



Design Innovation of Grease Trap for Wastewater Treatment Arduino-Based

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Abstract. Automotive workshop produce wastewater from the results of washing mechanic hands and machine components that containing Total Dissolve Solid (TDS). The TDS content in floodwaters is closely related to the level of turbidity and can reduce water quality so that it is harmful to the water ecosystem, therefore it is necessary to carry out a treatment process on wastewater so as not to pollute the environment. Based on the background of the problem, a grease trap installation was made equipped with an electronic device to monitor water discharge, TDS content, and water turbidity levels. The purpose of the study was to determine the effectiveness of wastewater treatment devices. The type of research is Experimental Quasi, Research begins with identifying and formulating problems, then designing, stringing, and testing water quality monitoring devices on grease trap. The electrical circuit design utilizes fritzing software while the grease trap installation design uses solidworks. The water monitoring device consists of Switching Mode Power Supply (SMPS), DC motor dimmer, 12V DC water pump, arduino uno as microcontroller, flow sensor, TDS sensor and turbidity sensor as input from arduino, and LCD 12x6 equipped with 12C module, and LED as output from arduino Based on the data, the most effective water treatment resulted in a TDS content value before treatment of 359ppm to 282.5 ppm with a percentage decrease of 20%, and the turbidity level before processing of 150 NTU to 10.05 NTU with a percentage decrease of 93%.

Keywords: grease trap, wastewater, total dissolve solid, turbidity

1 INTRODUCTION

The increase in the need for motor vehicles as a means of transportation is comparable to the rapid increase in the number of the population. The number of motorized vehicles has increased from 2018-2019, the economy of Malang City is the largest supported by the trade and repair sector of motor vehicles based on data published by the Central Statistics Agency of Malang City in February 2021 [1]. Motor vehicle

repair activities have the potential for negative impacts on the environment, one of which is wastewater. Wastewater from washing machine components and mechanic hand washing. In the socialization material for WWTP construction planning for workshop activities issued by the Surabaya City Environment Agency, it was explained that the wastewater of the automotive workshop contains Total Dissolve Solid (TDS). TDS is a dissolved solid which is one of the parameters of water pollution. The TDS content in floodwaters is closely related to the level of turbidity and can reduce water quality so that it is harmful to the water ecosystem, therefore it is necessary to carry out a treatment process on wastewater so as not to pollute the environment. The conductivity and conductivity of the solution form the basis in TDS measurements. TDS measurements can utilize TDS scans or TDS sensors [2].

Based on the background of the problem, a grease trap installation was made equipped with an electronic device to monitor water discharge, TDS content, and water turbidity levels. To maximize the effectiveness of wastewater treatment, hair and coconut shell charcoal are added as a filtration medium. Filtration is the process of separating a mixture between a solid substance and the fluid that carries it in a sewage treatment process, using a porous medium to remove as many suspended and colloidal substances as possible, and other substances. The filtration process will involve an adsorbtion process or a physical and chemical process where the substance accumulates in a surface layer of an absorbing substance (adsorbent) [3]. Keratin component and part of the cortex are microfibrils and then the cavity of the medulla part of human hair can capture and bind types of fats or oils [4]. Coconut shell charcoal is the best material that can be made into activated carbon because coconut shell charcoal has a lot of micropores, low ash content, high solubility in water and high reactivity [5], the selection of these two materials is made to make it easier for small-scale workshop owners to take advantage of this wastewater treatment plant, so that wastewater that has gone through the treatment process does not harm the environment.

2 METHODS

The type of research is Experimental Quasi. Research by applying treatment to the wastewater of automotive workshops by utilizing grease trap and then the filtration process.

2.1 Design Concept

In this reaserch, the wastewater treatment used a grease trap installation equipped with electronic components for water monitoring. The following are the basic principle of water monitoring in the grease trap.

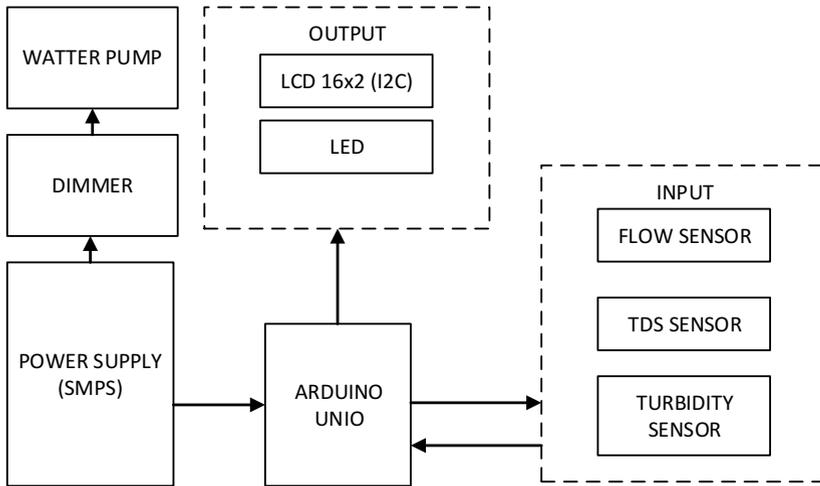


Fig. 1. Basic principal of water monitoring.

The pump drains the wastewater towards the grease trap. Regulation of flow speed by DC motor dimmer by adjusting the rotation of water pump motor, measurement of flow speed by flow meter. At the end of the process, the TDS sensor measures the TDS content and the Turbidity sensor measures the turbidity level of the treated water to find out if the filtration media has reached the saturation point and needs to be replaced. The measurement results will be displayed on the LCD.

2.2 Water Monitoring Equipment Design

In the process of designing electrical circuits using fritzing software while for micro-controller programming using the Arduino IDE application.

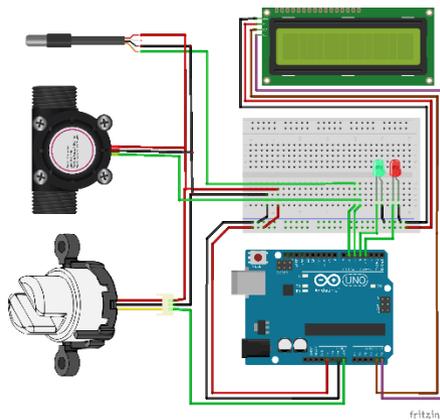


Fig. 2. Electrical circuits design of water monitoring

In the electronic components of water monitoring, the source ac voltage of 220V is converted into DC voltage by the power supply and the input voltage is converted to 12V according to the needs of the electronic circuit, in this study using the type of Switching Mode Power Supply (SMPS) with output of 12V 5A 60W. Electrical voltage is supplied to the water pump through a dimmer in order to regulate the motor rotation speed of the pump to vary the speed, the dimmer specification used is with a maximum current and power output of 0-5A and 90W with an operating voltage of 4.5-35V DC. The voltage from the power supply is also used to activate the Arduino Uno R3 as a controller. Arduino input is a flow sensor to obtain data on the speed of water flow at the inlet of the grease trap, TDS and turbidity sensor to determine the TDS content and the level of water turbidity after going through the treatment process. While the output of arduino is the result of flow speed and turbidity level displayed on the LCD 16x2 with I2C module, and LED that will provide a warning when the filtration media reaches a saturation point. The following are the results of the design of electronic components in the grease trap.

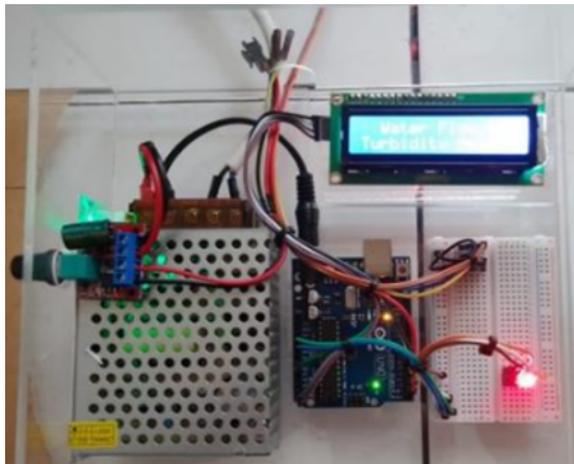


Fig. 3. Water Monitoring

2.3 Grease Trap Installation Design

Solid work software is used in the grease trap design process so that the dimensions of the grease trap can be clearly described, the dimensions of the grease trap are 100 cm x 20cm x 30cm, the distance between the bulkheads in the grease trap is 20cm. the following is the design of the grease trap as a waste treatment equipment. two levels of headings should be numbered. Lower level headings remain unnumbered; they are formatted as run-in headings.

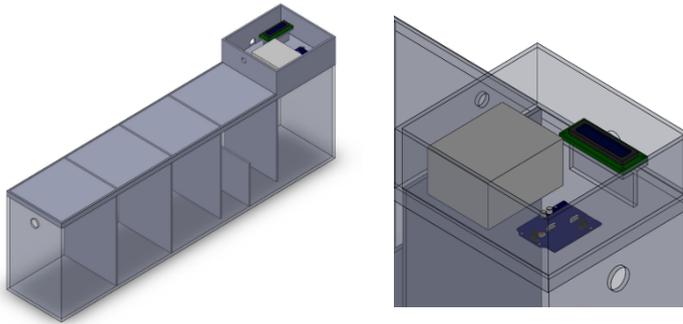


Fig. 4. Grease trap installation design

In the use of grease trap, water is flowed by a pump which is added to a dimmer to regulate the flow speed, measuring flow speed using a flow meter. The vertical bulkhead on the grease trap serves to slow down the flow, when there is a slowdown in the flow of solids in the wastewater it will settle and be trapped by the bulkhead, then the water will continue to flow and the remaining solids that still escape will be trapped by the next bulkhead. In the last two bulkheads there is a hair filter and coconut shell charcoal to catch the remaining solids that are still carried so that the TDS content decreases so that the turbidity level also decreases.



Fig. 5. Grease trap

3 RESULT AND DISCUSSION

3.1 Data Result

The value of the TDS content and the level of turbidity in wastewater before and after going through the processing using a grease trap is as follows

Table 1. Value Of Pollutant Content In Wastewater Before And After Treatment

Flow Rate (Liters/Min)	Hair:Charcoal Mass Ratio (Grams)	Pollutant Levels	
		TDS (ppm)	Turbidity (NTU)
30	750 : 1000	291,5	30,55
	500 : 2000	292	66,8
	250 : 3000	309	95,55
20	750 : 1000	283	12,35
	500 : 2000	287,5	44,25
	250 : 3000	306	86,4
10	750 : 1000	282	10,05
	500 : 2000	286	19,7
	250 : 3000	300	73,25
Before treatment		359	150

The average percentage reduction in pollutant levels is converted into a graph, the following is a graph of the percentage decrease.

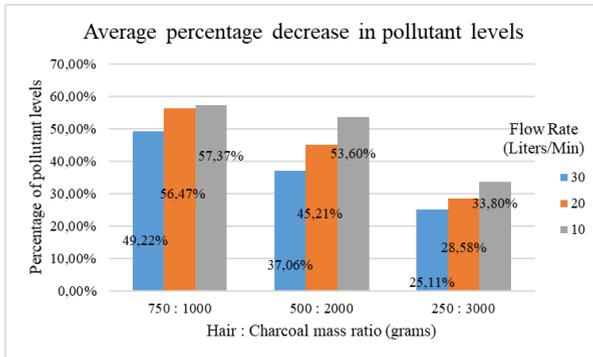


Fig. 6. Graph of the average value of the percentage reduction in pollutant levels

The graph illustrates that when there is a decrease in the flow speed, there is an increase in the average percentage of the decrease in pollutant levels in the wastewater treatment results. And when the mass of hair in comparison is increased, the percentage of decrease in pollutant levels in wastewater treatment results also increases.



Fig. 7. TDS content and turbidity level

The decrease in TDS content occurs because when the flow velocity is low, the solids contained in the wastewater settle so that they are trapped by the grease trap bulkhead. when the flow velocity is high it produces turbulent flow which causes the suspended solids in the wastewater to be difficult to settle so that the decrease in TDS levels is also low. Turbulent flow has a high Reynolds number, the Reynolds number is directly proportional to the flow velocity and inversely proportional to the viscosity of the fluid. Fluid viscosity is influenced by cohesive forces or similar intermolecular attractive forces, so a high Reynolds number value in turbulent flow results in low viscosity or attractive intermolecular forces of suspended solids.

While the graph of the influence of the mass of the filtration media illustrates the effect of changes in the mass ratio of the filtration media to the pollutant content of the treated water, when the hair mass in the ratio is greater, it will produce water with lower pollutant levels, this happens because the keratin component in hair is microfibrils, then the cavity of the medulla of the hair can filter and bind types of oil or fat, the hair also has adsorption properties, and is one of the good metal adsorbents, in addition when there is an increase in hair mass while the volume of the filtration tank will still increase the density of the filtration media, so when hair mass is increased, the effectiveness of reducing wastewater pollutants also increases.

3.2 Data Analysis

Data analysis with the two-way anova method for validity test by analyzing the output of anova, comparing the value of F counts and F table, if F counts > F of the table then H1 is accepted and H0 is rejected or the free variable affects the bound variable. Furthermore, test the significance by comparing the level of significance ($\alpha = 0.05$) with the P-value in the output of the anova. If the P-value ≥ 0.05 then the free variable has no significant effect on the bound variable, if the P-value ≤ 0.05 then the free variable has a significant effect on the bound variable. The results of two-way anova on the results of the value of the TDS content and turbidity level are as follows:

Table 2. The Results Of Two-Way Anova Tds Content Value

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-Value</i>	<i>F crit</i>
Mass Ratio	13876,8	2	6938,41	5314,53	0,00	4,256
Flow Rate	2704,89	2	1352,45	1035,92	0,00	4,256
Mass Ra- tio*Flow Rate	521,993	4	130,498	99,9562	0,00	3,633
Within	11,75	9	1,30556			
Total	17115,5	17				

Table 3. The Results Of A Two-Way Anova Turbidity Level Value

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-Value</i>	<i>F crit</i>
Mass Ratio	198,45	2	99,225	435,622	0,00	3,554
Flow Rate	309,5	2	154,75	67,93902	0,00	3,554
Mass Ra- tio*Flow Rate	38,5	4	9,625	4,22561	0,014	2,927
Within	41	18	2,277778			
Total	2373,5	26				

Based on the results of two-way anova in tables 3-4, a validity test was carried out for the influence of flow speed and mass on the content of wastewater pollutants. The TDS content and turbidity level of the flow speed obtained the value of $F > F_{crit}$, meaning that the flow speed affects the content of wastewater pollutants. The TDS content and turbidity level of the filtration media mass were obtained $F > F_{crit}$, meaning that the mass variable of the filtration media affects the content of wastewater pollutants. Furthermore, the TDS content and turbidity level to the interaction of flow speed and mass ratio of filtration media are also obtained $F > F_{crit}$, meaning that the interaction between flow speed and mass ratio of filtration media affects the content of pollutants in wastewater.

Significance test by comparing the significance level ($\alpha = 0.05$) and P-value in Tables 3 – 4. For the content of TDS and the level of turbidity on the flow velocity obtained P-value 0.05, meaning that the flow velocity has a significant effect on the pollutant content wastewater. For the content of TDS and the level of turbidity to the mass ratio of the filtration media obtained P-value 0.05, it means that the mass variable has a significant effect on the pollutant content of wastewater. Furthermore,

the TDS content and turbidity level on the interaction of flow velocity and mass ratio of the filtration media also obtained a P-value 0.05, which means that the interaction of flow velocity and mass ratio of the filtration media has a significant effect on the pollutant content of wastewater.

The interaction between flow velocity and the mass of the filtration media that was most effective in reducing pollutant levels was at flow rates of 20 and 10 l/min with a mass ratio of hair to coconut shell rang 750:1000g. Under these conditions, the average TDS content before processing was 359ppm to 282.5 ppm with a percentage decrease of 20% and turbidity levels before processing 150 NTU to 10.05 NTU with a percentage decrease of 93%.

4 CONCLUSION

The electrical circuit for water monitoring in the grease trap as an automotive workshop wastewater treatment consists of a Switching Mode Power Supply (SMPS), DC motor dimmer, 12V DC pump, Arduino Uno R3 as a microcontroller, flow sensor and turbidity sensor as input from Arduino, and a 12x6 LCD equipped with 12C module, and LED as output from arduino.

The flow velocity and mass of the filtration media have a significant effect on the pollutant levels in the wastewater treatment water. The flow velocity and mass of the filtration media were the most effective in reducing pollutant levels, namely at flow rates of 20 and 10 l/min with a mass ratio of hair and coconut shell charcoal 750:1000g. Under these conditions, an average TDS of 282.5 ppm was produced with a 20% decrease percentage and turbidity level of 10.05 NTU with a 93% decrease in percentage.

Acknowledgment

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