Designing IoT-Based Brackish Water Desalination Equipment to Meet Drinking Water Needs in Coastal Areas

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Abstrak

Water is one of the main sources that are very important for the needs of living beings. Water that has too high salinity can cause harm if used for certain activities, for example, it is harmful to health when used as drinking water, causing crop failure for agriculture, corrosion of equipment and buildings made of metal elements. The process of treating brackish water into fresh water is known as desalination. Brackish water treatment can also be done by filtration method. Based on the above background to avoid risks that occur in the use of brackish water in daily life that does not meet the standards of clean water that is safe to use in general and always ensures that the water is still suitable for use, this study designed and built a solenoid valve control system as an automatic valve used for the desalination of ready-to-drink brackish water that is safe and suitable for use in daily life and also has access to monitoring uses the internet of things (IoT) in its operation, so that it can be optimal in monitoring the pH of water and tds in the water as well as the water capacity in the water tank storage in real time by using Arduino uno as a data processor and the esp8266 wifi module for a connection to the internet that will send data to the blynk application. In the design of this device, several sensors were used, such as: pH sensor, tds sensor, and ultrasonic sensor so that it has three outputs, namely water tank storage capacity, water tds value, and water pH placed in the water tank storage to determine the value of the final result in the process of processing brackish water into ready-to-drink water in this study. The results of the work test of this brackish water desalination control system succeeded in removing the color and odor in the water and were able to change the pH level in brackish water from 8.7 pH to 6.43 pH, but the filtered water still tasted salty, so this research still needs to be continued to achieve the standard of drinking water content.

Keywords: *Arduino Uno; Solenoid Valve; Reverse Osmosis; IoT*

I. INTRODUCTION

Water is one of the main sources that are very important for the needs of living beings, both humans, animals and, plant In daily life water is needed for needs such as washing, bathing, cooking, drinking and others, so we cannot be separated from water [1]. Based on BPS data in 2018, Indonesia's population living in rural and coastal areas reached 63.47% (167.6 million people) of Indonesia's 264 million population. The main problem faced by residents who live on the coast is the availability of clean water. This is due to the high level of water salinity in the area. Water that has too high salinity is harmful to health when used as drinking water. If a liter of water contains 0.5 – 30 grm of salt, it is called brackish water, but if the concentration of salt exceeds 30 grm in a liter of water, it is called salt water [2]. Brackish water is water that has a salinity between 0.5 ppt and 17 ppt. In comparison, freshwater has a salinity of less than 0.5 ppt and drinking water has a maximum of 0.2 ppt. Brackish water contains relatively high sodium and chloride as well as Ca and Mg which cause salinity.

Brackish water is one of the water sources that cannot be used by humans directly for daily need, it is necessary to treat it first to reduce the amount of minerals or salt content [3]. One of the important factors in determining the feasibility of water for human consumption is the TDS (total dissolved solid) content in the water. TDS is the amount of dissolved solids in the form of organic ions, compounds, and colloids in water. The concentration of TDS in drinking water exceeding the permissible threshold limit can be harmful to health because it can cause kidney disorders. According to WHO (World Health Organization), drinking water that is suitable for consumption has a TDS level of < 300 ppm (parts per million). Meanwhile, according to the Regulation of the Minister of Health of the Republic of Indonesia number 492 of 2010, the maximum allowable TDS standard is 500 mg/liter or 500 ppm [4].

In addition, the level of acidity (pH) is also an important indicator for water before consumption, this is because high and low pH values will affect the taste of the water consumed.

According to PERMENKES No. 416 of 1990, the maximum permissible level of Fe in clean water is 1 mg/l, with the pH limit of drinkable water being 6.5 - 8.5, with a maximum hardness figure of 500 mg/l [5].

Related to the description above, Lubuk Saban is a village located in the coastal highlands of the Malacca Strait, with an altitude of 50 meters above sea level and an average temperature of around 28 -30° C with an average rainfall of 1,800 – 2,000 mm/year. Administratively, Lubuk Saban Village is one of 12 villages in the Pantai Cermin District, Serdang Bedagai Regency that uses brackish water to meet water needs every day. This is because the topography of the area is difficult to obtain fresh water. This is the basis for the application of brackish water desalination technology in this study.

The purpose of this research is to produce a brackish water desalination device, which is equipped with an IoT-based monitoring system to determine current, voltage, power, TDS value and pH in real time, so that users can monitor through smart phones only.

II. LITERATURE REVIEW

A comparison of conventional desalination technology with solar-based desalination was developed to integrate solar thermal desalination into existing network infrastructure in Australia [6]. This is also in line with research on small- to medium-scale solar desalination plants that are in the price range of US$ 0.2–22/m3, much higher than conventional fossil fuel-based plants. However, the estimated low water cost (US$ 0.9 – 2.2/m3) for large-scale solar power plants suggests that solar-based alternatives will potentially become feasible in the future [7].

Research related to the water purification process using solar heat devices continues to be developed, namely using flat plate collectors (solar water heaters) and TiO2-based solar photocatalytic detoxification systems to improve water quality. The observations made are the reduction of iron, nitrates, arsenic, chlorine and BOD (Biological Oxygen Demand) due to the heating and photocatalytic detoxification of water, with feasible recommendations for river water purification [8]. Then the design of a solar-based water purification system using a cartridge heater to produce drinking water in flood-affected areas or remote areas, using a distillation technique with automatic valves that fill the tank and heat the water. Then the steam is captured and flowed to the clean water reservoir [9]. Furthermore, the development of a solar-powered desalinator to produce pure water, where the maximum surface temperature on a stainless steel absorber is around 80 °C with a flow rate of 8.3 x 10-5L/second capable of producing 1.9 L per day [10].

Research related to water purification continues to be carried out through the design and modeling of solar-based portable Reverse Osmosis (RO) desalination plants using stand-alone PV systems with battery storage [11]. Followed by a techno-economic feasibility study of a solar-based desalination system through an RO system for a factory capacity of 500 L/hour, producing 60% of the total salt absorbed and 40% of the brine [12].

An experimental approach based on solar-based electrocoagulation with a filtration mechanism was developed into a new approach concept for turbid water treatment [13][14]. Dual-slope solar-based water purification combined with tube collectors has a significant impact on the reduction of salinity levels [15], the research is also supported by research [16].

Furthermore, a review of the role of solar disinfection in water treatment applications through different water treatment approaches including physical, chemical, and biological as well as the mechanism of inactivation of aquatic pathogens including bacteria, viruses, and even protozoa and fungi known as solar water disinfection has been carried out by the [17]. Membrane-based water purification technology was developed to produce a flexible method to obtain a high water filtration rate but low energy consumption. The main advantage of using membranes is that the energy needed to carry out the filtration process can be obtained from the sun/wind that uses "green energy" [18]. Membrane-based water purification techniques using solar power can be a viable solution to be used in semi-arid and arid areas, taking into account the basic concepts of specific energy consumption, water production costs, and applications of solar-based water purification technologies such as reverse osmosis, advanced osmosis, electrodialysis, membrane distillation, and hybrid membrane systems [19].

Treatment of artetic groundwater into potable water using ultrafiltration and reverse osmosis technology, with stages in the treatment of borewell water into clean water by coagulation, flocculation, sedimentation, filtration, decolorization, neutralization, and disinfection. From this study, it was concluded that from testing the water quality of the drilled well with a TDS level of 796 and a pH level of 7.21 and the output of the RO machine, the level of TDS was 332 and the pH level was 6.81. From the results obtained, the RO machine's process water is suitable for consumption because the TDS level is still below 500 in accordance with the national drinking water standard [20].

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III. RESEARCH METHODS

3.1 Research Location

This research was conducted in Lubuk Saban Village, Pantai Cermin District, Serdang Bedagai Regency. This location was chosen based on data on areas that use brackish water to meet daily needs.

3.2 Research Tools and Materials

The success of a research depends on the selection of the right materials to obtain quality research results. The following is a description of the research materials: water reservoirs, water pumps, solar panels, solar charger controllers, batteries, inverters, sand filter tubes, iron manganese filter tubes, carbon filter tubes, ultraviolet sterilizer cartridges, arduino, relays, sensors, panel boxes, monitoring systems, wood frame construction, piping, and other supporting equipment.

3.3 Research Implementation

3.3.1 Research Procedure

This brackish water desalination system has 3 stages, namely:

1. The first stage is to design and install solar panels as an energy source in the desalination process.
2. The second stage, the design and installation of the desalination system starting from the reactor tank pump, RO, filter with 3 (three) stages, the first is a sand filter tube, the second is an iron manganese filter tube, the third is a carbon filter tube and a cartidge filter. At the end is the water sterilization system, and testing.
3. The third stage is the design of an IoT-based control and monitoring system, both the provision of electrical energy and water quality standard standards for the TDS and pH values of water. The measurement parameters that will be detected include: voltage, current and output power, TDS value and water pH. This innovation is carried out so that the device can be monitored by users wherever they are.

3.3.2 Hardware Design

The materials used in this research are:

1. MCB is a safety when there is an overload and limits the electric current.
2. Power Supply is a rectifier circuit to change the voltage of 220V AC so that it produces an output voltage of 12V DC as a voltage source for other components that use DC voltage.
3. The LM2596 Stepdown module plays a role in lowering the voltage at 5V to make it more stable to be a voltage source for the microcontroller.
4. Arduino Uno is a microcontroller interface used to configure the entire brackish water desalination control system, precisely the configuration of the ultrasonic sensor that provides a signal to the relay to open and close the solenoid valve.
5. The Wifi module ESP8266 is an Arduino-like microcontroller add-on device that can be connected directly to wifi.
6. The 12v 2 channel Relay module is a relay component that is used as an automatic switching to open and close the solenoid valve.
7. Solenoid Valve 12V DC is a valve that can open and close the flow of water automatically.
8. The HC-SR04 Ultrasonic Sensor is a proximity sensor used to measure the water capacity of a water tank without touching.
9. pH sensor is a sensor to express the acidity and alkaline level of a solution.
10. A TDS sensor is a sensor whose output shows how many milligrams of dissolved solids are dissolved in a liter of water. In this study, the TDS sensor was used to measure the salt content in the water.
11. Filter media containing: cation resin, anion resin, zeolite sand, activated carbon, and gravel is a filtration system used to lower salt and tds levels in water before flowing to reverse osmosis.
12. Reverse osmosis is a water purification system using a membrane with pores of 0.0001 microns, with such a small density, reverse osmosis membrane is able to filter protozoa, bacteria, viruses, chemical contaminants and various heavy metals that are generally present in water.
13. The 16x2 LCD module is a visual text output component used to display the water capacity and output values of pH sensors and TDS sensors.
14. I2 DC LCD Module is a two-way serial communication standard using two channels specifically designed to send and receive data.

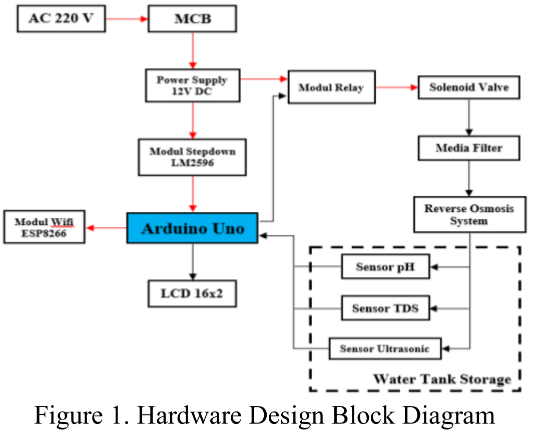

Figure 1. Hardware Design Block Diagram

The 220V AC voltage that is the source of voltage in the study comes from this solar panel connected to the MCB which serves as a safety when there is an overload and also as a switch to turn the system on and off. Power Supply as a voltage converter from 220V AC to 12V DC is connected to the LM2596 Stepdown Module to reduce the voltage of 12V DC from the Power Supply to 5V DC so that it is more stable and safe to use as an Arduino Uno input voltage. The Relay module acts as an automatic switch that can be controlled by Arduino to change the position of the Solenoid Valve from Normally Close to Normally Open. Solenoid Valve is an automatic valve that will be controlled in this study so that it can drain brackish water in the reservoir to be filtered through multi-media filters, the filtration results will be flowed by the reverse osmosis pump to the filters in the reverse osmosis machine, namely 5µ sediment filter, 1µ sediment filter, activated carbon block filter, mineral filter, Post Carbon Filter, Membrane Reverse Osmosis and Ultra-Violet Water Sterilizer Filter. The filtered water will be stored in a clean water storage tank to measure the water level, pH value and TDS value in the water. The ultrasonic sensor will measure the water level in the clean water storage tank if the water level is measured 10cm from the distance of the ultrasonic sensor, then the Arduino will instruct the relay to close the solenoid valve so that the water flow in the reservoir stops. The measurement results on the sensor will be processed by Arduino to be displayed on the 16x2 LCD and the measurement results can be monitored in real time through the Blynk application using a smartphone.

3.3.3 Software Design

To build this brackish water desalination control system, supporting software is also needed to support the work of the hardware. Some of these software are as follows:

1. The Arduino IDE application, is a software used to run and read the Programming Language on Arduino using the C Language.
2. The Windows operating system used to run other software in creating brackish water desalination control systems.
3. Sketchup app to create a whole design design tool.

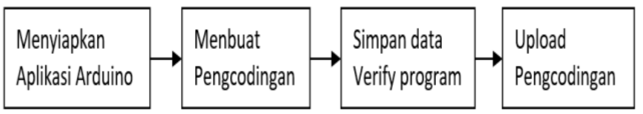

Figure 2. Software Designing Block Diagram

In software design, the first step that must be prepared is to install the Arduino IDE software so that the program for this control system can be created, after the program is finished it can be saved and verified to find out if the program that has been created is not an error and can be used, and the last step is to upload the program to Arduino so that it can be tested whether the program made is appropriate as it should be.

3.3.4 Overall Tool Design

The description for all the systems implemented is shown by figure 3, namely: water pump machine (1), underground water well (2), water reservoir (3), solenoid valve (4), artificial filter media, cation resin(5.1); anion resin(5.2); zeolite sand (5.3); activated carbon (5.4); gravel (5.5), filtered water reservoirs (6), reverse osmosis (7): Sediment filter (7.1); Carbon filter (7.2); carbon filter (7.3); and post carbon filters (7.4), water tank storage(8), ultrasonic sensors (9), pH meter probes (10), TDS probes (11), panels (12), solar panels (26).

Figure 3. Brackish Water Desalination System

The voltage source of this brackish water desalination system comes from a solar panel connected to the MCB as a safety as well as an on/off switch. The Power Supply is used as a voltage stabilizer for the Arduino Uno input. The Relay module acts as an automatic switch to change the position of the solenoid valve from NO to NC to control the flow of brackish water in the reservoir to be filtered through a multi-media filter. Hasil filtrasi akan dialirkan oleh pompa reverse osmosis menuju filter sediment 5µ, filter sediment 1µ, filter block activated carbon, filter mineral, post carbon filter, membrane reverse osmosis dan filter ultra-violet water sterilizer. The filtered water will be stored in a clean water storage tank to measure the pH and TDS values in the water. If the water level is measured 10 cm from the distance of the ultrasonic sensor, Arduino will instruct the relay to close the solenoid valve so that the flow of water in the reservoir is stopped.

The measurement results on the sensor will be processed by Arduino to be displayed on a 16x2 LCD and the measurement results can be monitored in real time through the Blynk application using a smartphone. The entire control system can be seen in figure 4.

Figure 4. Overall Network Design

Description of picture 4:
Mini Circuit Breaker (13), power supply (14), step down module (15), arduino uno (16), 2 channel relay module(17), esp8266 wifi module(18), TDS sensor module (19), pH sensor module (20), IC module (21), 16x2 lcd (22), resistor(23), green indicator light (24), off indicator light (red) (25).

3.3.5 IoT Design

The design uses Arduino IDE software as a software to create a program or coding system from a brackish water desalination control device. The coding stages are:

1. The first step is to prepare the Arduino IDE software on a laptop or computer and click the icon of the Arduino IDE application wait for loading until you see the display shape as shown in figure 5.

Figure 5. Arduino Initial Loading Display

2. Then you can see the Arduino IDE sketch display

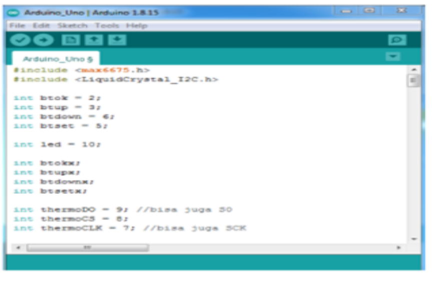

Figure 6. Sketch Arduino IDE

3. The second step is before uploading the program to Arduino Uno to make the necessary device settings and type the program according to what you want to create. Manage the selection of Arduino boards used in the software according to the Arduino Uno device, then set the USB port that will be used by the display form device such as figure 5 and figure 6.

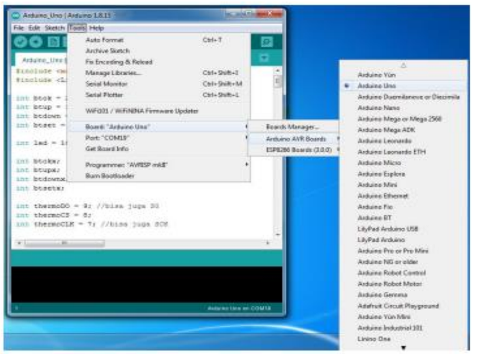

Figure 7. AU Board Settings Display

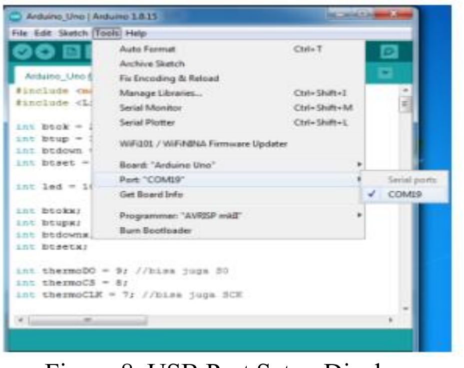

Figure 8. USB Port Setup Display

4. The third step is to set the selection of the "Arduino as ISP" programmer used by the device as shown in figure 9.

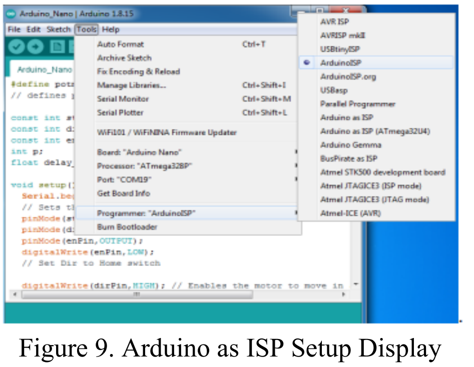

Figure 9. Arduino as ISP Setup Display

The fourth step, which is to verify or compile, aims to check whether the program code that has been entered is correct or still incorrect. If an error occurs, a warning will appear marked in yellow on the Arduino IDE and if it is correct, the message "Done compiling" will appear.

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Figure 10. Program Code Verification View

The last step is to upload the program from the Arduino IDE to the Arduino Board. To upload a program, just click and Upload and wait for Done Uploading to appear as shown in figure 11.

Figure 11. View Done Uploading

IV. RESULTS AND DISCUSSION

4.1 Brackish Moisture Measurement Testing

After designing the circuit according to the schematic described earlier, the design and construction of the brackish water desalination control system can be made according to the plan where the solenoid valve as an automatic valve will be controlled to flow and close the flow of water in the reservoir automatically and monitor the measurement results in the form of pH values, TDS values and water level levels in real time using the Blynk application via smartphones.

In the test that has been carried out using brackish water in the 18000 Mangrove Tree Conservation Area of Labu Beach, the brackish water is taken to be used as a water source to be filtered in this study. The following are the results of the measurements made.

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Table 1. Brackish Water Measurement Results Data

Water Alkaline (pH)	Total Dissolved Solid (ppm)
8,77	198

From the results of the measurements that have been carried out, it was found that the pH value in brackish water which is the main source of water to be filtered in this study contains a pH value of 8.77 and the amount of dissolved solids solution is 198 ppm. The results of the measurement have exceeded the safe limit where according to PERMENKES No. 416 of 1990, the pH limit of drinking water is between 6.5 - 8.5, therefore the brackish water must be filtered first.

4.2 Filtered Water Test Results

After testing the equipment, it was found that the results were brackish water sources from the 18000 Mangrove Tree Conversion Area after being filtered through multi-media filters in the form of cation resins, anion resins, activated carbon, zeolite sand, silica sand, and gravel had succeeded in removing color and odor in the water, and succeeded in lowering the pH level, but the filtered water still tasted salty.

4.2.1 First Testing

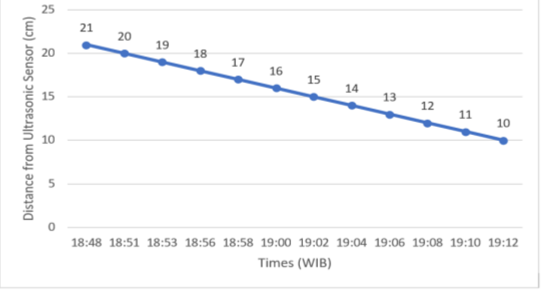
In the first test, it was carried out by fully opening the ball valve at the reservoir output so that the water discharge that flows through the filter media is not filtered optimally, and the water filtration results still taste very salty.

In the first test, data was found in the form of measurement results. The test is carried out by operating the tool and then paying attention to the performance of each component of the Ultrasonic sensor, pH sensor, and TDS sensor.

Table 2. Data of the First Test Measurement Results

Times (WIB)	Water Distance from Ultrasonic Sensor (cm)	Water Alkaline (pH)	Total Dissolved Solid (ppm)
18:48	21	7,58	250
18:51	20	7,78	250
18:53	19	7,43	250
18:56	18	7,18	248
18:58	17	6,89	244
19:00	16	6,00	244
19:02	15	6,55	244
19:04	14	6,42	243
19:06	13	6,18	243
19:08	12	6,64	244
19:10	11	6,74	243
19:12	10	6,82	244

Data collection using sensors can be seen in table 2 which aims to determine the performance of the monitoring system that is made to work properly, from the pH and TDS measurement values in the first test can be calculated the average values are 6.85 pH and 245.58 ppm. The results of measurements in the first test have succeeded in changing the pH and TDS levels in brackish water to a better and safer limit.



Gambar 12. Grafik Jarak air dari sensor Ultrasonic pada pengujian pertama

Figure 12 shows the change in the time it takes for the device to fill the water storage container that has been filtered by reverse osmosis in the first test and information is obtained in the form of the time needed to fill the clean water storage tank from empty to full is 24 minutes.

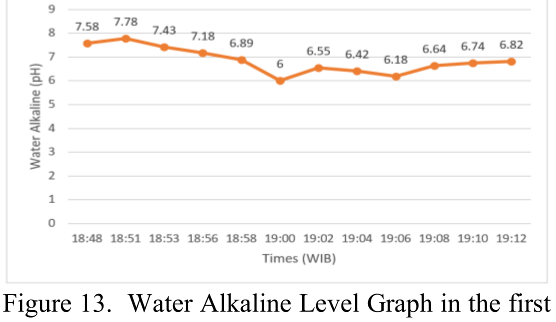


Figure 13. Water Alkaline Level Graph in the first test

Figure 13, shows the change in the alkaline level of water that has been filtered by reverse osmosis in the first test and some information is obtained in the form of:

1. The highest pH value was found at 18:51 with a value of 7.78 pH.
2. The lowest pH value is found at 19:00 with a value of 6 pH.
3. The average pH value of the water that has been filtered in the first test is 6.85 pH.

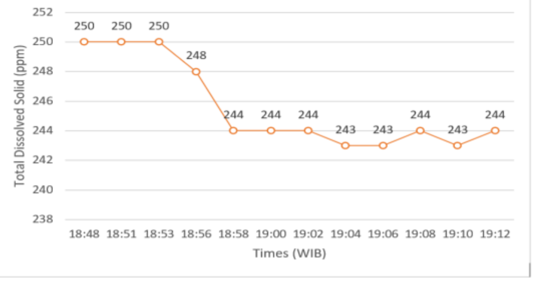


Figure 14. Graph of Total Dissolved Solids in the first test

Figure 14, shows the change in the amount of solute solids in the water that has been filtered by reverse osmosis in the first test and some information is obtained in the form of:

1. The highest TDS values are found at 18:48, 18:51 and 18:53 with a value of 250 ppm.
2. The lowest TDS values were found at 19:04, 19:06 and 19:10 with a value of 243 ppm.
3. The average TDS value of the water that has been filtered in the first test is 245.58 ppm.

4.2.2 Second Testing

In the second test, it was carried out by opening half a ball valve so that the water discharge that flows through the filter media is filtered for longer so as to maximize the filtration process, and the salt content in the water feels reduced but the water still tastes quite salty.

The data collection seen using a measuring tool can be seen in table 3 which aims to determine the performance of the monitoring system that is made to work well, from the pH and TDS measurement values in the first test can be calculated the average values are 6.76 pH and 245.41 ppm. The measurement results in the second test have succeeded in changing the pH and TDS levels in brackish water to be better than the first test, by opening half a ball valve so that the water discharge flowing through the filter media is filtered for longer so as to maximize the filtration process.

Table 3. Second Test Measurement Results Data

Times (WIB)	Water Distance from Ultrasonic Sensor (cm)	Water Alkaline (pH)	Total Dissolved Solid (ppm)
13:35	21	7,20	250
13:38	20	7,38	248
13:42	19	7,23	248
13:46	18	7,07	247
13:50	17	6,88	245
13:55	16	6,56	244
13:59	15	6,45	244
14:04	14	6,60	243
14:08	13	6,47	245
14:13	12	6,51	244

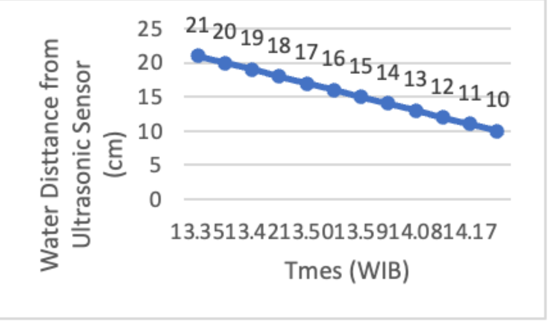


Figure 15. Water Distance Graph from the Ultrasonic Sensor in the second test

Figure 15, shows the change in the time it takes for the device to fill the water storage container that has been filtered by reverse osmosis in the second test and information is obtained in the form of the time needed to fill the clean water storage tank from empty to full is 46 minutes.

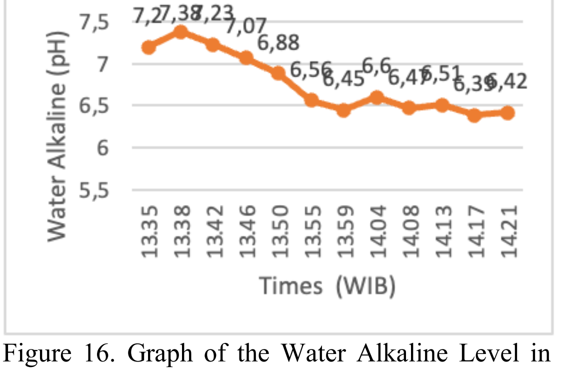


Figure 16. Graph of the Water Alkaline Level in the second test

Figure 3.16, above is a graph showing the change in the alkaline level of water that has been filtered by reverse osmosis in the second test and information is obtained in the form of:

1. The highest pH value was found at 13.38 with a value of 7.38 pH.
2. The lowest pH value was found at 14.17 with a value of 6.39 pH.
3. The average pH value of the water that has been filtered in the second test is 6.76 pH.

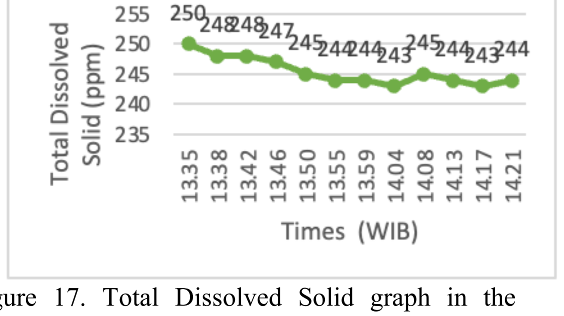
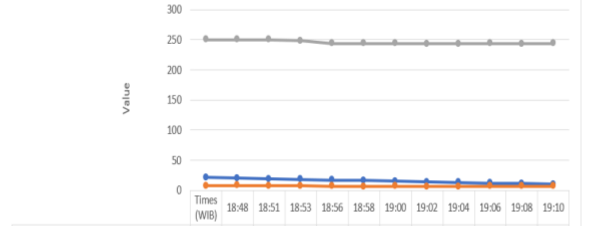


Figure 17. Total Dissolved Solid graph in the second test

Furthermore, figure 17, is a graph that shows the change in the amount of dissolved solids in water that has been filtered by reverse osmosis in the second test and information is obtained in the form of:

1. The highest TDS value was found at 13.35 with a value of 250 ppm.
2. The lowest TDS values were found at 14.04 and 14.17 with a value of 243 ppm.
3. The average TDS value of the water that has been filtered in the second test is 245.41 ppm.



Times (WIB)	18:48	18:51	18:53	18:56	18:58	19:00	19:02	19:04	19:06	19:08	19:10
Water Distance from Ultrasonic Sensor (cm)	21	20	19	18	17	16	15	14	13	12	11	10
Water Alkaline (pH)	7.58	7.78	7.43	7.18	6.89	6	6.55	6.42	6.18	6.64	6.74	6.82
Total Dissolved Solid (ppm)	250	250	250	248	244	244	244	243	243	244	243	244

Figure 18 Performance Comparison Graph of Each First Test Sensor

Based on Figure 18, it is known that the performance between water distances from the ultrasonic sensor (cm) with blue stripes appears to decrease steadily from 21 cm to 10 cm over time, meaning that the water level rises upwards closer to the sensor (perhaps due to increased water or the container filling slowly). This indicates an increase in water volume or a change in water surface height during the test. Furthermore, the Water Alkaline (pH) with the Orange Line was detected at an initial pH value of 7.58 (neutral), briefly rose to 7.78, then decreased drastically to around 6.18, then rose again at the end of the test, This indicates a change in the direction of acidity (pH < 7), possibly due to the addition of acidic solutes, contamination, aeration processes or chemical reactions in the water. The existence of these fluctuations indicates that water conditions are chemically unstable. The gray line representing Total Dissolved Solids (TDS) is seen to drop slightly from 250 ppm to 243 ppm, meaning that the amount of solutes in water is relatively stable. A decrease of 7 ppm is relatively small, and tends to be insignificant in the environment. This indicates that the quality of the mineral or solute material remained consistent during the test period. From the first test data, it was concluded that the water level rises over time (an indication of increasing volume), while the pH of the water fluctuates, towards a little more acidity which needs to be observed when it comes to the quality of clean water.

TDS is relatively stable, indicating no drastic addition of solutes.

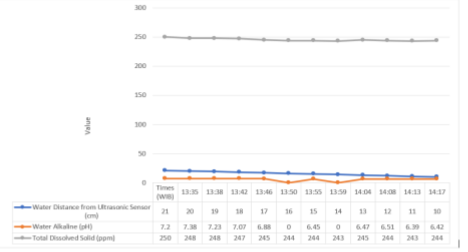
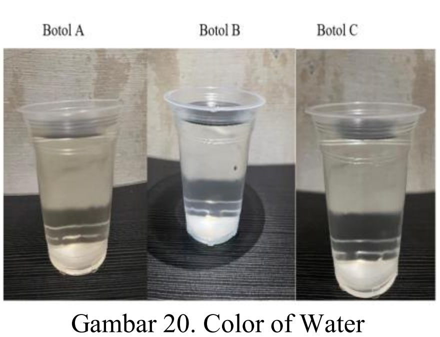


Figure 19 Performance Comparison Graph of Each Second Test Sensor

From the second test data in Figure 19, where the water distance from the ultrasonic sensor (cm) represented by the blue line shows that the distance decreases from 21 cm to 10 cm gradually, indicating that the water level is rising, possibly because the water increases over time. This is characterized by a smoother and more stable downward chart. Furthermore, the orange line representing Water Base (pH), the initial value of 7.20 (neutral), briefly rose to 7.38, then decreased slowly to around 6.39–6.42. The pattern is similar to Test I, where the pH becomes slightly more acidic. The pH drop was more consistent than Test I, showing that chemical reactions in the water occurred slowly and steadily. On the gray line representing Total Dissolved Solids (TDS) at the initial condition of 250 ppm, it drops slowly to 243–244 ppm. Just like the previous test, the decrease was so small that it did not show a significant change in the solute.

4..2.3 Test Results on Water Color

The results of the water filtration test for the color parameters are as follows:



Gambar 20. Color of Water

In water filtration testing, Bottle A is used to show the color of brackish water before undergoing the filtration process. Bottle B displays the color of brackish water after filtration using a combination of paralon and Reverse Osmosis systems, which successfully produces clear water with significantly reduced contaminants.

Whereas Bottle C shows the color of brackish water after passing through filtration with paralon without Reverse Osmosis, highlighting the difference in results between these two filtration methods. The evaluation of the change in water color from Bottle A to Bottles B and C provides a clear picture of the effectiveness of each filtration process in improving the quality of brackish water to be cleaner.

V. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusion

After the design, manufacture and testing process of IoT-based brackish water desalination monitoring equipment can be concluded as follows:

A brackish water desalination control system with internet of things based monitoring access has been successfully made where the Solenoid Valve is an automatic valve that will be controlled in this study so that it can drain brackish water in the reservoir to be filtered through multi media filters, the filtration results will be flowed by a reverse osmosis pump to the filters in the reverse osmosis machine, namely a 5µ sediment filter, 1µ Sediment Filter, Activated Carbon Block Filter, Mineral Filter, Post Carbon Filter, Membrane Reverse Osmosis and Ultra-Violet Water Sterilizer Filter. The filtered water will be stored in a clean water storage tank to measure the water level, pH value and TDS value in the water.
The ultrasonic sensor will measure the water level in the clean water storage tank if the water level is measured 10cm from the distance of the ultrasonic sensor, then the Arduino will instruct the relay to close the solenoid valve so that the water flow in the reservoir stops. The measurement results on the sensor will be processed by Arduino to be displayed on a 16x2 LCD and the measurement results can be monitored in real time through the Blynk application using a smartphone.

B. After testing the equipment, it was found that the results were brackish water sources coming from the 18000 Mangrove Tree Conversion Area after being filtered through multi-media filters in the form of cation resin, anion resin, activated carbon, zeolite sand, silica sand, and gravel which were then filtered by the reverse osmosis machine had succeeded in removing color and odor in the water, and succeeded in lowering the pH and TDS levels in the water to the point that it was safe to drink and also used in daily life.

c. However, the water that has been filtered still tastes salty because the salt content in the water is still high, with the existence of a monitoring system in the brackish water desalination process proven to be more efficient than conventional methods where the measurement results can be seen using smartphones in real time without having to bring the water filtration results to the laboratory for testing. Water discharge is one of the important factors that can affect the filtration results in water which can be seen in the results of the first and second tests, water discharge that is too large causes the filtration process to not run efficiently. This is because the flow that is too fast causes a reduction in the contact time between the surface of the filter media and the water to be filtered so that fine particles will be easier to escape from the filter media.

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