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Prototype of Oily Water Separator (OWS) system on the ship using Outseal PLC

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ABSTRACT

Maritime transportation carries high risks of marine accidents, both while underway and at anchor, impacting the safety of crew, cargo, passengers, and the marine environment. Marine pollution, particularly from shipborne liquid waste, is a global concern with IMO standards requiring that liquid waste discharge must be below 15 ppm. Currently, oil-water separation on ships is performed manually, which is prone to human error and suboptimal equipment effectiveness. This study aims to develop an oil-water separation system on ships using outseal PLC as the central control unit. The system involves determining the water quality and turbidity values before starting the separation process. The process begins with filling waste liquid into the processing tank based on turbidity sensor readings. If the turbidity meets the desired value, the process continues with transferring to the final tank and monitoring water quality using a TDS sensor. If the water quality meets the standard (<15 ppm), disposal occurs; otherwise, the separation process continues until the criteria are met. Testing reveals that the system has an average error rate of 26.93% with an accuracy of 73.07%, while the TDS sensor measurements have an average error rate of 104.76% and an accuracy of 4.76%.

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1. INTRODUCTION

Technological advances in the era of the industrial revolution 4.0 have triggered the use of modern technology to help human work. In the era of the industrial revolution 4.0, it has had a very big impact on all aspects of human life, one of which is the use of automation tools that are increasingly widespread in various fields, such as transportation [1],[2]. Geographically, Indonesia is an archipelagic country consisting of 17,000 islands. As an archipelagic country, it is undeniable that Indonesia needs a shipping network as an instrument for the traffic of people and goods, as well as facilitating interaction among the community [3]. Shipping is a transportation that has a high risk of sea accidents, both when the ship is sailing and when the ship is anchored. The field of shipping safety includes the safety of the crew, cargo, passengers and marine environmental pollution [4],[5]. Marine environmental pollution is an environmental issue that can be of concern to all international media. Marine environmental pollution has consequences that have a very big impact on all aspects of life at sea and on land and is a part that will disrupt the availability of natural resources for the country itself and for other countries, so in dealing with marine pollution, special treatment is needed in its accountability efforts [6],[7].

According to IMO (International Maritime Organization), the requirement for the consequences of liquid waste to be disposed of is below 15 ppm (parts per million). Oil spills from ships occur from many places, especially engine oil, engine rooms, and fuel line leaks. Liquid waste is commonly called oily bilge fluid or water [8]. OWS (Oily Water Separator) is an auxiliary machine on board a ship that functions as a filter and separator of liquid waste, until the separation mechanism reaches 15ppm. If the concentration of liquid waste shows 15ppm, the liquid waste can be disposed of into the marine environment, but if the concentration of liquid waste exceeds the limit of 15ppm, it will be collected in a sludge tank [9]. The way OWS works is by utilizing gravity, which does not affect each other because of the difference in density, where the density of water is greater than the density of oil so that when the separation process occurs, the water will be at the bottom and the oil will be at the top [10]-[15]. However, in working OWS has several obstacles, one of which is the OWS control system which is still manual, making its performance less effective and efficient. So that the control requires PLC (Programmable Logic Controller) control that can make OWS semi or fully autonomously controlled [16]. The development of the PLC control system is very rapid as evidenced by the existence of Outseal PLC [17]-[20]. Outseal PLC is a work of the nation's children in the form of a PLC based on the Arduino board. Outseal PLC has hardware that is very open to the public, which can study its electronic circuits freely. Outseal PLC uses visual programming (ladder diagram), on Outseal PLC hardware this is called Outseal PLC Shield [21].

In previous research, there are still some shortcomings of each oily water separator system that was made late using the Arduino Mega2560 microcontroller, which is quite difficult to apply above because the program is not simple. By implementing Outseal PLC with communication with Outseal Studio, it increases the working frequency, efficiency, and other advantages so that the oily water separator system can be controlled fully automatically. Click or tap here to enter text. On the other hand, oily water separator technology can minimize marine environmental pollution by ships with liquid waste on board being separated between water and oil before being discharged into the sea. Therefore, the author wants to create an oily water separator system using the Outseal PLC microcontroller Click or tap here to enter text.

2. METHOD

The research method used for testing in order to collect data from the tool experiment using the experimental method. The design of the tool is intended as a determination of the components of a tool to be made, so that the final result will be obtained as expected. The design also simplifies the process of making the tool. Based on Figure 1, there are several blocks that have various functions, here is an explanation of each block diagram: 1) Outseal PLC functions as a microcontroller that will receive data from the input block to the output, 2) TDS sensor is a sensor that detects water quality in the results tank before being discharged into the sea, 3) Turbidity sensor is a sensor that detects water turbidity in the process tank before the sample is flowed into the process tank, 4) Water level sensor functions to detect water level in the waste storage tank, 5) Water pump functions as a tool that pushes samples from the liquid waste storage tank to the process tank, 7) Solenoid valve as a water valve that functions to open or close the flow of water or liquid waste, 8) 12V indicator light functions to indicate that the device is functioning or ready to function. 9) 12VDC power supply functions to convert 220 volt AC voltage to 12 Volt DC voltage as the input voltage of the outseal PLC 10) 12V relay functions as a switch between 12V input and output such as water pumps, solenoid valves and indicator lights.

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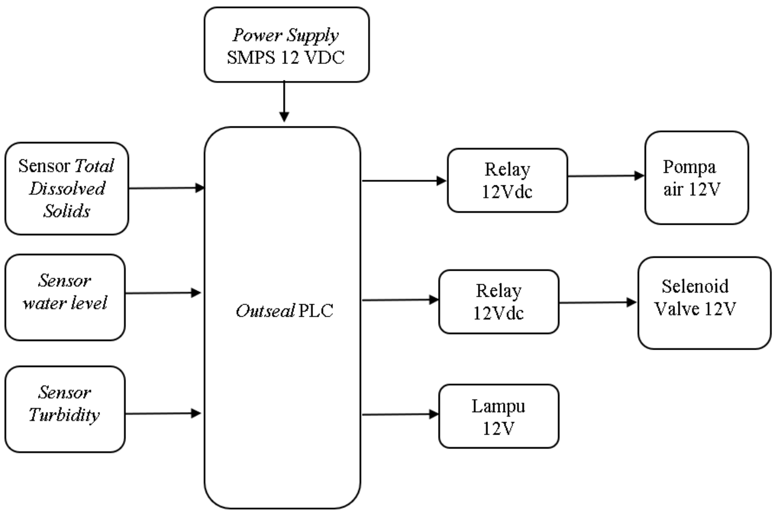

Figure 1. Block Diagram

All components are assembled according to the designed shape and size. The size used in the locker is 400 mm x 340 mm will be shown in Figure 2 below. Explanation of the components used for the oily water separator system, namely 1) Ship waste container, 2) 12V water pump, 3) Oil storage tank, 4) Water level sensor, 5) Tubidity sensor, 6) ½ pipe, 7) 12V solenoid valve, 8) Process tank, 10) Operation panel, 11) Pilot lamp, 12) Push button, 13) TDS probe and 14) Sterile tank, as shown in Figure 2.

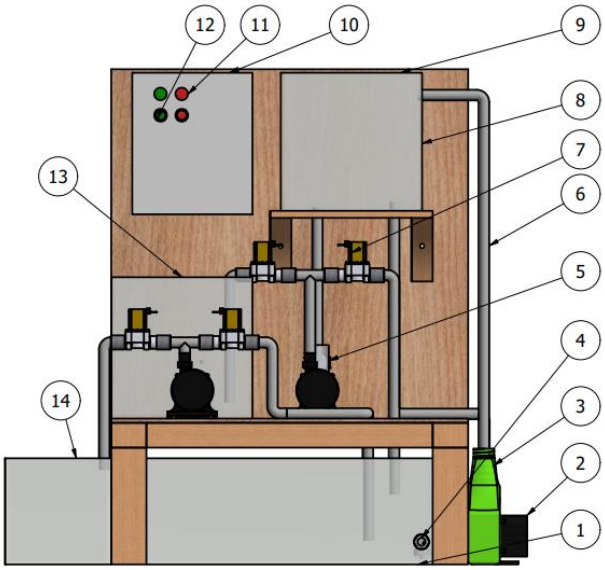

Figure 2. Design of oily water separator tool

After the locker frame and remote control are complete, the next step is to assemble the circuit using the Visio 2019 application. The circuit plays an important role in a moving object such as the tool in this study. In the process of assembling the electrical circuit on the oily water separator, a circuit image is required as shown in Figure 3 below.

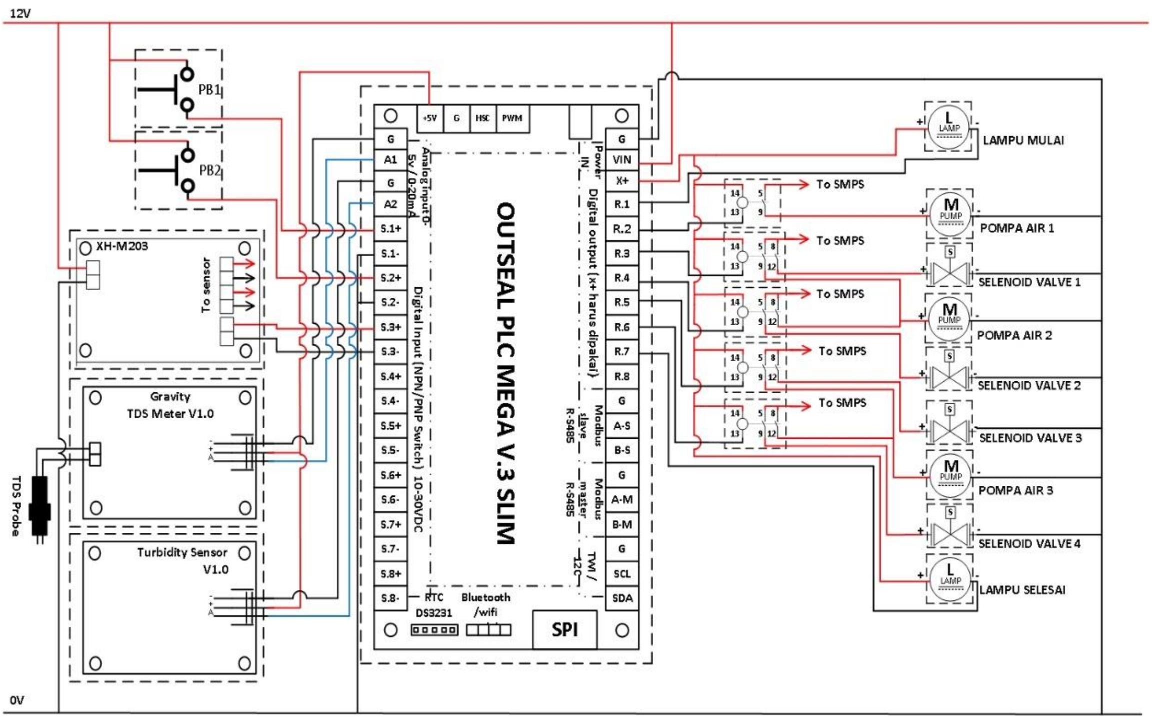

Figure 3. Electrical circuit in the oily water separator system

In order for the design of this final assignment to run well, an oily water separator flowchart is required, which is shown in Figure 4.

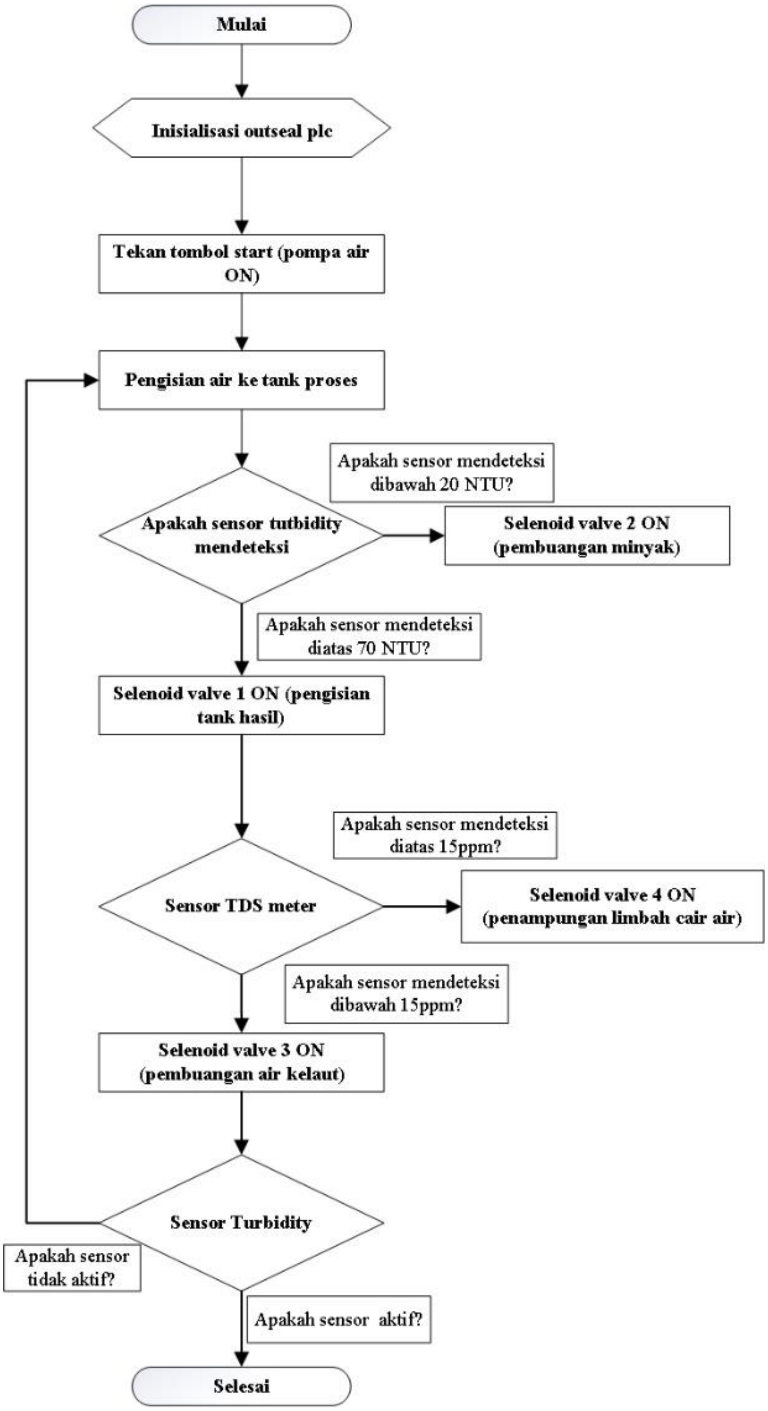

Figure 4. Transmitter Flowchart

3. RESULTS AND DISCUSSION

The results of this test will be used as a benchmark for the success of the system performance of the tool, and the performance of the tool will be analyzed based on the test results to draw conclusions regarding the effectiveness and efficiency achieved in this final task. The oily water separator that has been made in such a way according to the design can be seen in Figure 5 below.

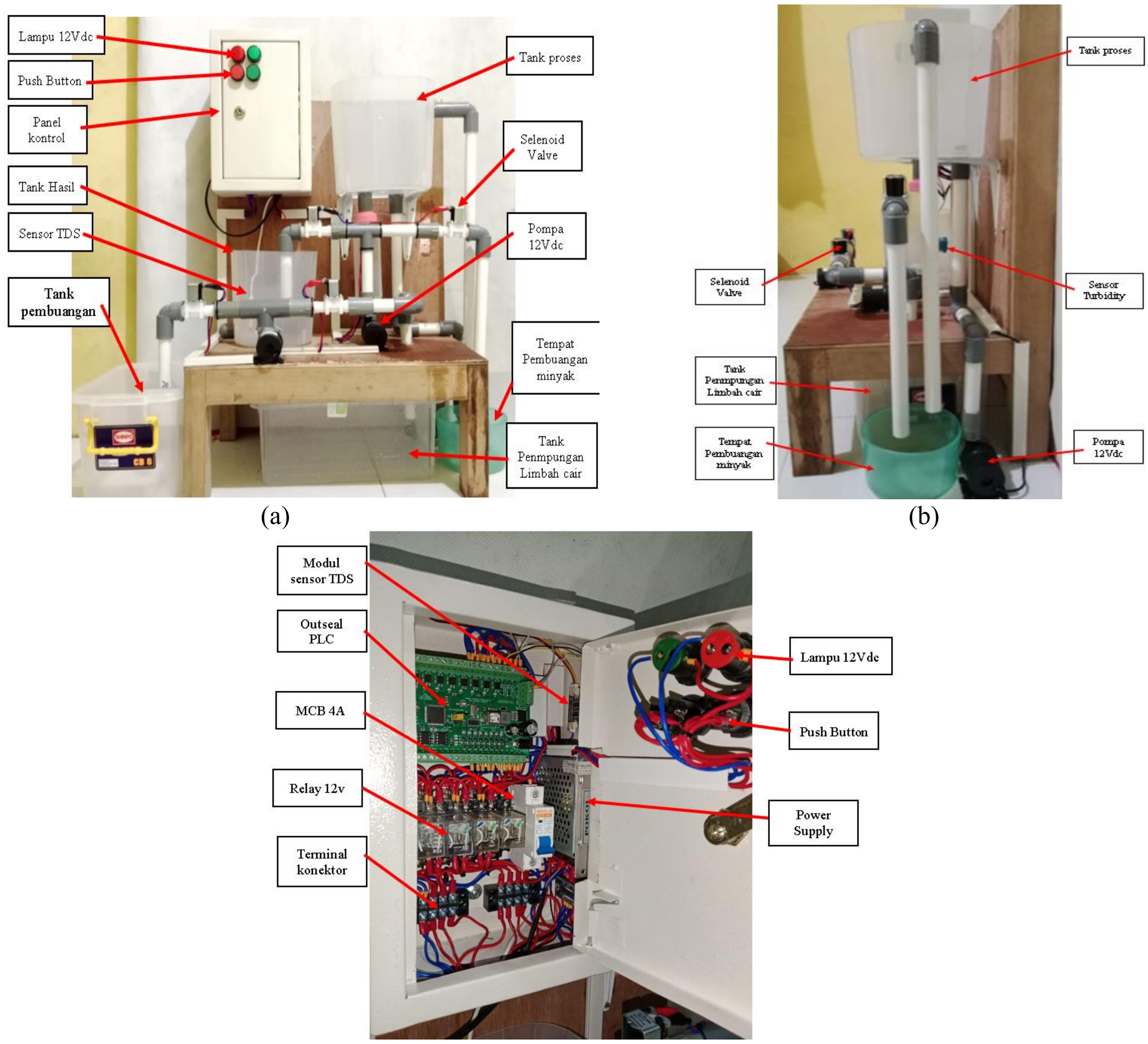

Figure 5. Mechanical results on OWS. a) Front view, b) Side view, c) OWS control panel

From the results of several tests such as testing the TDS sensor, turbidity sensor, water pump, water level sensor, solenoid valve and power supply, then the overall tool testing was carried out, namely by running the oily water separator which was made by taking several tests which can be seen in the table below.

Table 1. Results of turbidity sensor testing on the oily water separator

No	Sample (liter)		Turbidity (NTU)	Enter, Go, Storage		Presentation of success (%)
	Water	Oil		Selenoid 1	Selenoid 2	
1	8	0.5	170	V		100
2	7.5	1	156	V		100
3	7	1.5	133	V		100

Table 2. Results of testing the Total Dissolved Solids sensor on the oily water separator

No	Sample (liter)		Sample (liter)	Enter, Go, Storage		Presentation of success (%)
	Water	Water		Selenoid 3	Selenoid 4	
1	8	0.5	8	V		100
2	7.5	1	10	V		100
3	7	1.5	9	V		100

Table 3. Results of OWS performance testing using the TDS-3 meter

No	Separated Water Yield (liters)	TDS-3 Meter Value	TDS Sensor Value	Error (%)	Caption
1	7,4	6	8	33,33	More
2	6,9	7	10	42,86	More
3	6,2	7	9	28,57	More

4. CONCLUSION

Based on the research of the prototype oily water separator (OWS) on the ship using Outseal PLC, it was concluded that the system worked quite well. From this experiment, the results of the water separated by OWS were obtained with an average error of 26.93% with an accuracy level of 73.07%. Testing the water value obtained with ppm units using the TDS-3 tool and TDS sensor with an average error of 104.76% for an accuracy level of 4.76%. This is in accordance with the target to be achieved so that at the time of separation more accurate results are obtained. The results of the program were also obtained in accordance with the performance of each desired component. Based on this study, there are still shortcomings where there is still an error from the results of the separation of water and oil of 26.93%.

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