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FEASIBILITY ANALYSIS OF WATER IN SIDOARJO REGENCY USING TDS AND PH MEASUREMENTS BASED ON MICROCONTROLLER

Dzulkiflih [1], Imam Sya'roni[1], Meta Yanti Dewi [1], Rohim Aminullah Firdaus[1], Muhhimatul Khoiro[1]

[1] Physics department, Faculty Mathematics and Natural Science State University of Surabaya
Surabaya, 60213, Indonesia
dzulkiflih@unesa.ac.id

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ABSTRACT

The purpose of the study was to determine the quality of drinking water suitable for consumption through its pH and TDS content, as well as to provide mapping information on water levels in the Sidoarjo Regency area. This research is an experimental type with quantitative descriptive analysis. The stages of the research include making tools, calibrating tools, collecting, and analyzing field data covering 14 water sample points. Based on the reference for water quality that is suitable for consumption (<500 ppm) and suitable tolerance for use (<1000 ppm), there is 1 point of the water sample that is classified as suitable for consumption with a TDS value of <500 ppm, namely in the sedati area. While the other 13 points above have TDS > 500 ppm but still < 1000 ppm so they can still be used for household activities, but if they are consumed, they must go through a cooking process to remove heavy metals or materials contained in water. The pH value of the water from 14 points is not extreme outside the normal pH area of 6 - 9.5. The lowest pH value of water is in the Sidoarjo City area at 6.97 and the highest is in the Tarik area at 7.79. The main factor is that there is an even distribution of TDS and pH values in the Sidoarjo area because of the flow of rivers that flow so that if one area is contaminated, it will affect the water quality of other areas, both in terms of TDS and pH.

Key Word: TDS, pH, PPM, Sensor, Contaminated.

[1] Corresponding Author

Introduction

Water is one of the most important elements for the life of living things on Earth. Without water, living things cannot survive (Sumarjo, Arbi, & Dirja, 2017). The function of water in life cannot be replaced by other compounds. For human life, the main and very important use of water is as drinking water and is also used in other ways, for example for the industry, cultivation, agriculture, and others. However, water becomes dangerous if it is not available in proper conditions. Given the importance of water for life, it is very necessary to have a source that can provide good water in terms of quality and quantity (Purwonugroho, 2013). Permenkes No. 32 of 2017 concerning Drinking Water Quality Requirements, drinking water is different from sanitation and watering water. Drinking water is water that has been processed or without processing that meets health requirements and can be drunk directly. For water to be safe for use for human health, it must meet several requirements, namely physical, chemical, and biological requirements (Ministry of Health, 2014).

The Sidoarjo region is an area with rapid industrial development in East Java Province. Based on Ronald Ridho" i's Thesis. (2017), the industrialization process in Sidoarjo began in the third decade of the 19th century, which was marked by the development of the sugar industry. Since the 1950s, when there was an industrialization project from the central government, the manufacturing sector began to develop and experience rapid growth during the New Order. The massive manufacturing industry in Sidoarjo has changed the ecological conditions, socio-economic life and the environment. The environmental impact felt by the community is changing in water quality in the environment.

The degree of acidity or pH is one of the parameters of quality water, which is included as a chemical parameter. The value of the pH ranges from 0-14. A pH value of less than 7 indicates that the water is acidic. If the pH value is equal to 7, it means that the water is neutral, and if the pH value is more than 7, it means that the water is alkaline. (Astari, and Iqbal, 2020). Another parameter is TDS (Total Dissolved Solids), where TDS is a physical parameter. High concentrations of TDS can affect the taste of the water. High values of pH and TDS show a poor relationship with several water environmental parameters that have a significant negative impact on marine life (Rinawati et al., 2016). The feasibility of water is assessed from a TDS factor below 300 ppm with a pH value between 6 - 9.5 (Siswantoro et al. l, 2018).

Research from Desmira, Ariwibowo, and Pratama (2018) uses a pH sensor to determine the quality of water to be consumed but with a limited range of measurement results, namely 1-10. While the reference pH range is 1-14 (Sitorus, 2014). Another study by Nuvreilla Novenpa et al. (2020), measured water quality using temperature and pH sensors. The sensor accuracy is quite good with a temperature sensor accuracy of 99.39% and a pH sensor accuracy of 99.76%, but the tool error value is quite high, at 5.23%. Through this research, a portable TDS and pH device will be made to overcome the high error value of 5.23%. On the other hand, water data in the Sidoarjo area covers a wide area and has three sources, namely well water, tap water, and depot water. This research can help the community to know the condition of the quality of water consumed daily and map the water quality in the Sidoarjo area.

Research Methods

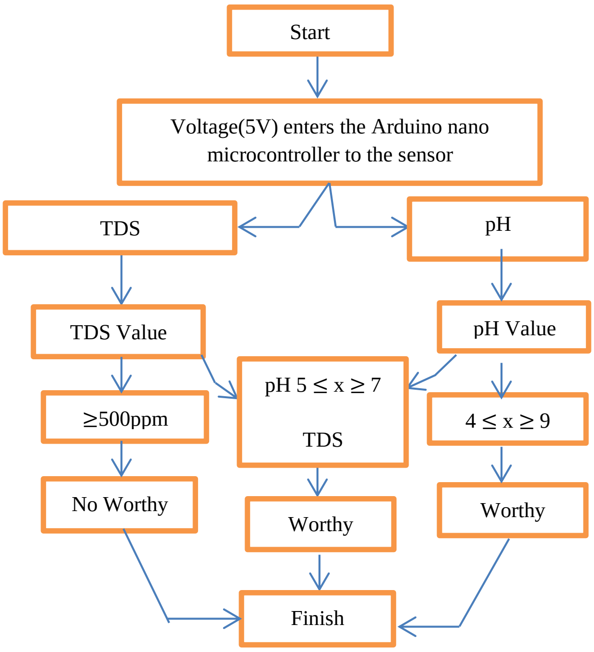

Figure 1. Water Sample Quality Test

The research used the experimental method by collecting data directly from the field, measuring and analyzing quantitatively descriptively. The stages are as follows: tool making, tool calibration, sampling, and testing. Furthermore, analysis is carried out based on quantitative data from the test results that have been obtained, and the results of the analysis are described based on water reference standards. The flow of testing pH and TDS on the research sample is shown in Figure 1.

Sampling was carried out at 14 different places in the city of Sidoarjo district. The research sample locations include Tarik, Prambon, Krembung, Porong, Jabon, Tanggulangin, Temple, Tulangan, Wonoayu, Sukodono, Sidoarjo, Buduran, Sedati, Waru, Gedangan, Taman, Krian, and Balongbendo. This whole place is an industrial area. Researchers took 600 ml of water from each place at random in residential areas around.

In testing water quality, 2 sensors are used with the design shown in Figure 2. The pH sensor is used to measure the pH value of the water. The normal water pH value is around 6 – 9.5. The working principle of the pH sensor changes the value of the chemical reaction that occurs or is detected and converted into an electric voltage. It also makes the pH sensor into the category of chemical sensors. The detectable pH range is 0-14 (Sapitra, 2020). The TDS sensor is used to measure the ppm value of water. Normal water has a TDS value below 300 ppm. If the ppm value is above 300, it is classified as unfit for consumption but can be processed to be feasible. While ppm above 1000 is classified as dangerous. The TDS sensor has a working principle according to the electrical conductivity properties. 2 electrodes can measure the conductivity of a liquid. The content of ionic particles and the nature of the electrolyte in the liquid affect the results of measurements using a TDS sensor (Wirman, I. Wardhana, and Isnaini, 2019).

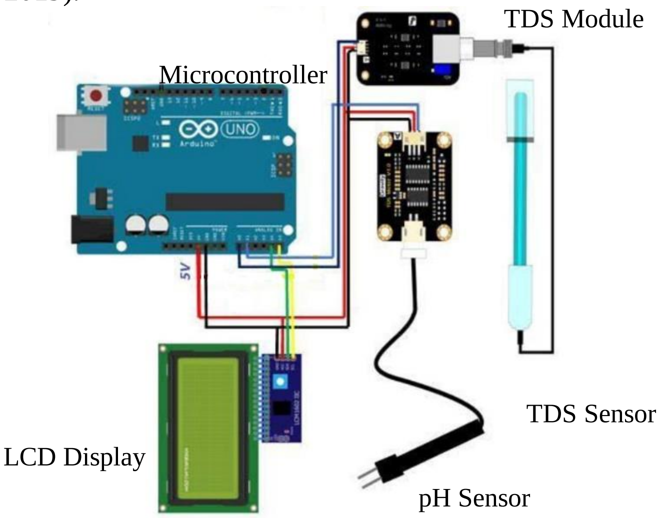

Figure 2. Water Quality Test Design

The microcontroller functions to receive input from each sensor to be processed automatically and displays data to the screen on the sensor monitor, which functions to store data. The complete equipment for testing research samples is shown in Figure 3.

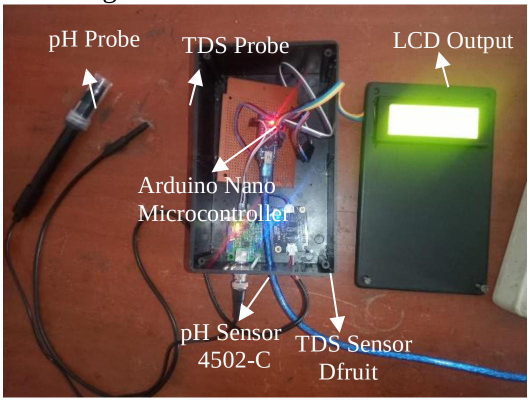

Figure 3. Water Quality Test Equipment

The TDS sensor and pH sensor were calibrated before being used for measurement using pH powder and raw water with definite values. The measurement results that are read on the sensor are in the form of ADC (Analog Digital Converter) values and will be compared with the change in voltage on the microcontroller that is read.

Results and Discussions

The results of calibration of sensor readings for changes in the measured quantities are shown in Figures 4, 5, 6, and 7. Based on Figure 4, the linearity of changes in TDS sensor voltage to ADC is 98.69%. Meanwhile, based on Figure 5, the linearity of the change in pH sensor voltage to the ADC is 98.59%. This indicates that the TDS and pH sensors have a good response. Then after knowing the ADC value of the two sensors. The ADC value is compared with the quantities to be measured, namely ppm and water pH. From the calibration powder, the ADC sensor is obtained as shown in Figures 6 and 7.

Changes in the TDS and pH sensors to the calibration powder readings obtained the following 2 linear equations:

$$y = 0{,}002x + 0{,}0522 \quad (1)$$

$$y = 0{,}1379x + 1{,}7341 \quad (2)$$

By entering the value of x = 1 into each linear equation, the y value is obtained as the sensitivity of the TDS sensor of 0.0542 V/ppm and the pH sensor of 1.872 V/pH. The linearity value of the TDS sensor to changes in the water ppm value of 98.7% with an error of 1.3%. For the pH sensor, the sensor linearity is 99.37% with an error of 0.63%.

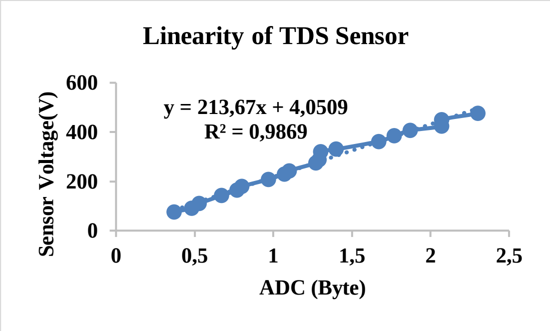

Figure 4. TDS Sensor Calibration to determine the linearity of sensor voltage changes to changes in ADC

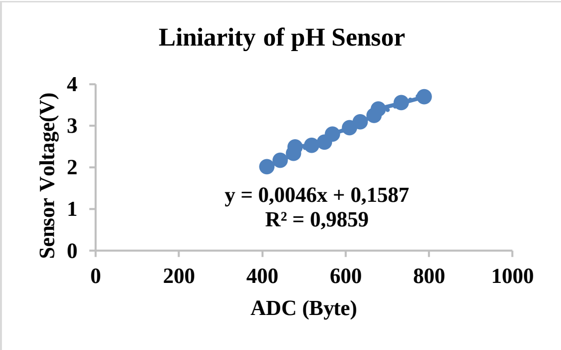

Figure 5. pH Sensor Calibration to determine the linearity of sensor voltage changes to changes in ADC

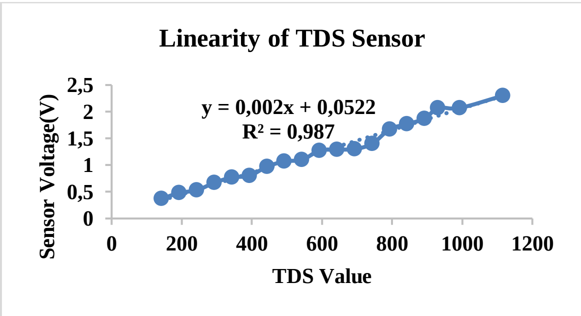

Figure 6. TDS Sensor Calibration to determine the linearity of sensor voltage changes to changes in water ppm

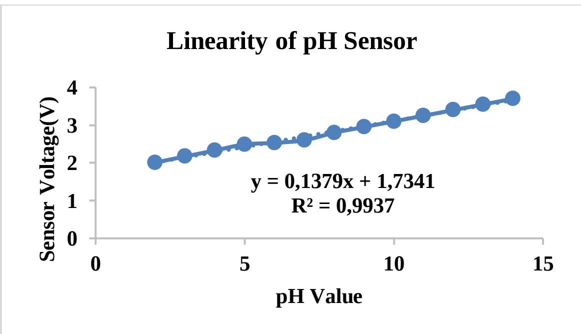

Figure 7. Calibration of the pH sensor to determine the linearity of changes in sensor voltage to changes in the amount of water pH

After the linearity of the sensor has been obtained, the instrument measurement calibration is carried out using bottled water sold in the market and calibrator powder, as shown in Table 1. It appears that two raw water drinks were measured using a microcontroller-based TDS and pH measuring instrument. The instrument calibrator shows the same reading value, namely 6.8 at the alkaline condition calibrator and 4.2 at the acidic condition calibrator. So that the accuracy of the tool is 98%. Table 1 shows the comparison of the normal indicators. The normal limits for proper drinking water are the TDS value (<500 ppm) and a pH is around 6-9.5. If the TDS value of water is (> 500), then the water contains heavy metals but is still considered for consumption. Meanwhile, if (>1000), the water contains pollutants and is not safe for humans (Nuraini, Iqbal, and Sabhan, 2015). Meanwhile, if the pH is too alkaline and too acidic, it is also not suitable for consumption because the pH indicator of normal water is in the range of 6-9.5. Following the Decree of the Minister of Health of the Republic of Indonesia number 907/Menkes/SK/2002 concerning the quality of drinking water, namely the total dissolved solids content or TDS maximum of 1000 ppm. From the calibration data using raw water drinks, the maximum limit of water is said to be suitable for consumption below (<300 ppm).

Table 1. Calibration data of raw water samples measuring TDS and pH of the sample.

Calibrator	ppm	ph
Acid Calibrator (pH 4,2)	1050	4,18
Base Calibrator (pH 6,8)	600	6,78
Reference Water 1	16	7,91
Reference Water 2	247	7,41
Normal	500	7

From the 14 sampling points, the results of the TDS and pH measurements are shown in Table 2. It appears that there are no samples that are classified as dangerous for consumption because the TDS level is <1000 ppm. Overall, the water in the 14 water sample points was classified as normal pH.

Sample 1 is in the area of Sidoarjo City with less clean city rivers. Sample 2 in the Waru area. The sampling site is close to a dirty river. Sample 3 in the Gedangan area. The pick-up place at the mosque is still a village close to the main road. Sample 4 in the Candi area. Taking water around the factory. Sample 5 in the Prambon area. Taking water at the mosque near the rice fields. Sample 6 in the Sedati area. Taking water at the mosque near the rice fields and residents' houses. Sample 7 in the Tanggulangin area. Water intake near the main road with surrounding mills. Sample 8 in the Drag area. Taking water around the rice fields. Sample 9 in the Buduran area. Water intake around the main road close to the factory. Sample 10 in the Wonoayu area. Water intake around the main road but few factories. Sample 11 in the Balongbendo area. Taking water from rivers around the highway but not exposed to factory waste. Sample 12 in the Park area. Water intake in the river, few factories in the area. Sample 13 in the Krian area. Drawing water from residential wells far from the factory. Sample 14 in the Sukodono area. Taking water at the mosque around the rice fields far from the factory.

Table 2. Water sampling data and measurement results of TDS and pH of the sample.

Address	Ppm	pH
Sidoarjo City	900	6,97
Waru Mosque	950	7,17
Gedangan Well	734	7,29
Candi Well	980	7,23
Address	**Ppm**	**pH**
Prambon Well	595	7,2
Sedati Well	437	7,17
Tanggulangin Well	990	7,23
Tarik Well	572	7,79
Buduran Well	809	7,41
Wonoayu Well	788	7,35
Balongbendo Well	693	7,32
Taman Well	702	7,09
Krian Well	684	7,17
Sukodono Well	535	7,44
Normal	500	7

Based on the water quality reference that is suitable for consumption (<500ppm) and the tolerance is suitable for use (<1000 ppm). In table 2, there is 1 point of the water sample that is classified as suitable for consumption, namely in the sedative area because it has a value (< 500 ppm). While the other 13 points are above (>500 ppm) but still below (1000ppm). So that it can still be used for household activities, but if it is for consumption it must go through a cooking process to remove heavy metals and other ingredients in the water. The pH of the water from 14 points is not extreme outside the normal pH area, which is 6-9.5. The lowest pH value of water is in the Sidoarjo city area at 6.97 and the highest is in the Tarik area at 7.79.

From table 2, water quality can be mapped based on the TDS value of the water sample in the Sidoarjo Regency in an information map, to facilitate the dissemination of information from water quality research obtained. Based on the color value of the water indicator, it is mapped into two colors as shown in Figure 8.

Figure 8. Information on the Feasibility of Water from the Results of TDS and pH Meters in Sidoarjo Regency

Figure 8 shows the mapping of the water quality of the Sidoarjo regional equipment testing results. The blue color indicates the area has water quality suitable for consumption (<500 ppm) and the yellow color indicates the area has a water tolerance that is suitable for use (<1000 ppm) and above (>1000 ppm) is red, which means the water in the area is not fit for consumption. The results of the TDS and pH measurements in the Sidoarjo area were classified as normal, but the TDS values for water ranged from 400–990 ppm. This indicates that the water in the Sidoarjo area has begun to be contaminated with metal objects. In line with the number of factories in several places in Sidoarjo (Ridhoi, R., and Wahid, A, 2017). The main factor that causes the water consumed by residents of residential areas to be contaminated is the presence of factories that produce production waste. It can be seen from the pH content of the water in the Sidoarjo area which is starting to approach acid and alkaline outside the pH between 6 - 9.5. The flowing river is also a factor in the distribution of water evenly in the Sidoarjo area. If there is one area that has been contaminated, it will spread to other areas through rivers or underground water. So other areas will be contaminated as well.

Conclusions

The microcontroller-based TDS and pH measuring instruments designed have a fairly low error rate, with error values of 1.3% and 0.63%, respectively. So that the results of the feasibility analysis of the water tested using this tool are more accurate. Analysis of the feasibility of water in Sidoarjo Regency after being tested using a TDS and pH measuring instrument based on a microcontroller shows that there is only 1 point in the area that has water quality suitable for consumption, namely in the Sedati area. The second test is the pH value of the water. The pH content of the water in the 14 tested samples has a value that is close to the normal pH level and is not classified as acid or alkaline so it is suitable for consumption. There was a change in pH in several places, approaching acid levels, namely in the Sidoarjo City area with a pH value of 6.97 and approaching alkaline in the Tarik area with a pH value of 7.79.

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