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Drinking Water Filtration Method with Sensors and Solenoid Water Valve

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ABSTRACT
This study uses a prototype design model consisting of several stages, namely needs analysis, design, coding, and testing. The results of the TDS (Total Dissolved Solids) sensor performance test indicate its ability to detect total dissolved solids (TDS) in saltwater solutions by measuring the salt content in the solution by detecting the amount of salt content in the solution, as many as 6 tests were carried out using salt with different amounts in grams into 100 ml of pure water. Based on the analysis of 3 tests on filtered water, the resulting water is physically odorless, colorless, tasteless, and the TDS value is at 151 - 153 ppm, and chemically has a pH value of 7.11 - 7.16. Based on the results of the tests carried out, it can be concluded that the water from filtration using the RO method is suitable and safe for consumption because it has met both physical parameters, such as color, odor, taste, and TDS levels, as well as chemical parameters, namely the pH level has complied with the applicable drinking water health requirements according to the Regulation of the Minister of Health of the Republic of Indonesia Number 492, 2010

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INTRODUCTION

Water is one of the essential resources for all living beings, consisting of hydrogen and oxygen (H2O). According to the National Socio-Economic Survey conducted by the Central Statistics Agency (2018), the average consumption of drinking water per capita in Indonesia is around 60 liters per day. However, this figure varies across regions or provinces in Indonesia, depending on factors such as access to safe water sources, sanitation conditions, and climate.

To ensure the quality of water is suitable for consumption, routine processing and monitoring should be carried out. Therefore, drinking water treatment can be carried out with various technologies, such as treatment with sedimentation filtration methods, disinfection, coagulation, and reverse osmosis. Water treatment with the filtration method is a solid-liquid separation process by passing liquid through porous media or materials to remove or eliminate as many fine particles of suspended solids as possible from the liquid (Sharma, S., & Bhattacharya, A, 2021).

The reverse osmosis filtration method is a separation process in which water molecules are forced through a semi-permeable membrane by applying a pressure greater than the osmotic pressure. This process produces purer water by removing most of the solutes and contaminants in the solution (Baker, R. W, 2012).

LITERATURE REVIEW

Drinking water is water that is not harmful to human health when consumed in sufficient quantities to meet basic physiological needs. Drinking water must meet the specified microbiological, chemical and physical requirements (American Water Works Association (AWWA), 2016). The filtration method is a process of separating particles or dissolved substances from a mixture using a porous medium that allows fluid to pass through and retains larger particles or dissolved substances (Metcalf, E., & Eddy, H. 2003). Filtration is the process of separating solid particles from a liquid using a filter. With this method, solid particles remain on the surface or structure of the filter media while the liquid flows through the porous media (Weber, W. J., & Smith, E. H. 2010).

Reverse osmosis is the opposite of the osmosis process, a phenomenon in which two solutions with different solute concentrations reach equilibrium through a semi-permeable layer. In this case, the two solutions are in one container but separated by a layer that allows only some of the solvent to pass through. Equilibrium occurs when the solvent moves from a solution with lower solute concentration to one with higher solute concentration to a solution with a high solute concentration (Elimelech, M., & Phillip, W. A., 2011). Reverse Osmosis (RO) membranes are a special type of semi-permeable membrane used in the reverse osmosis process. This membrane has very small pores that only allow water molecules to pass through, while blocking other solutes and contaminants. RO membranes are the main component in reverse osmosis systems (Farinas, M. C., & Hauser, E., 2021).

The solenoid water valve uses a coil that functions to move the piston. The movement is generated by AC or DC current, pneumatic solenoids or solenoids that function as drivers. This solenoid water valve can be activated when given a minimum voltage of 24 volts and is able to work in 2 conditions, namely on and off (Ferris, T. P., 2015). The solenoid water valve has an output, inlet, and exhaust hole. The inlet hole is considered the final position/channel for water that is pressed into the system, the outlet hole is considered the final position/channel for water that is released from the system, and the exhaust hole is considered a channel to release trapped water when the plunger moves or when the solenoid water valve works.

pH is a measure used to determine the level of acidity or alkalinity (alkalinity) of a solution. pH is an important factor that must be taken into account the degree of acidity contained in water, this aims to prevent corrosion that can affect the water treatment activity (Skoog, D. A., Holler, F. J., & Crouch, S. R., 2017). A pH sensor is an electronic device that functions to measure the pH (acid and base) of a liquid. The pH sensor is included in one type of chemical sensor because the output displayed is the result of a chemical reaction that is converted into an electrical voltage. On the pH sensor there are 2 types of electrodes, namely glass and reference. The glass electrode functions as a measure of the number of ions in the liquid and the reference electrode functions as one that changes the number of ions read on the glass electrode into an analog voltage value (Kim, J., Kang, S., & Park, J., 2018). TDS (Total Dissolved Solid) is a parameter that indicates the amount of dissolved solids in water, which can be organic and inorganic compounds. The main cause of increasing dissolved solids is non-organic materials in the form of ions that are commonly used in water. Solids in water come from various sources, for example natural materials such as leaves, mud, plankton. Meanwhile, inorganic sources come from rocks and substances containing calcium bicarbonate, nitrogen, iron, phosphorus, sulfur, and other minerals. The higher the TDS value, the greater the amount of dissolved solids in the water, and the less hygienic the water. As a result, the TDS value can be used as a parameter to assess the quality of domestic or household water.

IoT (Internet of Things) is a concept that aims to strengthen the benefits of a continuous internet connection that allows machines, devices, and other physical objects to be connected to network sensors and actuators, this will lead to data acquisition and management of their own performance, which will ultimately allow machines to collaborate and act on new information obtained separately (Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M., 2013). IoT (Internet of Things) is a concept that involves all objects in the real world communicating with each other via the internet as part of an integrated system.

METHODOLOGY

This research is a design-build type of research and uses a prototype design model. The designed product is expected to provide a clean water solution, especially drinking water in areas with inadequate clean water limitations. The RO (Reverse Osmosis) system is a filtration medium for water

equipped with a pH sensor and a TDS sensor to measure the quality of filtered water. These sensors are integrated with the ESP8266 microcontroller which functions to process input and output data. The ESP8266 microcontroller is connected to the internet via a Wi-Fi/Hotspot network, enabling input and output data processing on the Blynk server. This data is displayed in the Blynk application on a smartphone and can control the pump and solenoid water valve.

Product trials are conducted to determine whether the designed product has worked according to its function. The trials conducted were observing each part of the IoT-based drinking water filtration system and measuring the output of the system by conducting direct measurements and observations. In this study, the data analysis technique used was descriptive quantitative. Descriptive data analysis is the process of describing or explaining data that has been collected as it is without making conclusions that apply generally. The data analyzed are presented in the form of images, graphs and tables.

RESEARCH RESULT

This study uses a prototype design model consisting of several stages, namely needs analysis, design, coding, and testing. The first stage, needs analysis, involves identifying problems by gathering information about system requirements and collecting supporting data from books, journals, the internet, and previous studies. The second stage, design consisting of hardware and software design. Hardware design is the process of creating circuit designs and assembling electronic components, while software design is the process of creating an interface display on the blynk application. The third stage, coding which consists of creating a program on the Arduino IDE application, integrating programs on hardware, and the blynk application. The fourth stage, testing consisting of voltage testing, pH sensor performance testing, TDS sensors, and functionality testing

Drinking Water Filtration System with Filtration Method Using pH Sensor and Solenoid Water Valve Based on IoT is made to help people who live in areas with limited clean water. The use of a filtration system with RO filtration method with 7 filtration stages aims to produce water with a quality that is suitable and safe for consumption in accordance with the applicable water health standards according to the Regulation of the Minister of Health of the Republic of Indonesia Number 492 of 2010. IoT (Internet Of Things) technology on this tool functions so that monitoring and control can be carried out remotely, because the tool and the blynk application are connected to the internet network. This tool is made through several stages, namely design, coding, and testing. The first stage, hardware design consisting of designing circuits and assembling electronic components. The second stage, software design, namely creating an interface display on the blynk application. The third stage, coding consisting of creating a program on the Arduino IDE application, integrating programs on hardware, and the blynk application. The fourth stage, testing consisting of voltage testing, pH sensor performance testing, TDS sensors, and functionality testing

Based on the results of the voltage test carried out, it was found that all components worked to fulfill their functions according to the voltage that had been measured. The results of the pH sensor performance test (Acidity or Alkalinity Level) obtained an average error of the sensor of 8%. The results of the TDS (Total Dissolved Solid) sensor performance test were able to detect the total dissolved solids (TDS) contained in the salt water solution by detecting the amount of salt content in the solution, as many as 6 tests were carried out using salt with different amounts in grams into 100 ml of pure water. The first test, with 100 ml of water without salt produced a TDS value of 111. The second to sixth tests, with the addition of 10 grams of salt in each test into 100 ml of water, resulted in a continuous increase in the TDS value for every additional 10 grams of salt. The difference in this value is influenced by the amount of salt content in the water. Thus, the pH and TDS sensors used in this study are functional and meet their intended purposes. The pH test of water that has gone through the filtration process obtained data as in the following table:

Table 1. Water pH Testing

Testing of the	Water Volume (Liters)	pH of Well Water (Unfiltered)	pH of Filtration Water
1	1 Liter	7,4	7,16
2	2 Liters	7,4	7,16
3	3 Liters	7,4	7,13

TDS testing on water that has gone through a filtration process produces data as in the following table:

Table 2. Water TDS Testing

Water Volume (Liters)	TDS Well Water (Not Filtered)	TDS of Filtrated Water
1 Liter	180	152
2 Liters	195	152
3 Liters	200	152

The results of the functionality test by the validator successfully reached a value of 100% which indicates that the tool is good and feasible to be applied. Based on the analysis of 3 tests on the filtered water, the water produced is physically odorless, colorless, tasteless, and the TDS value is at 150 - 152 ppm, and chemically has a pH value of 7.11 - 7.16. Based on the results of the tests carried out, it can be concluded that the water from filtration with the RO method is suitable and safe for consumption because it has met both physical parameters, such as color, odor, taste, and TDS levels, as well as chemical parameters, namely the pH level has been in accordance with the applicable drinking water health requirements according to the Regulation of the Minister of Health of the Republic of Indonesia Number 492, 2010

CONCLUSIONS AND RECOMMENDATIONS

This final project can be considered successful as the device operates effectively with PLN electricity, the pH sensor can detect the pH level of water, the TDS sensor can detect the TDS level in water, the solenoid water valve that functions as a tap where the filtered water comes out, the electrical terminal connected to the relay can control the electric current at the terminal, the LCD can display the reading results of both sensors, and monitoring the sensor readings, as well as component control are all presented in the application. Based on the results of the voltage test carried out, it was found that all components work to fulfill their functions according to the voltage that has been measured. The results of the functionality test by the validator managed to reach a value of 100% which indicates that the device is good and feasible to be applied.

The results of the pH sensor performance test (Acidity or Alkalinity Level) obtained an average error of the sensor of 10%. The results of the TDS (Total Dissolved Solid) sensor performance test were able to detect the total dissolved solids (TDS) contained in the salt water solution by detecting the amount of salt content in the solution, as many as 6 tests were carried out using salt with different amounts in grams into 100 ml of pure water. The first test, with 100 ml of water without salt produced a TDS value of 111. The second to sixth tests, with the addition of 10 grams of salt in each test into 100 ml of water, resulted in a continuous increase in the TDS value for every additional 10 grams of salt. The difference in this value is influenced by the amount of salt content in the water. Thus, the pH sensor and TDS sensor used in this study are feasible and work according to their functions. Based on the analysis of 3 tests on the filtered water, the water produced is physically odorless, colorless, tasteless, and the TDS value is at 151 - 153 ppm, and chemically has a pH value of 7.11 - 7.16. Based on the results of the tests carried out, it can be concluded that the water filtered using the RO method is suitable and safe for consumption because it has met both physical parameters, such as color, odor, taste, and TDS levels, as well as chemical parameters, namely the pH level has been in accordance with the applicable drinking water health requirements according to the Regulation of the Minister of Health of the Republic of Indonesia Number 492, 2010.

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