.

The porosity and void ratio of the cover layer increased after 5 years. Against Lopes (2011), it was found from the porosity that the topsoil (ML) was obtained in around 7 % more voids than the base (ML). Similarly, was observed to void ratios topsoil 7 % higher than the sandy clay soil.

Comparing to Lopes (2011) results, it was observed on topsoil an increase on K_{sat} of two orders of magnitude and on K_{ar} an increase of one order of magnitude, within 5 years, causing an inefficient sealing in the cover layer. Comparing the permeability of base (clay) and topsoil (clay and compost), it was observed that the soil mixed with the compost is more porous, with higher permeability to air and water than the base.

The suction test is closely related to the porosity and voids ratio of the soil, it was observed that the soil mixed with compost (1:3 - topsoil), showed greater water retention capacity, on average, of 5.8 %, and the soil of the base, on average, of 5.1%.

The air inlet point (GAE) of the soil had a reduction related with saturation, after 5 years, demonstrating a correlation with increased porosity.

Analyze the weather and the water surplus are required to perform a cover layer of a landfill. Therefore, for anywhere that exists a water deficit of around 200-mm of rain, a layer of 0.6 m of clay soil of low compressibility mixed with compost in the ratio of 1:3, similar to the one analyzed from this paper, would have an efficient water proofing. For a region with precipitation around 100mm, a layer of 0.3m with the same 200-mm materials would be sufficient. In Recife city center with water deficit of 184 mm, it is suggested a layer of the same composition with 0.4m thick, which should bear a retaining around 213-mm of rain.

According to the features expected in a landfill, the soil presented compatible granulometry (clay - ML) and Ksat and Kar (10^{-7} m/s in average for both), after 5 years of the Muribeca landfill finalization. Its efficiency is has been maintained.

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The challenges of concentration in the agricultural product supply chain: a study of Producer Organizations in Portugal

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Abstract— *One of the greatest challenges facing rural producers stems from the difficulties in accessing markets majority controlled by the major distribution chains. The small quantities under production and the low level of investment capacity ensure that smallholders in particular encounter an asymmetric relationship with the retail sector. The European Union (EU), through means of the Common Agricultural Policy (CAP),has adopted strategies to overcome these obstacles through stimulating farmers to concentrate their own supply through Producer Organisations (POs).These POs, in addition to concentrating supply, also act to improve productivity and guarantee reasonable prices to consumers. The objectives of this article include analysing challenges faced by the concentration of the agricultural product supply chain through a study of POs in Portugal. The research findings arise from analysis of both primary and secondary sources of information. The research techniques applied were documental analysis and holding interviews with six key players. The research results demonstrate how the average level of PO participation in the EU stands at 46% but falls back to 25% in Portugal. The results are also below those presented at the EU level despite accelerated growth taking place in the horticultural sector, which more than doubled its level of participation over the last decade (10% in 2005 rising to 26% in 2014). We conclude that, on the one hand, POs respond positively to the challenges of supply chain concentration; on the other hand, this has lacked the impact necessary to reversing the ongoing rural desertification in Portugal.*

Keywords— *Producer organisations; Agricultural production; Horticultural sector; Common Agricultural Policy (CAP).*

I. INTRODUCTION

It was above all from the 1990s onwards that the agro-food industry began losing influence over the coordination of distribution and retail channels, which were captured by the major retail distribution chains. The omnipresent supermarket and hypermarket formats essentially form the most visible facet of this process.The change experienced in control over the market fundamentally results from the privileged position of the retail sector in terms of access to information about consumer behaviours and habits, the volatility in agricultural product prices; the concentration in the sector through means of mergers and acquisitions; among others (EC, 2009; Velázquez and Buffaria, 2017).

These transformations provided consumers not only with access to a greater variety of better quality products but also declining prices. The latter trends stemmed both from economies of scale and from the rise in the negotiating power of retailers over their suppliers. This process has indeed witnessed a growing concentration of negotiating power in the retail sector and becoming especially able to impose their terms on inputs from small scale farmers.

These transformations have enabled the distribution sector to attain a privileged position in the chain of value, especially within the EU context. Thus, agricultural producers and even industries in the sector became far more exposed to their power of influence. Hence, the positioning of the agricultural sector has progressively slid down the overall chain of value (EC, 2007). Currently, the aggregated value of agriculture in the food chain accounts for 21% of the total against 31% in 1995. The food processing industry represents28% and with the distribution sector on 51%[1] (EC, 2015a; Nicholson and Young, 2012; Cavicchioli, Cacchiarelli and Pretolani, 2016).

In order to mitigatethis situation, the EU, under the auspices of CAP and through the Organisation for Common Markets (OCM), set up a set of instruments for regulating agricultural markets. The first stimulus for consolidating the OCMcame with the training incentives for Producer Organisations (POs),launched in the early 1970s(EEC regulation no. 1035/72).Henceforth, POs have experienced various changes both in terms of their design and their objectives. From their initial function, planned

to facilitate the management of the post-harvest supply to the fresh produce sector, this then emerged as a means for improving on the competitive position of rural producers following the market deregulation carried out by the reforms of CAP that began in 1994(EC, 2009).

The EU strategy to strengthen the negotiating powers of agriculture through means of POsarose out of the recognition of how the small scale of rural operations represented one of the main problems to commercialising their products. Therefore, there was the correspondingly perspective that concentration of supply might bring beneficial effects for rural producers to the extent that they might not only reduce their costs through economy of scale effects but might also boost their negotiating power downstream.In the case of Portugal, the level of organisation and concentration of production still remain at fairly low levels when compared with other member states[2](GPP, 2015).

Based on this problematic framework, this article seeks to analyse challenges posed by the concentration in the supply chain for agricultural products through studying the role of POsin Portugal.

From the conceptual framework perspective, the current research seeks to corroborate other studies carried out on POs and the relevant factors that impact on the agricultural sector in the EU and in Portugal. From the survey made of POs, we may highlight the increasingly deep interconnections between agro-food systems. This trend shapes the competitiveness of the food supply chain, the distribution of the negotiating powers prevailing among its actors and, finally, its efficiency and economic performance (Severini and Sorrentino, 2017).In methodological terms, this research stems from analysis of primary and secondary sources of information. As research techniques, we above all made recourse to documental analysis and holding semi-structured interviews with six privileged informants, with their identities withheld and identified only by "E" and their respective interview number.

The article contains a total of four sections. Following this brief introduction, analysis turns to the market powers of the retail sector and the challenges inherent to the concentration of supply (second section) and the EU strategies to (re)balance the negotiating powers in the agro-foodstuffs sector (third section). Subsequently, the article focuses on the role of POsin Portugal as regards the concentration and commercialisation of agro-food production (fourth section). This also analyses aspects regarding the constitutions and the general panorama of recognised POsand the challenges in the concentration of production in Portugal. Finally, we set out our final considerations.

II. THE MARKET POWER OF THE RETAIL SECTOR AND THE CHALLENGES OF AGRO-FOOD SUPPLY CHAIN CONCENTRATION

After the 1980s, the main change taking place in terms of the workings of the agricultural market was the shift in the power relations controlling them. According to Dobson and Waterson (2001 and 2003),there was a radical transformation: the replacement of the market power of producers/suppliers by the market power of retailers. This shift in power took place not only through the implementation of sophisticated logistics systems that enabled the storage of large quantities of products and their just-in-time distribution to the networks but alsodue to the capacity to meet the needs of consumers through carrying out market studies and prioritising their own brands as a means of competing with suppliers.This combination of factors resultedin the growing capacity of the retail sector to influence the terms and conditions of unilateral procurement contracts and aggressive negotiating strategies with.

The asymmetric negotiating powers prevailing in the market generate imbalances in keeping with the concept of unequal bargaining power.Thus, one of the parties holds sufficient power to impose unfavourable contractual terms and conditions on the other party, generally resulting in unfair outcomes from the social point of view (Inderst and Mazzarotto, 2008). As the authors refer, this process falls under the definition of buyer power(oligopolistic/monopolistic market powers / powers of monopsony)that,in a broader sense, corresponds to the negotiating powers that the buyer holds over the respective suppliers. Such imbalances drive practices effectively restricting competition, with negative effects on the wellbeing of consumers, producers, with predatory prices, the elimination of competitors, among other consequences.

In the agro-food sector, such weaknesses extend beyond the concentration of supply and, despite the enormous technological advances, the segment remains entirely hostage to climate conditions, soil fertility, product perishability and seasonality. These factors generate instability in terms of production, pricing, storage, transport and commercialisation. These issues have been decisive in altering the negotiating power relationships prevailing in agro-food sector markets (EC, 2009; EC, 2013; McCorriston, 2002).

The way in which the market for agricultural products is structured is susceptible to oligopsonic[3] practicesdue to the fact that the retail chains may influence the prices, varying only in the quantities acquired (Sexton, 2012; Vasconcelos and Garcia, 2014).Among the various existing market structures, the

oligop sony differs from monopolies and oligopolies due to having an inverse structure given that the former are characterised above all by a small group of buyers in a specific field in which there are many sellers. This concentrated structure, just as Vasconcelos and Garcia (2014) highlight, assumes the prevailing existence of imperfect competition. The fact of having a restricted number of buyers takes effect through their strong influence over the formation of prices. In such markets, sellers commercialise their products at the prices defined by the buyer due to the restrictions in place over any increase in price, with that defined by the buyer the final price in effect. In such cases, should there be any price rises, the tendency is for buyers to acquire products from other suppliers.

In the case of agricultural markets, studies carried out by Rogers and Sexton (1994) and Felis and Garrido (2015) demonstrate the trend towards the concentration of power in the retail sector, greater in this sector when compared to other segments, and thus reflecting the more limited scope for rural producers.The research conclusions from the Sexton and Zhag (2006) study on the United States report the behaviours of supermarket chains for fresh produce and other products.

Other research also brought to light similar concerns about the negative implications of concentrating power in the markets for agricultural products. The Sexton (2012) study identified a loss of economic vitality in rural areas due to the inequalities in their negotiating powers. As collateral effects of this concentration of power, Dobson *et al*. (2001) highlight the control wielded over suppliers. Furthermore, the United Kingdom's Competition Commission's report (DFID, 2004) detectedimbalances in the negotiating powers of producers and buyers.

Studies by Wilkinson (2006)had already identified the trend towards the concentration of power in the retail sector at the global level. The large companies operating in the processing segment lost ground in the face of the large supermarket chains. In adopting their own "generic"brands, they also provided lower prices and lessened their dependence on suppliers even while faced by the importance of the leading brands due to the capacity of their images to influence consumer choices.

Research by Lianos and Lombardi (2016) examinedpower and the level of concentration of the market for agricultural produce over the extent of the food supply chain. This study arrived at conclusions pointing to losses in overall wellbeing, especially for producers with lower levels of negotiating power. Hence, the greater the concentration in the processing and retail stages, the greater the vulnerability of the interests of both farmers and consumers in the resulting supply chain.

Out of this trend emerges at least three characteristics: the existence of only a small number of buyersbut on very large scales; the domination of the market by these actors, which leaves producers with few alternative outlets for their products and are compelled to maintain constant pricesand; the creation of barriers to entrance as a means of pre-reserving market outputs and avoiding the arrival of any new competitors.These practices, even while low in profile, are recurrent and harmful, especially to agriculture smallholders that cannot meet the requirements imposed and are thus effectively cast out of the marketplace.

The issues around the concentration of the retail markets remain far from resolved. The trend is for them to become still more concentrated resulting from mergers and acquisitions and not uncommonly from disloyal competitive practices, which results in an unequal distribution of income over the course of the supply chain of value. What has aggravated this scenario is how such a reality has turned into common practice in an apparently inexorable process (McCorriston, 2002; McCorriston*et al*.,2013; Kinsey, 2013; Felis and Garrido, 2015; Sexton, 2012)at least over the short and medium term.

Deriving from this trend, in many EUregions, and especially inPortugal,there are a significant number of producers harmed by processes of directly participating in the market. Even when achieving a relativeperformance in terms of production and productivity, this pattern reproduces and worsens inequalities in the distribution of income, continuing the rural exodus through unemployment and social and economic exclusionand regional breakdowns in economic and social development processes.

III. EU STRATEGIES TO (RE)BALANCE NEGOTIATING POWERS IN THE AGRO-FOOD SECTOR

The weaknesses of the negotiating powers of rural producers in contrast with those of the retail sector ensured that the EU, in the CA Preforms for 2013-2020, established a whole series of strategies to re-balance this relationship of power. The recognition that farmers are frequently atomised and in need of cooperation to attain efficiency in production, commercialisation and distribution were underlying factors driving the reforms enacted to CAP.

We would duly mention that the changes ongoing to CAP reach back to the 1990s with the changes in the support regime for production shifting in favour of a regime providing direct assistance to farmer income. This transformation had downsides for rural producers and left them more exposed to the market and still further

worsening their weak powers of negotiation (To thova and Velazquez, 2012; EC, 2010).

This reform then strengthened the PO role in keeping with the satisfactory results hitherto attained. Indeed, since their launch in the 1970s, POs have spread from fruit and vegetables to cover the entire agricultural sector. Thecriteria for the recognition of POs feature in the European Parliament Regulation no. 1308/2013 that definesthe following objectives: concentrating supply, improving commercialising, planning and tailoring production to demand, optimising production costs and establishing set prices for the producer, encouraging best practices and providing technical assistance as well as mechanisms for strengthening the position of producers within the respective supply chains (EC, 2013).

These new rules (OCM Regulation no. 1305/2013)[4]enabled producers to jointly commercialise their products through POs. To this end, there was the need to observe the following conditions: 1) the POsare to make the farmers more efficient, providing support service that are not sales based such as storage, distribution or transport services; and 2) the volumes commercialised by the POs are not to exceed certain set limits as stipulated by the Regulation.Furthermore, POs had to accept the commitment to obtain markets for their products, manage production in relation to demand and optimise production so as to stabilise prices, among others. This furthermore involves the definition of an operational program that details both the objectives and the means to attain them. The activities described in these programs receive financing according to a 50/50 division between the PO members and the EU (GPP, 2015). In order to receive financial support, POsneed to comply with certain conditions as stipulated by the Rural Development Program,in the case of specific exemptions, these are defined and decided upon according to a case by case approach (Velázquez and Buffaria, 2017; EC, 2013).

In general terms, this recognises the individual benefits to farmers from becoming members of collective organisations of the PO type. To the extent that farmers are able to aggregate their production through organising into POs, they strengthen their negotiation powers both as regards both buyers (downstream) and suppliers of inputs (upstream). Hence, in groups, producers are able to negotiate better contractual terms and conditions, which in turn reflects in higher prices and the acquisition of inputs at lower prices, among other advantages (Sexton and Zhang, 2006;Herck, 2014).

Another advantage associated with production that Herck (2014) identifies stems from the reduction of risks during the harvest period should the buyer refuse to accept the products in an attempt to force prices downwards. In this case, producers who are unable to sell their products in due time face losses, thus, POsare able to reduce risks caused in case of any hold-up time by the buyer. Furthermore, the vertical integration strategy enables access to new sales channels, for example, whenever retailers prefer to source products in large quantities so as to cut transaction costs (Reardon *et al.*, 2003).

Additionally,membership of a PO, in addition to concentrating supply, facilitates access to new technologies and to the exchange of information. Through such structures, members obtain higher levels of earnings whenever compared with situations when acting only in isolation alongside intangible benefits such as the deepening of social cohesion, the network of partners and the development of specific competences, such as the capacity to resolve conflicts and conciliateindividual interests (Herck, 2014; EC. 2014).The studies by Herck (2014) report that larger scale POsreturn more advantages to their producer members as they are able to concentratelarger volumes of sales, obtain better prices and generally provide more services to their members than their smaller peers. In addition, the findings report that average prices are higher in regions with strong cooperative organisations and POs.

Generally, there is a relativeconsensus around collective actor initiatives, such as the POs, representone approach to mitigating the imbalances in market power. However, there remain controversies when questioning this from a broader perspective. This almost always demonstrates the benefits resulting from "strength in numbers" but this may have limitations to the extent that this objective may not be attained due to hostile market conditions as is indeed the case with the retail sector (Eastham, 2015).According to the author,the POsmay have limitations on their capacities for intervention able to counterbalance the asymmetric forces or attenuate the negative effects of unequal relationships with the retailers. Furthermore, this highlights the need to consider the existence of other variables involved in this process, such as scarcity, level of participation, barriers to entry, product importance, and among others.

While differences exist around this theme, the empirical studies by Sexton (2000)corroboratethe thesis that the growing concentration of the retail sector represents one of the main causes of the unequal distribution of earnings along the agro-food chain of value. Other research findings have also confirmedthe unequal allocation of the value generated by the chain of production with the corresponding identification of asymmetries in the distribution of fixed costs,in the oscillations of prices and in the losses of perishable products (Felis and Garrido, 2015). Furthermore, studies have also reported on the importance of public policies

for the mitigation of the imbalances in the powers of negotiation when analysing the role of POs in counterbalancing the unequivocal relations prevailing in the marketplace (Cacchiarelli,Chiavicchioli and Sorrentino, 2016).

The studies made by Velázquez and Buffaria(2017) and Severini and Sorrentino(2017) reported on the positive results obtained by the POs in demonstrating how the horizontal integration of farmers favourably impacts on their powers of negotiation towards downstream buyers. In their works, the authors analysed the regulatory framework of CAP in order to verify whether this obtains the objectives set in terms of strengthening producer powers of negotiation.The study conclusions list how the CAP's measures and instruments have contributed towards improving the efficiency and income of farmers and the wellbeing of consumers and that the defined objectives are getting met even while there remains the scope to improve on the current regulatory framework.

In general terms, with the latest CAP reforms, the POs attained greater flexibility even while also experiencing an expansion of their responsibilities especially as regards the application of operational funds. In this case, the requirements include each PO holding the capacity to define their own specific actions (Operational Programs) and guaranteeing that they align with the European policy objectives. These are the main challenges set for the POs with such demands taking on greater relevance in countries such as Portugal given its agro-food sector experiences significant weaknesses especially when compare with countries in the North of the EU.

IV. RESULTS AND DISCUSSION: THE ROLE OF THE POSIN CONCENTRATING AGRO-FOOD PRODUCTION IN PORTUGAL

The concentration of supply through POs reflects a priority factor in Portugal as enacted by Decree no. 169/2015, which transposes to the national level, EU regulation no. 1308/2013.Based on this framework, transformations have taken place in Portuguese agriculture both in economic and in social terms. In order to describe the impact of these changes on Portuguese

agriculture, we shall first set out a brief description of the general aspects regarding the founding and launching of POs in Portugal. Subsequently, we survey the general panorama of the POsrecognised in Portugal and, finally, details spanning the concentration of agro-food production in the country. In order to develop this item, we made recourse to GPP (Office of Planning, Policies and General Administration)data and excerpts from interviews with key actors.

4.1 General PO panorama in Portugal

The concentration of supply represents one of the leading means of POs facing the challenges of commercialising their products in markets with oligopolistic characteristics. Hence, evaluating the performance of POs in terms of their number of members and the value of the products thereby commercialised holds relevance in a sector experiencing difficulties, as is particularly the case with Portuguese agriculture, primarily made up of smallholders.

From the regulatory performance of the CAPframework in Portugal, one of the core PO objectivesis to boost the level of production organisation in order to benefit not only the producers seeking to place their products in markets but also the downstream supply chain through contributing towards greater equity in the distribution of the value generated. Furthermore, this deems improvements to the organisation of production furthermore enable the development of medium and long term strategies, lowering barriers to innovation, market access and among other opportunities.

With the goal of improving the distribution of value generated by the agro-food supply chain, the organisation and concentration of production is thus incentivised by the founding of the POs. The concentration of supply features as a priority, established by Decree no. 169/2015, which harmonised the rules for recognising POs across all the sectors covered by CAP, which made significant changes to the following aspects: reviewing the criteria for PO recognition, promotion an increase in POscales, the appropriateness of the minimum VPC (Value of Products Commercialised) value required for PO recognition, the launch of Producer Groups (PGs),among other alterations (Decree no. 169/2015; GPP, 2015).

Table.1: Terms for Recognising POs and PAs in Portugal

Sector or Product/ Vegetable animal products	Min. num. ofproducers	Min. VPC in thousands of euros - POs	Min. VPC in thousands of euros - PAs
Cereals, oil and protein rich seeds, including maize	12	900	650
Cereals, oil and protein rich seeds, not	12	1800	1350

including maize			
Rice	12	1800	1350
Olive Oil	25	1500	1000
Olives	12	1000	750
Wine	12	3500	2500
Flowers	7	2300	1750
Bananas	7	15	10
Fruits and Horticultural Products	7	3000	N/A
Fruits with Hard Skins	12	500	N/A
Small Fruits*	12	750	N/A
Aromatic and Medicinal Plants**	12	250	N/A
Transformed Fruits and Horticultural Products	12	1500	1200
Potato	12	2000	1500
Cork	7	1750	1350
Other Vegetable Products	10	1000	750
Wood, Biomass and Resin	10	1000	750
Beef	12	2000	1500
Pork	10	8000	5000
Milk and Dairy Products	12	8000	6000
Honey el	10	120	90
Eggs	12	300	250
Other Vegetable and Animal Products***	10	1000	750

Source: Adapted from Decree no. 169/2015, CAP (2017) and GPP (2015).

*Blackberry, Raspberry, Redcurrant, Myrtle, Physalis, Elderberry and Strawberry Tree Fruit.

**Fresh or refrigerated aromatic and medicinal plants as stipulated in part IX of annex I of the Regulation (EU) no. 1308/2013, specifically, saffron, thyme, basil, melissa, mint, Origanumvulgare (oregon/wild basil), parsley, chervil, tarragon, watercress, rosemary, sage and savoury.

These legislative changes took effect in regulations that set out comparable information about the POs formally recognised in Portugal, whether attributed on the grounds of sector or product. In practical terms, this provides the scope for a producer to be a member of more than one PO (whenever producing different products)and, similarly, a PO may gain recognition for more than one sector or product (GPP, 2015).

The POs, by definition founded on the initiative of producers, have to comply with minimum levels of products commercialised and members, defined whether by sector or product as set out in table 1. The Portuguese legislation established the statute of PAs – Producer Associations as transitory structures requiring lower levels of VPC than those in effect for POs so as to enable them to adopt the measures and instruments necessary to convert into POsover a maximum period of three years (Decree no. 169/2015).

Setting up POs requires compliance with various criteria, among which features the minimum VPC level and the minimum number of producers, which may serve as barriers to the launching of new POs.For the wine, fruit and horticultural sectors, there are minimum VPCsof between 3.5 and 3 million euros annually, amounts that doubled in relation to the previously existing legislation. Furthermore, no member may hold over 20% ofthe capital orthe voting rights either directly or indirectly, with this holding able to rise up to a maximum of 49% whenever this percentage correspondsto the member's contributions in terms of the value of the products commercialised by the PO. However, the remaining members always have to hold at least 51% ofthe capital or the voting rights (Decree no. 169/2015; GPP, 2015).

Under the terms of the current legislation, Vicente (2015)maintains that the majority of Portuguese farmers face difficulties in setting up POs. There is the scope to join the existing POs but these are dominated by the large producers and distributors and in which there would be little scope for influencing the strategies or operational rules. The author demonstrates these difficulties in accordance with examples from the

Ribatejo and Oesteregions of Portugalwhere setting up a PO would require bringing together 135 producers in the case of the fruit sector; 154 in the horticultural sector and 890 in the wine sector.Furthermore, according to the same author, some POsrecognised in Portugal were already intermediate and autonomous distributors in the marketplace.However, there is substantial pressure to join the POsas CAPfinancial support is to a large extent structured and dependent on such membership.Benefitting from public policies requires an exclusive commitment to a PO for a specified period of time[5].

Another concern over the pressures to participate in POs was raised by Eastham (2014) due to the fact of members having to guarantee exclusivity over their sales to the POs in order to prevent parallel sales or members quitting. According to the latter author, over the medium term, this strategy may reducethe real impact on the revenues received by producers, not only by PO members but to all the sector. This concern has arisen due to the practice of some retailers adopting additional sources for supply as a means of reducing prices through means of threatening exclusion.

Furthermore, the pressures on producers to join POsmay still further worsen the lack of coordination and the exclusion of small scale producers from the market or even from blocking the development of new POs. However, the current CAP objectives foresee POs expanding in scope and scale rather than in terms of the number of their members so as to gain negotiating powers as regards the main distribution network in accordance with the position adopted as follows:

> [...] this facet of public policy *(CAP)*for market access, is highly active and has been a policy transversal across governments, in conjunction with their different challenges. It has also always produced, according to my analysis,a great deal of success. It is clear that if you ask who are the farmers inside these PO structures? Are they the smallholders, info-excluded, excluded, with low levels of access to technology? No, they are not! [...] Therefore, I would say that obviously those farmers that join these structures *(POs)*tend to be the most evolved farmers [...]in their knowledge, in understanding the problems that the market presents them with, better evolved even to the extent of education – with higher levels of education or with more specialised training, etcetera. (E1).

In this sense, the discussions on the direction of POsin Portugal generate substantial controversyas regards the strategies in effect for the agro-food sector to raise its negotiating capacity through means of concentrating supply, however We would highlight that expanding the POsinto the diverse agricultural sectors may effectively constitute a factor capable of driving the development of the agricultural sector but also contains its own significant limitations as already detailed.

In general terms, over the period under, from 2004 to2014, the POsrecognised in the horticultural-fruit sector registered VPC growth of over 200%. Nationwide, in 2015, there were 164 recognised POs,with almost half (46%) belonging to the horticultural-fruit sector. This furthermore highlights the considerable number of recognised POsin the animal products sector (18%) and cereals, oil and protein-rich seeds (33.2%).

However, in other sectors of rural production, the level of PO representation remains poor. The cereals and meats segments display low VPCs, especially when compared with the fruit and horticultural sectors; additionally, in cases such as wine, honey, milk and olive oil, there are only a few POs representing these sectors..We would however highlight that in these cases there are strong cooperative producer organisations.These also fulfil the objectives around concentrating supply but do not hold the same function and hence were not included within the scope of the indicators under[6].

The total value of PO products stood at 737 million euros in 2014,580 million euros in 2013 and 550 million euros in 2012, which corresponds to growth of 27% and 34%over this period.The VPC accounted for by POsrepresent 11% ofthe total value of Portuguese agricultural.The concentration of PO commercialization between 2013 and 2014 achieved 26% growth in general terms with significant increases in certain particular sectors and products, including rice, sheep/goat meat, cereals, wine, honey and olive oil.

Subsequently,there has been continued growth in the VPC registered by POs in conjunction with their rising contribution to Portuguese agriculture, the horticultural sector has more than doubled its VPC over a decade, surging from 10% in 2005 to exceed 26% in 2014. Meanwhile, despite this progress, these figures still fall well short of the EU average (43%) (GPP, 2015). As regards the changes introduced by Decree no. 169/2015, their impacts on Portuguese POs over the medium and long term remain uncertain, whether the concentration and loss of producers shall continue or fall away to generate new asymmetries

4.2. Features of the concentration of agro-food production in Portugal

In various sectors, the Portuguese POsplay important roles and especially in fruit and horticulture. As

already stated, the POsare necessarily majority controlled by farmers even while not exclusively given that the objectives extend to enabling some downstream companies to also move into production.The founding of a PO has in practice the main objective of getting a specific type of product onto the market and to this end requires associating with the companies that already have a commercial presence in the respective market.The quotation below details the role of the POs:

> [...] these POshave their capital open and are therefore open to other types of entity that may bring greater value to the organisation, [...] following their foundation. Having set the PO up, there are the applications made under the auspices of CAPto types of funding: one designated the 'Operational Fund'.In practice, the organisation applies for annual support that is designed to push it forwards, ensure financial autonomy so that it can do whatever it needs to do. Furthermore, in addition to this 'Operational Fund', [...] the*POs* [...] may also apply to investment support measures for undertaking transformation processes and commercialising the agricultural outputs of their members. [...] This has been a very successful approach, especially for fruit and horticulture, [...] (E1).

In Portugal, the fruit and horticultural POsare organised into such as FNOP (the National Federation of Fruit and Horticultural Producer Organisations). The objectives of FNOP include defending and representing the interests of POs and APsin addition to staging events and initiatives able to promote and develop the production of their members, coordinating activities in the common interest as well as other actions, studies, training and information initiatives (Magazine 1, 2016). However, the stimulus for the concentration of production, represents the main criteria for choosing new fruit PO members:

> We have experienced [...]across all the country, [...]a truly violent phenomenon in terms of the reduction in the number of producers and the increase in area per producer. The case of tomato, for example, is very significant[...]. There was genuine specialisation of producers, they produce a lot and the area under exploration per producerhas also soared massively and also boosting productivity per hectare. Twenty years ago, the *Cooperativa*had around 120tomato producers and who produced around 25,000tons [...]. Today, the

*Cooperativa*has about 19 producers and with an output of almost 80,000tons per year (E2).

These incentives for boosting productivity and expanding in scale may also further block the access of small producers to the market and effectively force them out of rural activities. The argument underpinning this stems from the need for the POs to grow in terms of scale rather than in the number of members so as to gain in negotiating powers with the major retailers, which has served to aggravate the situation faced by smallholders (Vicente 2015).According to figures from the INE (the Portuguese Institute ofStatistics), inthe period between 2009 and 2013, 40,800farms disappeared from Portugal, with over 90% farming less than 20 hectares. The persistence of this strategy to expand the size of agricultural properties will only tend to accelerate the process of smallholders leaving the land. However, the stimulus for the concentration of production, represents the main criteria for choosing new POmembers fruits:

> [...], depending on their output, the quantity in tons that they can show us, if it's a few tons then there is some justification, above 50 tons per hectare, I suppose, 70 tons per farm, then is the justification. If it's just 10 tons, then there is not much justification in practice, therefore, [...]we do not accept members with 10 tons, 5 tons... because this becomes a cost that we incur for a low level of production (E 4).

The arguments set out by the FNOP president corroborate the positions stated by the interviewees above in terms of how "without scale, there is no capacity to deal with market challenges"and also added:

> [...]the advantages of the production getting organised into POs is that we gain dimension through scale, we have greater power of negotiation, we have more capacity to supply larger markets, we have greater planning capacity, we have more and better information, indeed, we have a set of advantages already under exploration and still others for exploration [...]. (FNOP President, Magazine 1, 2016, p. 04).

Furthermore, the statement from the State Secretary of Agriculture and Food Supply follows a similar direction::

The current recognition regime contemplates[...] – not necessarily the number of POs but rather the increase in the production commercialised by these entities, fostering an increase in their average scale. This means having better POsrather than more POs.[...]Without the scale, there lacks the capacity to face the challenges of the market and a lossof effectiveness in accessing the support instruments (Magazine,1, 2016, p. 13 and 14).

Producers, on joining POs,strengthen their negotiating position in relation to both their buyers and the suppliers of inputs, in addition to reducing the inherent risks related to their agricultural activities, benefiting from economies of scale and accessingretail channels that would otherwise be difficult individually. As members of POs, they may invest collectively in activities and services with highfixed costs, access to new technologies, improving efficiency and productivity, consequently driving the return of better income levels.However, this risks accelerating the process of excluding producers and the desertification of the rural environment as producers unable to join POs run the risk of disappearing.

In summary, through analysis of the studies, we were not able to verify any statistically significant relationship between PO size, profitability and efficiency; however, the majority of the research findings corroborate the argument put forward by the interviewees maintaining that concentration opens up opportunities for significant economies of scale and improvements in market access. Furthermore, the largest POs are more profitable as they are able to better distribute the operational costs through the commercialisation of great quantities and provide more services to its associates, especially as regards investments in technologies and management.

V. FINAL CONSIDERATIONS

In general terms, we may conclude that the Portuguese rural sector has been undergoing profound transformations. Furthermore, we may testify to the success of the stimuli to concentrating the supply of products via POs and alongside improvements to various different aspects (productivity, innovations, access to markets).However, the greatest benefits have accrued to the medium and large scale producers with smallholders facing difficulties in accessing the public incentives made available via POs due to the small size of their farms and their corresponding lack of scale (POs resist accepting producers with such characteristics).

Based on the information analysed, we may thus verify the relationship between the size, profitability and efficiency of POs. This therefore reflects convergence with the main PO objective that involves concentrating supply (strengthening the power of negotiation held by producers). The means adopted in Portugal enabled growth in the levels of commercialised PO production. With a particular emphasis on the horticultural sector that more than doubled its level of coverage over the last decade (from 10% in 2005 to 26% in 2014), this level however still remains well below the EU average (43%).

Among the limitations of this study are the lack of detailed analysis of the retail sector in Portugal and the level of concentration. Hence, this would suggest the need for future research on this issue and especially on the composition of the membership of POs in order to ascertain whether there is sustained trend to integrate medium and large scale producers to the detriment of their smaller scale peers.

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[1]The five major distribution chains in Portugal account for 64% of the total market according to APED –the Portuguese Distribution Company Association, while in the majority of countries in the North and East of the EU, the percentages are still higher, with this percentage reaching 91% in Sweden (Berger, 2012). In 2011, in the EU, the five largest retailers accounted for over 60% in 13 member states, with a weighting of over 80% in Denmark and Estonia (Nicholson and Young, 2012; Cavicchioli, Cacchiarelli and Pretolani, 2016). For further details, see Rioux (2015).

[2]The number of POs varies among countries in the North of the EU that have higher rates than in the South.For example, the level of PO production stands at

approximately 25% in Portugal against an EU average of 46%, while in Belgium and the Netherlands, this exceeds 90%. For further details, see Magrama (2015).

[3]Oligopsonies reflect markets in which there are few buyers and many sellers.One example of these markets comes with perishable products such as tomatoes. When producers cannot sell their produce, they have no means to store it and thus buyers, for example, supermarkets stipulate the price which they are prepared to pay given that they know that sellers have no option but to sell as otherwise their products shall perish (Vasconcelos and Garcia, 2014).

[4]Prior to this regulation, there were various OCMs each with their own rules. With the advent of this regulation, the OCM became a single entity even while there still remain different rules in effect for the various types of product, as is the case with fruit and horticultural products with a differentiated support regime to that for cereals, for example, and entirely different to the case of potatoes, which do not receive any support (Interviewee, 2).

[5]Remaining a member of the PO throughout a minimum period of at least three years or for the duration of the operational program, whenever greater, inthe case of fruit and horticultural products, orfor a minimum period of ten years in the case of the cork and forestry sectors (Decree no. 169/2015).

[6]Olive oil sector cooperatives account for 36%, wine 41% and milk 62% of the total value produced in each sector. This explains the lack of PO representativeness in these sectors of production even while many of these cooperatives are now undergoing PO recognition processes. To learn more about the cooperative movement in Portugal.