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Water level control in regional river vessels using automatic rule-a-matic attached to the rule basement pump

Erick de Souza Dourado, Izaias Castro Farias

Graduating from the Mechanical Engineering Course at Centro Universitário do Norte/SER

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***Keywords*— Vessel, Automatic, Bilge pump.**

***Abstract*—** *The economic impetus caused by the need to renew the Brazilian fleet of vessels, together with the growth of activities in the sector, collided with the major obstacle of the lack of construction structure in the country, due to the high degree of obsoleteness of the industrial park of the shipyards, including the ship parts industries. The most economically viable solution found by shipowners and operators was to order vessels designed and, when possible, also built abroad, which would not generate jobs and income for Brazilian workers and would not place the national industry within the current level of technological development of the international shipbuilding. The purpose of the present work is to use the automatic RULE-A-MATIC coupled to the RULE bilge pump so that the captain and engineer can be alerted about possible unexpected flooding at the bottom of the vessel. A comparison was made between the main pumps available on the market in order to justify the choice for the RULE pump, as well as describing each of the materials used for the construction of the prototype. The results indicate that, at the end of the prototype construction and after several tests, as well as reading and comparison about other bilge pumps, it is pointed out that the choice of the RULE 500 GPH pump (Galão per Hour) is due to the fact that most medium and large wooden vessels use a centrifugal pump coupled to the vessel's engine for this removal in motion and, when the vessel is anchored, the engineer starts the HONDA 5.5 HP engine, to remove water from the bottom of the vessel. vessel. However, we use the RULE pump to avoid physical wear and tear by the driver and also a higher fuel consumption, as well as a lower energy cost on the vessel. Being this pump market leader, featuring better quality, durability and reliability.*

I. INTRODUCTION

According to Abdalla (2009), maritime transport has been considered as the mainspring of the global economy. More than 90% of world trade is conducted by sea, and by some estimates, the operation of merchant ships contributes approximately US$380 billion in freight charges annually within this economic sector, equivalent to around 5% of international trade. .

According to ANTAQ (2013), river navigation is the most important means of transporting people and goods in the Amazon region, connecting the various communities and production, commercialization and consumption centers established along its vast and remarkable waterway

network. At the same time, its economic dynamics, its operational peculiarities and the quantitative and qualitative information on the activity are little known and systematized. The great heterogeneity of the profile of operators and users, the dispersion of port facilities, the predominance of informal practices deeply marked by the local culture and its traditions, among other regional peculiarities, contribute to this scarcity of information.

As Ferreira (2016) emphasizes, in the Amazon, especially in the state of Amazonas, transport is primarily by river and operates without efficient control by the State and civil society, with consequences not yet analyzed, both for natural resources and for the population. in socioeconomic terms. In Amazonas, river transport is carried out by vessels that transport cargo and passengers and works until today, without proper regulation.

Clandestine vessels, excess passengers and cargo in high season, schedules are not respected, there is little investment in technology added to naval construction and operation, as well as the absence of essential navigation equipment and, finally, the quality of the services offered inferior in relation to other modes. This is all due to the lack of regulation of the sector and, mainly, the omission of the State. However, it is important to emphasize that, for the population of Amazonas, it is an essential modal.

According to Silva Júnior (2009), after almost two decades of decline (the 1980s and 1990s), the construction of regional river vessels in Brazil has been experiencing an intense growth process since the beginning of the 2000s. The Brazilian fleet of vessels allied to the growth of the sector's activities faced the major obstacle of the lack of construction structure in the country, due to the high degree of obsoleteness of the industrial park of the shipyards, including the naviparts industries.

However, the most economically viable solution found by shipowners and operators was to order vessels designed and, when possible, also built abroad, which would not generate jobs and income for Brazilian workers and would not place the national industry within the current level of technological development of the market. international shipbuilding.

Thus, the State created mechanisms to promote the increase in the level of jobs in the productive sector of the economy with the construction of new vessels, the latter being responsible for the entry of current shipbuilding technology. In this context, shipbuilding and operations need to adapt their methods to new technologies and concepts (SILVA JÚNIOR, 2009).

Therefore, based on this technology principle, the importance of using the RULE bilge pump will be studied, together with the automatic RULE-A-MATIC so that excess water can be removed from the vessel's bilge, and thus, alert the captain and the engineer about possible unexpected flooding at the bottom of the vessel.

River transport in this region is mainly carried out by vessels characterized as mixed, which in addition to transporting passengers, transport cargo in general, both to smaller centers, municipal headquarters and their interiors, and to large centers (BENCHIMOL, 2011).

Souza and Silva (2013) point out that the vessels are small and medium-sized and may pose a risk to passengers, due to poor maintenance, overcrowding and disorderly loading.

According to the Port Authority (2014), since 2005, 246 accidents have been recorded involving vessels from the Amazon, with 175 fatalities. The main causes were: excess of passengers and cargo, low technology added to the construction and naval operation, lack of preventive maintenance, lack of port structure, clandestine vessels, absence of equipment such as radar and echo sounder, lack of signaling and beaconing of rivers, traffic intense, tree trunks in rivers and occasional atmospheric phenomena, such as storms and winds.

It should be noted that, in general, regional river vessels, most of the time, need a system that can pump water into their interior, either by the action of rain or by infiltration in their locomotion, being infiltrated by the axis and helm.

Currently, to extract this water and keep the level within a standard limit, most of the time, it is necessary to carry out constant inspections. The engineer goes down to the hold and activates a manual pump, if the vessel is berthed, in order to remove excess water from the bottom, preventing water from reaching the vessel's engine or even avoiding damage to cargo.

In view of the above, the following question arises: How is it possible to improve the water withdrawal process, replacing the manual pump together with the physical effort of the machinist for an automated system?

With the resumption of boat building, there is a desire to rescue the practice while learning new technologies. The revival of the old shipbuilding practice is the result of the knowledge acquired from the workforce of engineers and technicians with many years of experience, many of whom work in areas other than shipbuilding and design.

Learning new technologies is based on research and development of scientific knowledge produced in universities, combined with new tools and instruments developed. As a result, there was a need to create and/or modernize project equipment. Due to the complexity and number of systems contained in the engine room of

vessels, it is desired to present procedures that contribute to the reduction of accidents and that ensure the safety of crew and passengers.

Manual water pumping on vessels is still considered a critical circumstance. Bearing in mind these problems and with the aim of overcoming them, a system was developed that does not have visible moving parts that could be prevented from working or have its functioning altered by any foreign object and that has no possibility of infiltration of moisture that may come to deteriorate the wires.

In this way, this system solves a problem that affects the security of the property and also of the owner with the advantage of having a system that performs the process of removing water from the basement of the vessel, avoiding unexpected flooding and keeping transport as a safer means.

Thus, the objective of this article is to propose, in a case study, the withdrawal of water from the bottom of the vessels through the RULE bilge pump, and the automatic RULE-A-MATIC.

II. LITERATURE REVIEW

2.1 Vessels

Despite the frequent inaccuracies in the use of the concepts of vessel and ship as synonyms, such concepts are not confused.

It is a consensus in the literature that a vessel is a genus that comprises several species of maritime structures, which have in common the fact that they move or float on water. In this sense, Anjos and Gomes (2012, p. 28) point out that “vessel is the genus of which the ship is a species”.

In fact, under this generic name, corresponding to the French bâtiment de mer, English vessel, German fahrzeng, Spanish vessel, we deal with any construction that, floating, serves to transport people or things by water. The kayak, the dinghy, the canoe, the dredge are vessels, but they are not ships, as this expression is reserved for large vessels intended for the transport of people or things. (SIMAS, 2008. p. 40)

“The term 'vessel' designates a variety of maritime structures, while the term 'ship' is limited to a few species of the same genus” (LAZARATOS, 2009, p. 64).

Simas (2008) teaches that the ship is one of the species of the vessel genus in which locomotion over the seas is used for the specific purpose of navigation, that is, for the transport of people or goods over navigable waters, towards a certain destination. destiny.

It is certainly an advantage that the concept of a vessel is so comprehensive and flexible, considering that such an object is subject to constant innovation arising from technological advances.

2.2 Navigable rivers and types of vessels in the region

The definition of waterway or river transport, according to Faria (2008), is any vehicle that moves in the liquid environment, including sea, river and lake. Water has been used as a means of transport since the most remote times of our society, sometimes as a displacement of people, sometimes as a means of sustenance and commercial exchanges. In antiquity, sailing was an art passed down from generation to generation. The vessels were small and propelled, most of the time, by muscular force, winds or natural currents.

At the end of the 15th century, beginning of the 16th century, the era of the great navigations provided the economic development of Europe, due to the search for new trade routes with the East. This impelled several European countries to invest in acquiring knowledge in the areas of shipbuilding and the art of sailing, so much so that in the 16th century, Portugal led naval technology, and from its shipyards some of the largest ships that crossed the seas of the time left – the islands of Carreira or Rota das Indias (CARVALHO and CASTRO, 2006).

It would be impossible to think about, live and produce the Amazon without it being equipped with means of transport such as navigation, which would allow the traffic of people and products (BENCHIMOL, 2011). For this reason, the river along with its Paraná, lakes, holes and streams are of singular importance to the riverine people of this region. However, one cannot talk about navigation in the Amazon without referring to the history of this place, since both are interconnected at the heart of their context.

To enter the region and then colonize it, Europeans needed native knowledge of the region. In this way, the first action of the white was to recruit the indigenous as a forester and slave. Navigation was extremely difficult, given the magnitude of the distances, which made it difficult to explore and populate the region, made at that time with rowing or sailing canoes, taking hundreds of days to climb the channels of the Amazon and its main tributaries. The indigenous, in turn, crossed the region in their migrations on foot and later in ubás (LOUREIRO, 2007).

The Amazon hydrographic region has a vast amount of natural waterways, which form the largest waterway network in Brazil and in the world. It consists of the Amazon River basin, located in the national territory, and the basins of the rivers existing on the island of Marajó, in addition to the hydrographic basins of the rivers located in

the state of Amapá that flow into the North Atlantic, totaling 18,300 km of waterways and 724 km of potentially navigable waterways CNT-(National Transport Confederation – 2013, p. 50), which represents about 60% of the national waterway network ANA – (National Water Agency – , 2005, p. 23).

In terms of extension and availability of water, according to Souza (2013), the Amazon hydrographic region has the largest territorial area, 45.3% of the national territory (3.9 million km²), and covers areas of the States of Acre. (3.4%), Amapá (3.2%), Amazonas (35.0%), Mato Grosso (20.2%), Pará (27.9%), Rondônia (5.3%) and Roraima (5.0%).

According to Lino, Carrasco and Costa (2008, p. 21), the Brazilian waterway network currently comprises 29,000 km of naturally navigable rivers, of which only 8,500 km are in regular commercial use. Of these, 5,700 km are in the Amazon region. This picture could be changed with investments in adequate works, increasing the extension of the national waterway network to 44,000 km.

"This lack of investment is directly reflected in the growth of this modal in Brazil. Proof of this are the numbers released by ANTAQ – (Agência Nacional de Transportes Aquaviários, 2013, p. 8), in its study on the indicators of cargo transport in Brazilian waterways, "which shows a considerable reduction in the growth of the waterway modal, in compared to other modes.

There are countless types of vessels that travel in the waterways of the Amazon. Not only in the diversity of size, category, types of cargo and material from which they are built, but also in the grandeur of the numbers, proportional to the immensity of their rivers. There are no studies that put the estimated number of vessels sailing in the region. It can be considered that there are about 60,000 vessels registered with the Port Authority and its subordinate offices and agencies, in the jurisdictions of the Western and Eastern Amazon, and more than double this amount, that is, 120,000 actually in operation (MACHADO, 2014). .

The types, according to Machado (2014), Correa (2009) and Santos (2013) are divided into:

a) Merchant ships:

- Container carriers – have size and draft limitations due to the characteristics of river navigation. They transport general cargo that supplies the region, mainly the city of Manaus and its surroundings;

- Gas tanks – built especially for the transport of LPG – (Liquefied Petroleum Gas). They carry out production flow from Petrobras' Urucu field, located in the Solimões river basin, in the region of the municipality of Coari/AM, to REMAN – (Manaus Refinery);

- Bulk carriers – can transport solid or liquid bulk. In the case of solid bulk, they carry out the flow of grain production, especially soybeans, produced in the north of the state of Mato Grosso, from the existing terminals in the city of Itacoatiara/AM. The flow is initiated by the road modal to the city of Porto Velho/RO, and from this point, by means of tugboat convoys and ferries, which will be described below, in navigation on the Madeira River, to the city of Itacoatiara, where shipped on bulk carriers. In the case of transporting liquid bulk, they carry out the flow of oil production from the Urucu field to REMAN – (Manaus Refinery). Also, carry out the transport of oil derivatives, from the aforementioned refinery, to other states and abroad;

b) Regional trains - are the typical transport vessels in the previous waterways. They consist of one or more pushers, which lead a set of one or more rafts, which sail tied together. In the Amazon they are known as "Rol-on-Rol-off caboclo" or, simply, "Ro-ro caboclo". According to Nogueira (2009, p. 81, apud MEDEIROS, 2012, p. 30), this type of vessel was created as an alternative to river road transport, as an adaptation to the international "roll-on-roll-off" model.

- General cargo trains – consist of a pusher and one or more barges, which transport general cargo on deck. This cargo can be stowed inside trailers that are distributed on the deck, or it can be stowed directly on the ferry decks;

- Liquid bulk transport trains – composed of a pusher and one or more ferries, which transport the liquid cargo inside it. Normally, petroleum or ethanol derivatives are transported. The ferries used in these convoys must have accessories and special safety equipment, in accordance with NORMAM – (Maritime Authority Norm), specific, as they are dangerous cargo;

- Solid bulk transport trains - composed of a pusher and one or more barges, which transport solid bulk cargo inside the same. Normally, soy, corn or ore grains are transported;

c) Passenger vessels:

- Regional passenger transport boats – these are the typical passenger transport boats in the Amazon region. Also known as "cages", they are often built by hand, without a project or monitoring by a naval engineer. Passengers are transported in hammocks or cabins, usually with little comfort. They are built in hull and wooden structure. Newer ones are usually built using naval steel. These are vessels that offer little safety, as they are designed without watertightness in their compartments. In

addition, because they do not have an adequate project, many of them do not have the ideal stability conditions for bad weather and storms, typical of the region. Generally, they transport general cargo on their main deck or in their holds, normally to supply the small towns through which they make their line;

- Tourist boats – they are usually medium-sized yachts that offer greater comfort to their passengers, with cabins for their accommodation. Formally, they are classified, by the Maritime Authority Rules, as passenger transport vessels, as the classification of tourist boats does not exist;

- Express vessels – these are small and medium-sized vessels, with aluminum hulls, which develop high speed, on average 30 knots, to transport passengers, seated on benches or armchairs, between the various municipalities in the region. Due to the speed they develop and the light structures, they offer and are subject to several risks, including collision with other vessels, or collision with logs or other types of debris, known as camalotes, or stranding on sandbanks, common in rivers of the Amazon.

d) Small vessels - are small vessels and small vessels, existing in large numbers in the region. Usually, they have aluminum or wooden hulls, often handcrafted by the riverside population and propulsion with an outboard motor. Many of them have propulsion with a very popular and low-cost type of outboard motor, widely used in the region, consisting of a rod with a small propeller at the tip, known as "tail". These types of boats are popularly known as “voadeiras”, “rabetinhas” or “catraias”, in the region. They are used to transport a small number of passengers and/or a small amount of cargo. They are often used for the owner's benefit. They are equivalent to private vehicles or taxis on urban roads. They travel in large numbers, most of them driven by pilots not qualified by the Brazilian Navy and, on many occasions, they pose a great risk, for not observing the navigation safety rules.

Most of the Amazonian boats used to transport cargo and passengers are handcrafted, with their technology transmitted through oral tradition (Figure 1). Design drawings are made only so that the vessel can be legalized after construction is complete. The technical requirements are evaluated by the naval authority or by certification companies that submit the boat to the tests necessary for its approval. The procedures must comply with the rules of the naval authority prescribed in the compendium called NORMAM – (Norma da Autoridade Marítima 02), (MARINHA DO BRASIL, 2010), which specifies the minimum requirements for inland navigation vessels. Data from the Indigenous Port Authority cam that the highest numbers of fatal victims are associated with accidents involving cargo and passenger transport boats, common in the region.

2.4 Use of the centrifugal pump in regional river vessels

According to Allé (2011), centrifugal pumps are a subclass of turbo absorption machines. Centrifugal pumps are used to transport fluids by converting rotational kinetic energy to the hydrodynamic energy of fluid flow. Rotational energy typically comes from an electric motor or motor. Common uses include suction of water, sewage, oil, pumping in petrochemicals, and some centrifugal fans are commonly used to implement a vacuum cleaner. The inverse function of the centrifugal pump is a water turbine converting water pressure potential energy into mechanical rotational energy.

The fluid enters the pump through a suction nozzle. In this nozzle, the gauge pressure can be higher (positive) or lower (negative pressure, vacuum) than atmospheric. From the suction nozzle, the fluid is forwarded to one or more rotors that give energy to the fluid, followed by a device for converting kinetic energy into pressure potential energy. The fluid leaves the pump through the discharge nozzle. The energy transferred to the fluid appears in the form of the pressure difference between the suction and the pump's discharge. This specific energy (energy per unit of mass) is known as HMAN – (Total Head Height). Due to this energy transfer, we can lift, pressurize or transfer fluids (FERREIRA, 2011).

The rotor of a centrifugal pump is a turbine that gives energy to the fluid as it flows continuously through the interior of its vanes. Although centrifugal force is a particular action of inertia forces, it gives this class of pump its name. The power to be supplied is external to the pump, be it an electric motor, a diesel engine, a steam turbine, etc. The energy transfer is carried out by one or more rotors that rotate inside the pump body, moving the fluid and transferring the energy in the form of kinetic energy - increase in speed - and this can be converted into pressure energy (METSO, 2011).

A centrifugal pump works by transferring kinetic energy to the fluid and transforming it into potential energy, either of position or, more often, of pressure at the pump's discharge nozzle. This action is carried out using the concepts of Bernoulli's Principle (SOARES, 2009).

Ferreira (2011) highlights that, mechanically driven by a rotating shaft, the rotation of the pump rotor transfers energy to the fluid through the rotor blades. The fluid present in the suction enters the eye of the impeller - a cavity of smaller diameter, internal - from where it flows towards the external diameter through the channels formed between the blades of the impeller. The fluid leaves the

rotor with considerable absolute velocity, the portion of kinetic energy - which must be converted into pressure potential energy. This is performed on the non-rotating parts.

The most frequent form of energy recovery in non-rotating parts is a spiral-shaped housing, known as a volute, which ends in a discharge nozzle. Another common form of energy recovery device is a series of static vanes, called a diffuser. The vane diffuser can be followed by a return channel - directing the fluid to another rotor - or a spiral collector, very similar to a volute (METSO, 2011).

According to Soares (2009), the energy transferred by the centrifugal pump to the fluid is a function of the rotor diameter, the drive rotation and the rotor design. If the discharge requires an energy even higher than that supplied by the pump to the fluid, there is no flow: the fluid is only pressurized. A centrifugal pump needs to be selected with a view to an application: the simple installation of any centrifugal pump in a hydraulic installation does not guarantee the operation of the installation. The application requires adequacy between the pump installed, the piping system used and the supply source of the pumped fluid.

Vertical centrifugal pumps are mostly built with horizontal shafts. Although pumps with a vertical shaft are also manufactured, there is a class of vertical pumps in which the impeller is installed at the lower end of an extended shaft and thus submerged in the fluid. This construction is convenient when, for example, we want to lift water from a river or lake without submerging the actuator, usually an electric motor that does not support immersion. These vertical pumps are intended for installation in a well flooded with water and are called "vertical wet well pumps" (SOARES, 2009).

Vertical wet well pumps are also called vertical turbine pumps. In the more distant past, pumps equipped with diffusers were called turbine-type pumps. As hydraulic turbines require the presence of steering blades for control, pumps equipped with diffusers with fixed vanes were called turbine-type pumps (METSO, 2011).

Ferreira (2011) points out that a centrifugal pump that contains more than one rotor is a multistage centrifugal pump. Each stage provides the fluid with a certain energy, and these are added together. If there is a need for more energy - more pressure - the number of rotors arranged in series is increased. The rotors can be mounted on the same shaft or, more rarely, on different shafts.

As with all pumps, energy is supplied by the driver: electric motor, internal combustion engine, steam turbine, etc.

It is certainly possible to install two rotors in pairs. We can have cases of two pieces with independent specular symmetry and mounted on the same axis or a single piece, containing both sets of symmetrical vanes.

Single-stage pumps with double suction impellers are often considered balanced by symmetry, reducing the efforts to be absorbed in the bearings. Also, due to the division of the flow in two streams, it presents a reduction of the NPSH – (Positive Suction Head) required in relation to equivalent single suction pumps.

The following parameters characterize a centrifugal pump, according to Soares (2009) and Ferreira (2011):

The pumped flow Q;

The total head H;

The absorbed power P;

The efficiency, or yield, η;

The outside diameter of the rotor, D;

The positive charge on suction, or NPSH required;

The drive speed n.

According to De Matos (2008), the most frequent form of energy recovery in non-rotating parts is a spiral-shaped housing, known as a volute, which ends in a discharge nozzle. Another common form of energy recovery device is a series of static vanes, called a diffuser. The vane diffuser can be followed by a return channel - directing the fluid to another rotor - or a spiral collector, very similar to a volute. The energy transferred by the centrifugal pump to the fluid is a function of impeller diameter, drive speed and impeller design. If the discharge requires an energy even higher than that supplied by the pump to the fluid, do not there is flow: the fluid is only pressurized.

The author also mentions that a centrifugal pump needs to be selected with a view to an application: the simple installation of any centrifugal pump in a hydraulic installation does not guarantee the operation of the installation. The application requires adequacy between the pump installed, the piping system used and the supply source of the pumped fluid.

The main requirements for a centrifugal pump to have a satisfactory performance, without presenting any problems, are:

• correct installation;

• operation with due care; and

• proper maintenance.

Even taking all the care with operation and maintenance, engineers often face problems with pumping system failures. One of the most common conditions that

necessitate the replacement of a pump in the process is the inability to produce the desired flow or load.

III. METHODOLOGY

Having defined the research objectives and executed the theoretical basis for the study proposal, the research methodological procedure is then defined, which has the function of defining the parameters used in the development of the study, as well as relevant aspects in this process so that achieve the ultimate goals.

Thus, for the present study, field research was defined as a method. According to Gil (2009), this type of research aims to provide greater familiarity with the problem, in order to make it more explicit or to constitute hypotheses.

The study was carried out in a regional river vessel with the objective of proposing improvements through bibliographic studies and applications, to reduce the physical effort of the operator or machinist, avoiding unnecessary drives, low energy cost, improving the systematized part of the vessel.

3.1 Methods and techniques

The work begins with the exploratory stage, with the field research, in which we sought to identify ways to contain the non-conformities found in the vessel's hold about the pumping of water, which documents and instructions the vessel uses and what benefits they have with the use of the same.

A technical visit was carried out on the Big Mar vessel (Figure 1) on May 22, 2022, at 10:30 am, duly authorized and accompanied by the owner, in order to know how the process of removing water from the bilge would be carried out in practice. of the vessel, which uses a centrifugal pump model FAE 40 (Figure 2) to aid in this removal.

Fig. 1 - Visited vessel.

Figure 2 represents the FAE 40 centrifugal pump, used on the vessel to remove water when it reaches its maximum limit in the engine room. Centrifugal pumps are extremely necessary on vessels, as these pumps are directly coupled to the vessel's engine, with the pump specified for its discharge output of 1 ½ inch, having a better flow compared to other types of pumps, such as bilge pumps.

Fig. 2- Centrifugal pump used on the vessel

When the vessel is anchored, water enters through the hull. This is very common on regional wooden boats, when the water rises to the maximum level in the hold. The present vessel uses a HONDA 5.5 HP engine (Figure 3) manually turned on by the machinist together with the automatic one, removing the water, throwing it into the river again. When in excess of water, the automatic (Figure 4) is activated along with a siren to alert the crew.

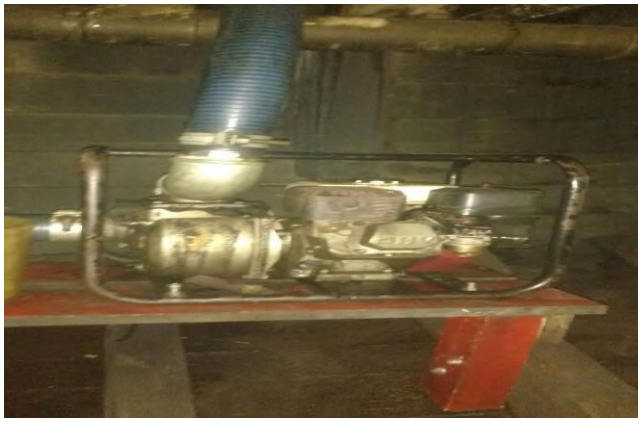

Fig. 3 - Vessel auxiliary engine.

Figure 3 illustrates the vessel's auxiliary engine, it is responsible for generating energy, being able to operate the centrifugal pump, when the vessel is moored in the port. The same has as its reference the HONDA 5.5 HP engine.

Fig. 4 - Automatic RULE-A-MATIC

Figure 4 shows the Automatic RULE – A – MATIC, used to activate the centrifugal pump or the RULE pump. When submerged in water, it has a sensor built into it, which when 5 cm is reached, it alarms the pump.

IV. RESULTS AND DISCUSSION

The purpose of this work was to create a prototype to meet the stated objective.

In this sense, Figure 5 shows a flowchart of the creation of this material.

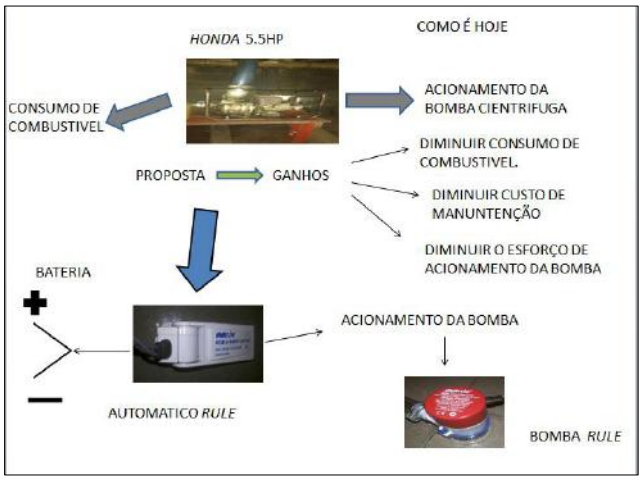

Fig. 5 - Flowchart of today's component installation, compared to the case study.

In view of the results presented in chapter 3, it was decided to use the RULE bilge pump and the automatic RULE-A-MATIC coupled to it.

Currently, the evacuation of water from the bilge of vessels is mainly performed by the centrifugal pump coupled to the vessel's main engine, when it is in its path. When the vessel is berthed, and the water level reaches 5 cm, it alerts the vessel's driver or the vessel's owner, causing him to go down to his hold to turn on the auxiliary engine, that is, the HONDA engine. 5.5 HP to pump the water manually, until it reaches the standard level in the engine room.

With this case study, the installation of the RULE pump, together with the automatic RULE-A-MATIC, will give greater savings to the vessel owner with: fuel savings, energy savings through the generator, reduce the physical effort of the machinist and avoid unnecessary activations.

These pumps are market leading, feature quality, durability and reliability.

The motor is specifically designed for use in bilge pumps following high quality standards; has better heat transfer; The engine is stronger and bigger, it is closer to the water flow, generating better cooling. RULE produces its own engines.

Other points of advantages that we can mention when choosing the RULE pump are:

- The motor is fixed to the body through a brass plate to avoid vibration and wear of the gaskets and retainers;

- The closer the engine is to the water flow, the better it is cooled;

- All terminals are welded to prevent corrosion and disconnection due to vibrations;

- The shafts and rotors are chamfered, preventing the rotor or shaft from turning falsely;

- The supplied wiring receives a silicone layer to prevent corrosion.

In this way, it is emphasized that it is of utmost importance to always examine the components of the bilge pump, including hoses, wiring and connections. If you find that one of these elements is damaged, peeling, cracked, dry, cracked, this is the time to repair or replace the part.

Another important factor is to always test the bilge pump switches. Make sure that the automatic reaches a certain level of 5 cm, that when it reaches it, it activates the bilge pump, and suctions the water, when there is no more water at the bottom of the boat, the automatic returns to its origin. , avoiding unnecessary energy consumption from the source, battery or generator. If it's not working properly, you'll need to check the wires connecting the automatic or bilge pump. These items need to be replaced if they are not working properly.

It is also relevant to test the high water level alarm, through a siren connected together with the automatic one.

Many sinking accidents are caused by a faulty water alarm. The user does not have the routine of inspecting the

basement for water, trusting the alarm and ends up being taken by surprise.

It is essential to take care of any accumulation of oil in the basement. The sludge of oil residues in the water can cause the submerged parts of the bilge pump to malfunction. If you have an engine oil leak, even a small one, it is important to have it repaired. If a large amount of oil has fallen off due to a filter change or some maintenance, you must remove as much oil as possible before starting the bilge pump, and at the end of the process, let the pump run with plenty of clean water, diluting it to the maximum fattening.

Do not let the bilge pump drains/grids clog. Regularly check that there are no sheets or plastic or anything preventing the pump from sucking water from the bottom of the boat. It was made to work by pulling water, and if it stays "dry spinning" for too long, it can end up burning or damaging its internal parts.

At the end of the day, carry out regular inspection and verification to ensure the safety of the vessel and all users.

In this sense, every engineer who is studying a higher degree in the technology course can have this automatic, together with the RULE pump, in his work and creative performance, as it presents an ease in its handling in the development of any invention. of technological devices, because its technological structure makes it easy to decipher its technical details.

The result of this action, in which a prototype was created, is of magnitude for human knowledge, since science at every moment offers man the feat of creating his own inventions, as the technological support devices are presented with low costs and easy to understand. In this way, man, especially those who work in the technical/scientific field, have the possibility to advance in technological knowledge.

For the student in the field of Mechanical Engineering, the robotics culture itself contributes to the formation of an inventive and creative spirit. In this sense Vargas et al. (2012, p. 45) state the following:

The experiment, the invention, the creation and the very action in the man are linked to a knowledge that is proper to him, of the innate. However, the scientific workshop provides an environment that stands out for an even greater development, due to science itself fostering ideas, concepts, paradigms that will enable improvement and capacity already internalized in the spirit of man since his first understanding of the world.

In this study, the results for an understanding of a scientific technical knowledge emerged for the growth of the invention, as this small invention shows that it is possible to advance, because in the face of the inventor and the invention itself, obstacles will always be present, but the what is equivalent in knowledge is to always advance and persist.

V. CONCLUSION

At the end of the work, it was found that most small and medium-sized regional vessels use centrifugal pumps coupled to the vessel's engine, and their applications are according to their size and engine performance. It can be considered that the bilge pump is one of the most important equipment of any type of vessel.

The boats have several water entry points. From rainwater, small leaks in radiators or cooling hoses, water pump, or hydraulic hoses from faucets and showers, to engine coupling gaskets, small holes drilled in the hull and transom for the installation of equipment. There are still water sprays when navigating in rougher waters and even the fresh water shower, after a relaxing dip, they bring water into the boat.

Water easily penetrates into any crack or hole and, therefore, becomes common in the hold of boats, but if not eliminated, it can cause mold and bad smell, short circuit, engine malfunction and even sinking of the boat.

The bilge pump installed on the inner and lowest part of the hulls of boats and boats is the equipment that eliminates these small amounts of water, pumping it out of the boat.

In addition to taking the water out of the boat, the bilge pump has another importance. The water in the hold of a boat can contain contaminants such as oil, gasoline and other fluids that can be harmful if handled, for example, using the famous mug. Therefore, it is important to have and maintain the bilge pump in full working order and, whenever you suspect a fault, have the equipment repaired or replaced. Testing and checking the bilge pump regularly (which unfortunately in the case study was not carried out).

An extremely important accessory, not to say mandatory, are the automatic ones for the bilge pump. This piece works as a buoy close to the bottom of the hull/hold that, when detecting a certain level of water in the vessel's bilge, automatically activates the bilge pump. The equipment is essential for boats that are, for example, in berths, at the mercy of the rain, as is the regional vessel studied, allowing the bilge pump to be activated and to eliminate the water that ran into the bilge.

The choice of the RULE bilge pump was chosen, together with the automatic RULE-A-MATIC, because when the vessel is anchored in the port and water starts to

infiltrate through the hull, either due to rain, or through the axle and rudder, the engineer goes down to the vessel's hold, starts the pump manually, and evacuates the water.

Already with the case study, the installation of the RULE pump with the automatic RULE-A-MATIC, would avoid physical wear, through the driver going down to the basement of the vessel, having a consumption of energy and fuel in the vessel because it is Easy to install and can be connected to a 12V battery.

However, the assembly of the prototype was carried out to test and validate its operation, both of the bilge pump and of the automatic one, specifying its advantages and disadvantages in relation to other types of pumps, measuring the performance of the pumps that are most used in the boat branch. Its limitations were also identified and the advantages of the proposed model for this case study were pointed out.

It is important to remember that for the bilge pump to work it depends on the 12 V battery, so you should be concerned about keeping the boat battery always charged. This can be done with solar powered battery chargers, for example.

REFERENCES

[1] ABDALA, Thiago Canavarro. Análise de estrutura administrativa e Métodos de gerenciamento de frota: Estudo de caso. **Trabalho de Conclusão de Curso** (Engenharia Naval e Oceânica). Universidade Federal do Rio de Janeiro, 2009.

[2] AGÊNCIA NACIONAL DE ÁGUAS (Brasil). **A navegação interior e sua interface com o setor de recursos hídricos**, 2005. 57 p. Disponível em: <arquivos.ana.gov.br/planejamento/planos/pnrh/VF%20Navegacao >. Acesso em: 29 abr. 2022.

[3] ALLÉ, A.V.A. **Apostila de sistemas de bombeamento**. PUC-RS, 2011.

[4] ANJOS, Haroldo dos; GOMES, Carlos Rubens Caminha. **Curso de direito marítimo**. Rio de Janeiro: Renovar, 2012.

[5] ANTAQ. **Agência Nacional de Transportes Aquaviários**. Caracterização da Oferta e da Demanda do Transporte Fluvial de Passageiros na Região Amazônica. 2013.

[6] BENCHIMOL, S. **Navegação e Transporte na Amazônia**. Manaus: Edição reprográfica, 2011.

[7] BRASIL. Ministério da Defesa. Marinha do Brasil. **Diretoria de Portos e Costas. Normas da Autoridade Marítima**. Disponível em: <http://www.dpc.mar.mil.br>. Acesso em: 10 mai. 2022.

[8] CARVALHO, C.; FONSECA, N.; CASTRO, F. **Notas sobre a tecnologia de construção naval nos estaleiros navais portugueses do século XVI**. Projeto Reconstrução Virtual de uma Nau Quinhentista, 2012.

[9] CONFEDERAÇÃO NACIONAL DO TRANSPORTE. **Pesquisa CNT da navegação interior** 2013. Brasília, DF. 2013. 299 p. Disponível em:<www.cnt.org.br>. Acesso em: 28 abr. 2022.

[10] CORREA, M. de A. Desenvolvimento de Indicadores de Sustentabilidade para a Gestão de Recursos Hídricos na UGRHI Tietê-Jacaré (SP). **Dissertação** (mestrado). Centro de Ciências Exatas e de Tecnologia. Programa de Pós-Graduação em Engenharia Urbana. Universidade Federal de São Carlos. São Carlos, 2009.

[11] FARIA, S. F. S. **Transporte Aquaviário e a modernização dos portos**. São Paulo: Aduaneiras, 2010.

[12] FERREIRA, Márcio Antônio Couto. TRANSPORTE FLUVIAL POR EMBARCAÇÕES MISTAS NO AMAZONAS: uma análise do trecho Manaus-Coari e Manaus-Parintins. **Tese** (Doutorado em Ciências do Ambiente e Sustentabilidade da Amazônia) Universidade Federal do Amazonas,2016.

[13] LAZARATOS, George. ***The definition oh ship in international Law Revue Hellénique de Droit International****, 2009*.

[14] LINO, G. L.; CARRASCO, L.; COSTA, N. **A hora das hidrovias**: estradas para o futuro do Brasil. Rio de Janeiro: Capax Dei, 2008.

[15] LOUREIRO, A. J. S. **História da navegação no Amazonas**. Manaus: Gráfica Lorena Ltda., 2007.

[16] MACHADO, Waltair Vieira. **Construção Naval no Amazonas**: proposições para o mercado. Manaus, [2014]. 15 f. Disponível em: <portal2.tcu.gov.br/portal/pls/portal/docs/2307474.PDF>. Acesso em: 12 mai. 2022.

[17] MEDEIROS, Juliana Terezinha da Silva. O transporte fluvial e o direito à dignidade da pessoa humana na Amazônia, 2012. **Dissertação** (Mestrado em Direito Ambiental) - Universidade do Estado do Amazonas, Manaus, 2012.

[18] SANTOS, Marina Gonzalez Ferreira dos. **Análise de acidentes com embarcações em águas sob jurisdição brasileira – uma abordagem preventiva**, 2013.

[19] SILVA JÚNIOR, M. A. Diretrizes para Projetos de Terminais Hidroviários Urbanos de Passageiros. **Dissertação de Mestrado**. Instituto Militar de Engenharia do Rio de Janeiro. Rio de Janeiro, 2009.