https://dx.doi.org/10.22161/ijaers.610.32 *ISSN: 2349-6495(P) | 2456-1908(O)*

Utilization of solar energy for processing sea water into fresh water by the distillation method

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Abstract**—** *Coastal areas and small islands in the middle of the high seas are areas that have very few sources of fresh water. resulting in problems meeting the need for drinking water. Water resources in the area are generally of poor quality, for example brackish or salty groundwater. Source of water that is not limited in quantity is sea water, although the quality is very bad because many contain very high levels of salt. One way to overcome this problem is by applying water treatment technology that is in accordance with the social, cultural, economic and HR (Human Resources) conditions, in addition to the condition of the raw water sources themselves. The process of treating sea water into fresh water is known as the distillation process From the results obtained from the distillation process, the highest tube discharge = 1.9 cm on the first day, high distillation water 0.0307 m3 and the collector temperature 38ºC, on the second day the highest tube discharge = 1.8 cm, distillation water height 0, 0287 m3 and the collector temperature of 40ºC, on the third day the highest tube discharge = 1.8 cm, high distillation water 0.0287 m3 and the collector temperature 33ºC, on the fourth day the highest tube discharge = 2.0 cm, high distillation water 0, 0319 m3 and the temperature of the 36ºC collector and on the fifth day the highest tube discharge = 2.2 cm, high distillation water = 0.0351 and the collector temperature 38ºC.*

Keywords**— *Sea water, Fresh water, Distillation, Temperature, Collector***

I. INTRODUCTION

Coastal areas and small islands in the middle of the high seas are areas that have very few sources of fresh water. resulting in problems meeting the need for drinking water. Water resources in the area are generally of poor quality, for example brackish or salty groundwater. Source of water that is not limited in quantity is sea water, although the quality is very bad because many contain very high levels of salt. One way to overcome this problem is by applying water treatment technology that is in accordance with the social, cultural, economic and HR (Human Resources) conditions, in addition to the condition of the raw water sources themselves. The process of treating sea water into fresh water is known as a desalination process.
To answer this challenge, the team tried to design a sea water treatment system into fresh water, this treatment system utilizes solar energy as a natural source of heat.

II. STUDY OF LITERATURE

a. Literature Review

In this theoretical study, several basic theories relating to the research object described include water definition, water treatment systems, distillation and solar energy.

b. Previous Research Review

Water is a compound of two hydrogen atoms and one oxygen atom to become H2O which is very important for human life (SitanalaArysad). The function of water for life cannot be replaced by other compounds. The main use of water and very vital for life is as drinking water because the absolute substances that make up the human body consist of 70% water. According to Government Regulation No. 121 of 2015 concerning Water Resources Management, states that "Water is all water that is on, above or below the surface of the land, including sea water that is on land".

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1. Sea water

Sea water has a salty taste because it contains NaCl compounds which are quite high. According to some research sources, the salt content they have is 3.5%, which means that in 1 liter (1000 ml) of sea water there are 35 grams of mineral salt. Data from the National Oceanic and Atmospheric Administration explains that more than 70% of the earth's surface is covered by water and the rest consists of islands with many lakes and other water sources. Of the total percentage of water that meets the earth recorded 97% consists of sea water and is not good for consumption. To be utilized, the seawater needs to be processed first into fresh water / clean water / raw water.

2. Clean water

Clean water is healthy water that is used for human activities and must be free of germs that cause disease, free of chemicals that can pollute clean water. Water is an absolute substance for every living thing and cleanliness of water is the main condition for ensuring health. According to the Regulation of the Minister of Health of the Republic of Indonesia Number: 41 6 / Minister Of Health/ Per / IX / 1990 concerning requirements for water quality control, clean water is water used for daily needs whose quality meets health requirements and can be drunk if cooked.

Distillation

According to the Big Indonesian language, distillation is the process of heating a liquid or solid object until it turns into steam which is channeled into a separate vessel. Where this process is carried out by removing salt and minerals that are dissolved in seawater to get water that is suitable for community use, especially for people in coastal areas who have minimal water supply. An additional result of this process is salt which when seawater is brought to a boil.

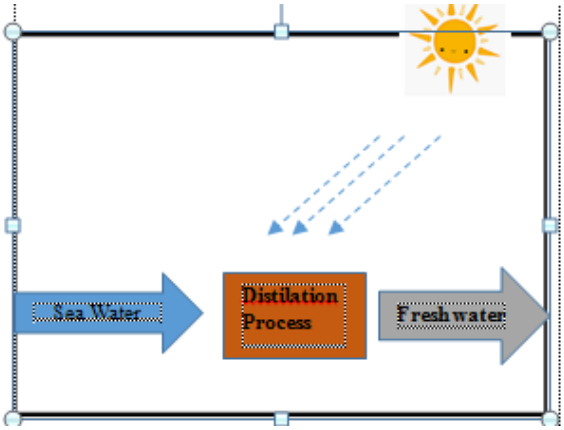

Fig. 2.1.The process of distillation sea water

a. By Linsey et al (1995) in his book explained that distillation is a water distillation technology to get fresh water from dirty water or sea water whose principle is to evaporate sea water by heating, which then the water vapor is condensed so that fresh water is obtained. The heat source that is used comes from diverse energy, one of which is solar energy. Utilization of solar energy for the distillation of sea water is one of the simplest ways to do, where sea water is heated so that it occurs evaporation and separation of mineral elements contained therein with fresh water (**fig 2.2**).

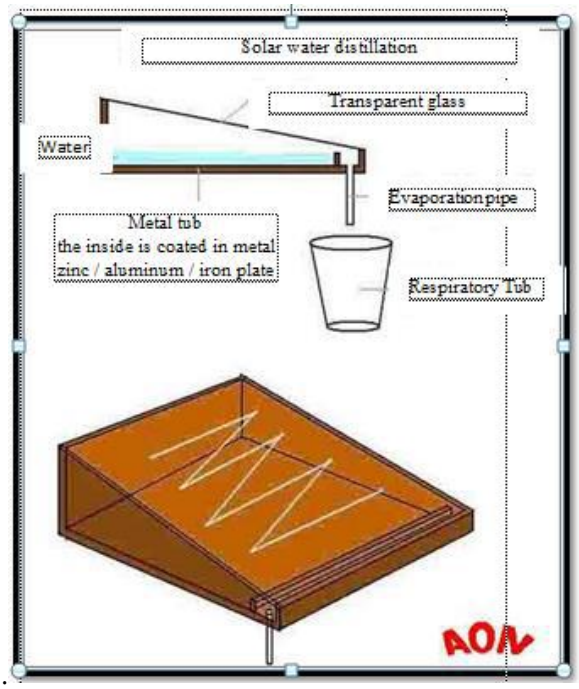

Fig. 2.2.The process of refining sea water by utilizing solar energy

Previous Research Review

Research on processing sea water into salt water several times has been done by previous researchers, including:

1. Mulyanef., Et al (2014) with the research title "Processing Seawater Into Clean Water and Salt with Solar Distillation". In this study the instrument used was a flat plate collector with an area of 1.6 m2 and the volume of sea water in the basin was 10 liters (**fig** 2.2).

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Fig.2.3. Flat Plate Solar Collector

The results obtained with the sun's intensity of 542 W / m2 are clean water as much as 1360 ml / day and it takes 7 days to produce 642 grams of salt. In conclusion, the authors say that the productivity of the resulting salt can increase if the area of the collector is enlarged and the heating time can be shortened if the intensity of the sun increases. Salt productivity is determined by the process of evaporation from seawater in a solar collector's chamber and the condensation process that occurs in the cover glass. The evaporation process will be better if the temperature of sea water in the solar collector room is getting higher. The lower the temperature of the cover glass, the condensation process will be faster. This results in higher condensate productivity and will accelerate salt production in solar collectors.

2. Mulyanef., Et al (2006) with the research title "Solar Water Seawater Distillation System Using Flat Plate Collectors With Tilting Cover Glass Type". The study was conducted on several alternative types of cover glass used including type one tilted glass surface, type two tilted glass surface and type four tilted glass surface. The results explained that of the three types of glass, the most clean water produced the most was type two sloping glass surface.

Concept Framework

The evaporation process will be better if the temperature of sea water in the temperature collector chamber is getting higher. The lower the temperature of the cover glass, the condensation process will be faster.

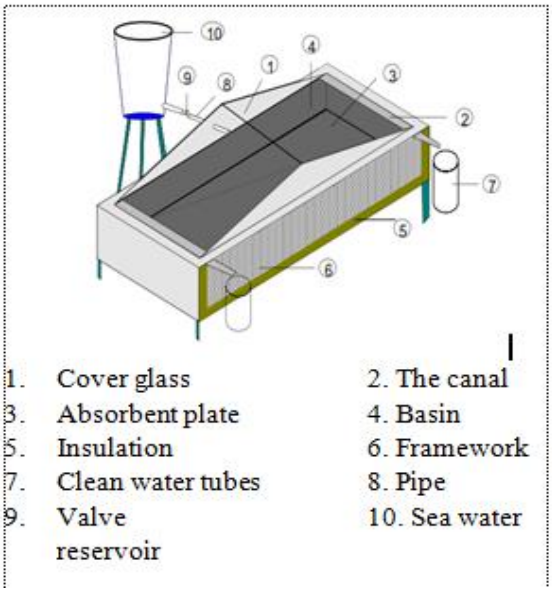

Fig. 2.4.Solar distillation type two sloping the surface of glass

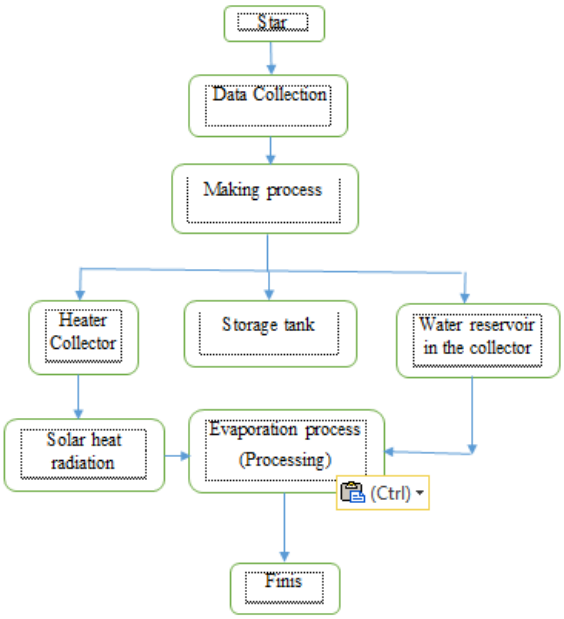

Fig 2.5 Research flow chart

III. METHODOLOGY

a. Types of research

There are various types of research, can be adjusted with the perspective and scientific basis. Judging from the method approach, this study is a type of experimental research that aims to investigate the causal relationship by controlling.

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b. Research sites

The research location is a place or region where the research was conducted. For this research took place in the yard of Civil Engineering Workshop.

c. Research time

This research was conducted for three months from April and is planned until July 2019.

d. Research Data Types

The type of data taken is primary data that is data obtained by researchers collecting directly at the study site. The data obtained include measurements of the ambient temperature, control of the heat produced in the collector's room and the percentage of raw water obtained.

e. Population, Sample and Research Unit

This research is an experimental study, so the research sample here is sea water. With the distillation method, sea water with a certain volume is processed into fresh water. For this process, a tool for processing sea water is designed using solar energy. The design of the processing system can be seen in **Fig 3.1.**

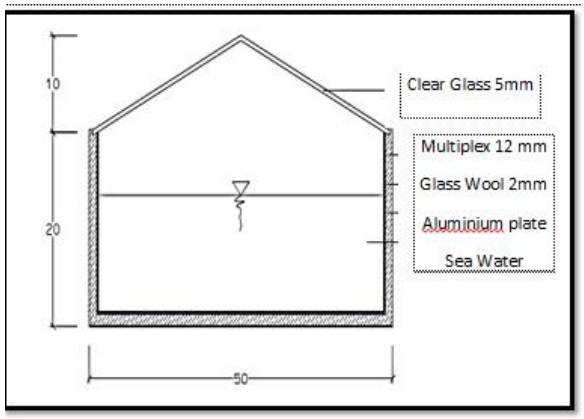

Fig. 3.1.Details in front of the collector

f. Method of collecting data

One important component in research is the process of researchers in collecting data can be done to obtain the information needed in order to achieve research objectives. In this study the method of data collection in the form of observation. Where researchers directly observe the work process, phenomena that occur during the testing process and measure the primary data obtained.

g. Analysis Method

Measurements were made of the ambient temperature and the temperature in the collector's chamber. Calculations of the temperature of the sun's heat and displayed with a graph of the relationship between the intensity of solar heat, the addition of sea water and temperature.

h. Operational Definition

In this study used several variables that are defined operationally so that they can be used as a guide in conducting research as well as instructions for those who read. Some important variables related to the process of seawater distillation are as follows:

1. The independent variable is the volume of sea water. In this study the number of samples used varies in this case is the treatment of sea water by the distillation process.
2. The dependent variable is the sun's heat energy that is produced and penetrated in the collector's chamber causing the room temperature to rise.
3. Control variables are the temperature / temperature in the collector's chamber and the heating time

- Temperature or temperature is a physical quantity stated to measure the degree of heat of a substance. The temperature measured at the time of testing is the temperature / ambient temperature and the temperature / temperature produced in the collector's chamber.
- The time needed to state the duration of the warm-up.

IV. RESULTS AND DISCUSSION

a. General description and characteristics of place / location / object / research unit

The distillation process is the process of filtering seawater into raw water through a heating process. The heat source that is utilized can consist of artificial heat sources such as heating using fuel oil, gas, electricity and natural heat sources in the form of utilization of solar energy or solar energy. This processing system has been widely introduced ranging from simple to modern. The simple method is carried out by heating the seawater until it boils and takes its steam and at the lowest temperature turns into fresh water. While the modern method is to filter sea water through high pressure pipes. However, this method is not suitable to be applied in low-income coastal communities such as coastal areas in Maluku.

b. Description of research variables

Temperature / air temperature greatly affect and water clarity and meet clean water requirements such as not containing harmful substances, colorless, odorless and others

c. Testing and analyzing research data

Materials and Equipment consisting of

1. Heat-absorbing collector tube
2. Collecting water in the water
3. Collector cover glass
4. Water storage steel plate

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Table 4.1. Observation of day 1 to day 5

No	Date	ischarge a tube	The height of water distillation (Raw)	The height of water collector	Temperature collector	Outdoor temperature	processing time	The height of water	The water
		Cm	m3	m^3	ºC	ºC	Jam	Cm	Salt/Fresh
1	22/07/2019	0	0.00	0,036	38	30	10	8	Fresh
		0,5	0,0079	0,036	41	30	11	8	Fresh
		0,9	0,0143	0,036	45	31	12	8	Fresh
		1,3	0,0207	0,036	45	31	13	8	Fresh
		1,5	0,0239	0,036	50	31	14	8	Fresh
		1,7	0,0271	0,036	45	30	15	8	Fresh
		1,9	0,0307	0,036	38	30	16	8	Fresh
	Rata -rata	1.3	0,0178		43,14		6		
2	24/07/2019	0	0.00	0,036	40	29	10	8	Fresh
		0,5	0,0079	0,036	48	29	11	8	Fresh
		0,7	0,0111	0,036	51	30	12	8	Fresh
		1,4	0,0223	0,036	52	30	13	8	Fresh
		1,6	0,0255	0,036	50	30	14	8	Fresh
		1,7	0,0271	0,036	40	30	15	8	Fresh
		1,8	0,0287	0,036	40	29	16	8	Fresh
	Rata -rata	1,18	0,0175		45,85		6		
3	26/07/2019	0	0.00	0,036	39	29	10	8	Fresh
		0,3	0,0047	0,036	43	29	11	8	Fresh
		0,6	0,0095	0,036	46	29	12	8	Fresh
		1,2	0,0191	0,036	48	30	13	8	Fresh
		1,5	0,0239	0,036	47	30	14	8	Fresh
		1,6	0,0255	0,036	47	30	15	8	Fresh
		1,8	0,0287	0,036	33	29	16	8	Fresh
	Rata -rata	1,16	0,0159		43,28		6		
4	29/07/2019	0	0.00	0,036	42	29	11	8	Fresh
		0,5	0,0079	0,036	50	30	12	8	Fresh
		0,9	0,0143	0,036	54	31	13	8	Fresh
		1,3	0,0207	0,036	52	31	14	8	Fresh
		1,8	0,0287	0,036	50	31	15	8	Fresh
		2,0	0,0319	0,036	36	29	16	8	Fresh
	Rata –rata	1,3	0,0172		47,33		5		Fresh
5	30/07/2019	0	0.00	0,036	41	29	10	8	Fresh
		0,4	0,0063	0,036	45	30	11	8	Fresh
		0,7	0,0112	0,036	48	30	12	8	Fresh
		1,3	0,0207	0,036	48	31	13	8	Fresh
		1,8	0,0287	0,036	50	31	14	8	Fresh
		2,0	0,0319	0,036	45	31	15	8	Fresh
		2,2	0,0351	0,036	38	29	16	8	Fresh
	Rata –rata	1,4	0,0191		45		6		

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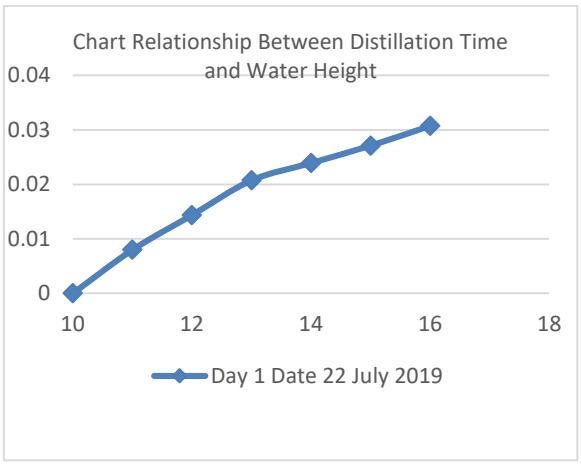

Fig. 4.1. Chart Relationship between distillation time and water height date 22 July 2019

From graph 4.1 above it can be seen that the height of distilled water on July 22, 2019 is 0.0307 m^3 at 16.00 WIT for the initial reading at 11.00 high distillation water 0.0079 m^3

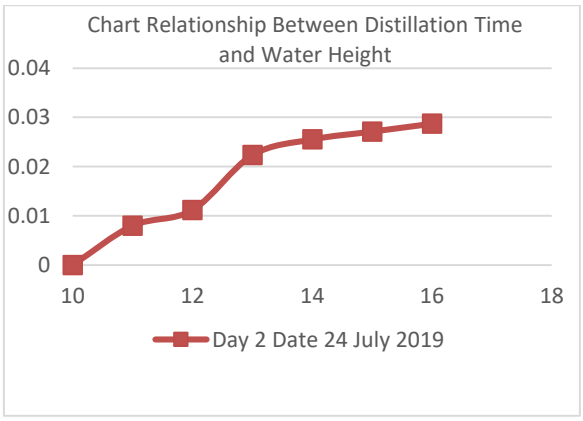

Fig. 4.2. Chart Relationship between distillation time and water height date 24 July 2019

From graph 4.2 above it can be seen that the height of distilled water on July 24, 2019 is 0.0287 m^3 at 16.00 WIT for the initial reading at 11.00 WIT high distillation water 0.0079 m^3

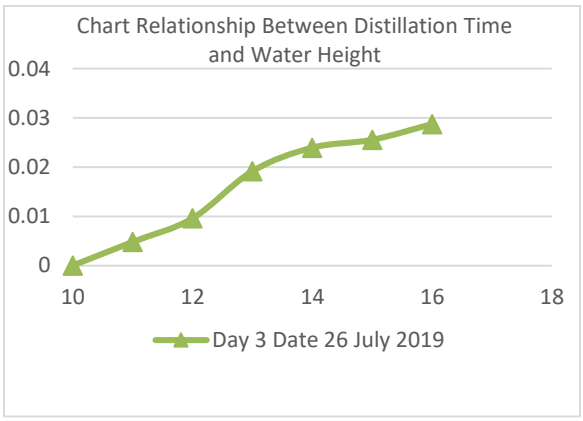

Fig. 4.3. Chart Relationship between distillation time and water height date 26 July 2019

From graph 4.3 above it can be seen that the height of distilled water on July 26, 2019 is 0.0287 m^3 at 16.00 WIT for the initial reading at 11.00 WIT high distillation water 0.0047 m^3

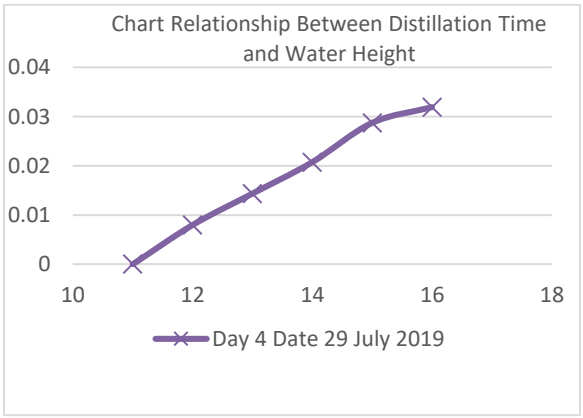

Fig. 4.4. Chart Relationship between distillation time and water height date 29 July 2019

From graph 4.2 above it can be seen that the height of distilled water on July 29, 2019 is 0.0319 m^3 at 16.00 WITfor the initial reading at 12.00 WIT high distillation water 0.0079 m^3

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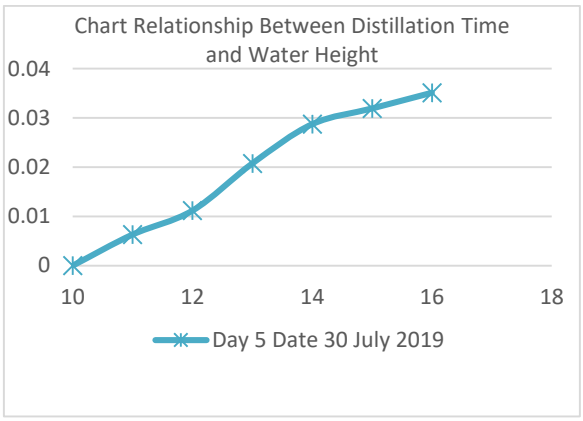

Fig. 4.5. Chart Relationship between distillation time and water height date 30 July 2019

From graph 4.5 above it can be seen that the height of distilled water on July 30, 2019 is 0.0351 m^3 at 16.00 WIT for the initial reading at 11.00 WIT high distillation water 0.0063 m^3

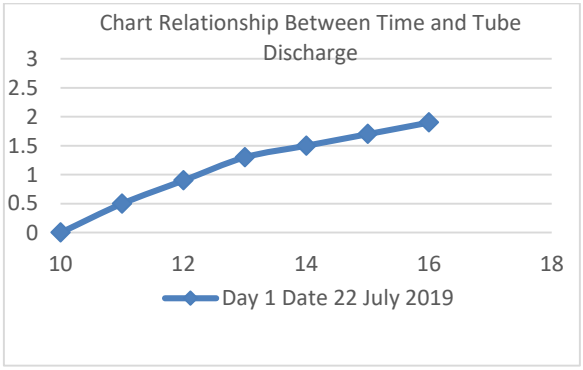

Fig. 4.6. Chart Relationship between time and tube discharge date 22 July 2019

From graph 4.6 above it can be seen that the discharge of the tube on July 22, 2019 was 1.9 cm at 16.00 WIT for the beginning of the initial reading at 11.00 WIT 0.5 cm tube discharge

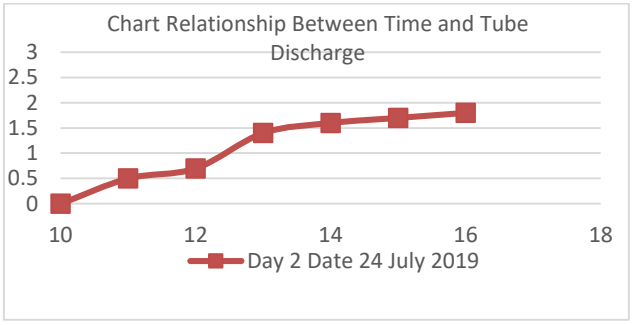

Fig. 4.7. Chart Relationship between time and tube discharge date 24 July 2019

From graph 4.7 above it can be seen that the discharge of the tube on July 24, 2019 was 1.8 cm at 16.00 WIT for the beginning of the initial reading at 11.00 WIT 0.5 cm tube discharge

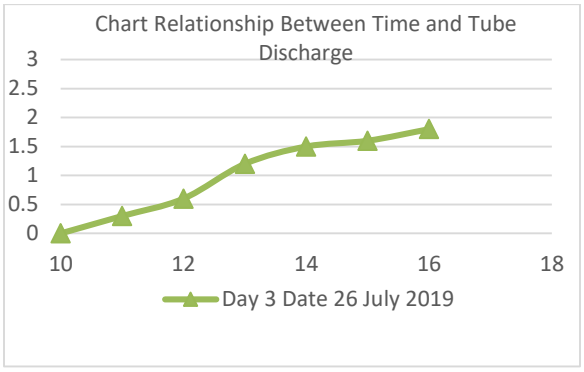

Fig. 4.8. Chart Relationship between time and tube discharge date 26 July 2019

From graph 4.8 above it can be seen that the discharge of the tube on July 26, 2019 was 1.8 cm at 16.00 WIT for the beginning of the initial reading at 11.00 WIT 0.3 cm tube discharge

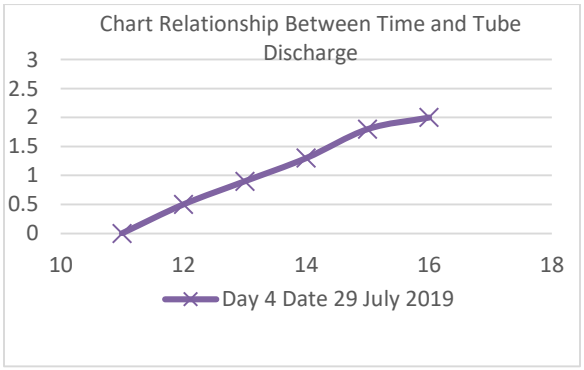

Fig. 4.9. Chart Relationship between time and tube discharge date 29 July 2019

From graph 4.9 above it can be seen that the discharge of the tube on July 29, 2019 was 2,0 cm at 16.00 WIT for the beginning of the initial reading at 12.00 WIT 0.5 cm tube discharge

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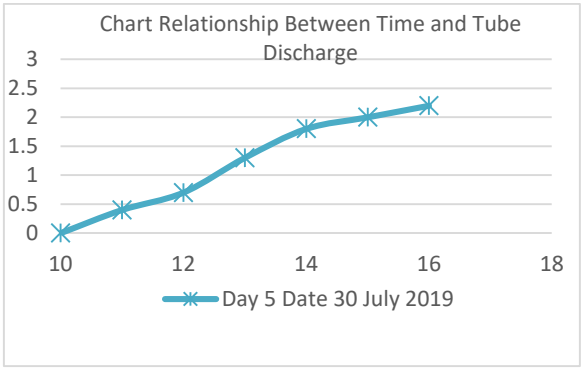

Fig .4.10. Chart Relationship between time and tube discharge date 30 July 2019

From graph 4.10 above it can be seen that the discharge of the tube on July 30, 2019 was 2,2 cm at 16.00 WIT for the beginning of the initial reading at 11.00 WIT 0.4 cm tube discharge

d. Discussion

Based on the results of tests in the field by using sea water as a basic material for the process of changing sea water into raw water using a distillation system through daylight heat irradiation by conducting through 5 trials in 5 days where the implementation time consists of 5 to 6 hours of observation this is due to the current conditions of the rainy season so that the temperature is not constant so the implementation of the trial is limited to hot time, as attached in the observation table 4.1. and graph 4.1 until the graph 4.10

V. CONCLUSION AND SUGGESTIONS

A. Conclusion

The results of this study can be summarized as follows:

1. For the temperature of utilizing solar energy with an average of 0.36 m^2 collector area with a water level in the collector is 0.036 m3 distillation occurs with an average temperature of 29.94ºC by producing raw water for an average of 6 hours and 5 times the experiment is 0.02 m^2 or 20 liters due to dependence on the utilization of solar energy, the area of the collector cover glass and the area of the collector.

2. Based on the results of previous studies, the area of 1.6 m^2 wide, 10 liters of sea water volume and 136 liters of raw water require 7 days of experiment with the distillation method shows that the results obtained by utilizing solar energy and air temperature with solar intensity 542 W / m^2.

Thus the volume of raw water is determined by the area of the collector, the area of the collector glass, the temperature in the collector and utilizing solar energy

B. Suggestions

1. For further research with the deslilation method, it can increase the observation time and can predict the utilization of solar energy.

2. Going forward so that subsequent research can create a renewable collector model and the extent of the collector's variety.

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