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SUITABLE TECHNOLOGY FOR A HOUSEHOLD SCALE WORKSHOP SYSTEMS FOR THE TREATMENT OF WASTEWATER

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Abstract: One of the causes of water pollution is the presence of workshop activities. Gasoline residue from washing spare parts and washing hands after repairing and maintaining motor vehicles can harm the surrounding environment, namely water pollution. This study aims to determine the efficiency of reducing the levels of pH, BOD, COD, TSS, oil and grease, Ammonia, and total coliform in wastewater from Astra workshop operations using three treatment and treatment units in the piping section and to determine the design of wastewater treatment tanks for operation astra workshop. Based on the preliminary test results, the waste from Astra workshop activities had a pH content of 7.2, a BOD content of 2.9 mg/l, a COD content of 58 mg/l, a TSS content of 2.45 mg/l, an oil and fat content of 8.702 mg/l, the ammonia content was 0.027 mg/l. The total coliform content was 2000 MPN/ml. Of these values, there is one parameter that does not meet the quality standards according to the Decree of the Minister of Environment and Forestry No. 68 of 2016 concerning Domestic Waste Quality Standards, namely a pH concentration of 6-9, a maximum level of BOD of 30 mg/l, a maximum level of COD of 100 mg/l, a maximum level of TSS of 30 mg/l, a maximum concentration of oils and fats allowed 5 mg/l, maximum ammonia concentration of 10 mg/l, and maximum permitted total coliform content of 3000 MPN/ml. This workshop liquid waste treatment uses three treatment and treatment units in the piping section with one filtration media, which is carried out in duplicate to anticipate and minimize the possibility of errors that can occur during the process. Efficiency in reducing parameters in liquid waste from Astra workshop operations using filtration media and treatment in the piping section can reduce the pH concentration by -15.29%, from an initial concentration of 7.2 to 8.5, TSS by 59.18% from an initial concentration of 2.45 mg/l to 1 mg /l. BOD was 72.41% from an initial concentration of 2.9 mg/l to 0.8 mg/l. COD was 65.51% from an initial concentration of 58 mg/l to 20 mg/l. Fatty oil was 45.41% from an initial concentration of 8,702 mg/l to 4.75 mg/l. Ammonia by 48.14% from the initial concentration of 0.027 mg/l to 0.014 mg/l, and Total Coliform by 100% from 2000 MPN/ml to 0 MPN/ml.

Keywords: *Appropriate Technology, Wastewater, Workshop.*

INTRODUCTION

Based on PP No.22 of 2021 concerning the implementation of Environmental Protection and Management, water pollution is defined as: "water pollution is the entry or inclusion of living things, substances, energy, and other components into the water by human activities so that they exceed predetermined water quality standards."

Generally, the sources that cause water pollution are divided into 2 (two): direct and indirect. The direct source is a source of pollution originating from a certain point along the receiving water body with a clear location. The point location of the pollution mainly comes from industrial waste disposal pipes that do not treat the waste or the disposal of waste processing products at the WWTP (Waste Water Treatment Plant) that enters the receiving water body. Indirect sources originate from agriculture, livestock, small or medium industry, workshops, and domestic activities in the form of consumer goods [1].

One of the causes of water pollution is the presence of workshop activities. Every repair and maintenance of motorized vehicles can harm the surrounding environment, especially those caused by liquid waste generated from workshop activities in the form of oil, gasoline residue from washing spare parts, feces from toilets, and workers who wash their hands and one of the parameters The products produced by this workshop are oil and grease which are a source of water pollution and a nuisance to people who use the water for bathing and washing.

Oil and grease are compounds that can cause pollution in water, so their concentrations must be limited. Oil has a lower specific gravity than water, forming a thin film on the water's surface. This condition can reduce dissolved oxygen concentration in water due to fixation. Free oxygen is inhibited. The oil that covers the surface of the water will also block the penetration of sunlight into the water, thereby disrupting the balance of the food chain [2].

Workshop activities produce liquid waste in the form of oil and grease, which is in the form of oil [3]. Oil is a mixture of viscous hydrocarbons plus various chemical additives. Used oil itself contains heavy metal components such as Iron (Fe), Cadmium (Cd), Lead (Pb), Polychlorinated Biphenyls (PCBs), and Polycyclic Fragrant Hydrocarbons (PAHs); these components contain highly toxic materials when released into the environment. Used oil is included in B3 flammable and explosive waste, so if it is not handled and disposed of, it will endanger humans and the environment [4].

Of the many workshops on the island of Lombok for Astra workshops, 66% still need treatment for their wastewater. While in the case study this time, namely at the Astra workshop located on Jln. Bungkarno No.13 Kelurahan Pagesangan Timur, Mataram District, only has one holding tank, without any treatment or treatment in each tub for wastewater treatment. And from the results of laboratory testing, the waste from Astra workshop activities had a pH content of 7.2, a BOD content of 2.9 mg/l, a COD content of 58 mg/l, a TSS content of 2.45 mg/l, an oil content and fat of 8.702 mg/l, ammonia content of 0.027 mg/l, and total coliform content of 2000 MPN/ml. So that if the waste is discharged into water bodies, it can damage and pollute water bodies. According to the laboratory results, one of the parameters that did not meet the quality standards following the Decree of the Minister of Environment and Forestry No. 68 of 2016 concerning Domestic Waste Quality Standards, namely the maximum allowable concentration of oils and fats, is 5 mg/l, while other parameters still meet quality standards, namely pH concentrations of 6-9, maximum levels of BOD of 30 mg/l, maximum levels COD was 100 mg/l, maximum TSS content was 30 mg/l, maximum ammonia concentration was 10 mg/l, and maximum permitted total coliform content was 3000 MPN/ml.

From the description above, the authors see the need for research on "Appropriate Technology for Household Scale Workshop Wastewater Treatment Systems" to increase processing efficiency and meet the required quality standards.

RESEARCH METHODS

This research was conducted at Bengkel Astra, located in Jln. Bung Karno No. 13 Pagesangan Timur Kec. Mataram City of Mataram, West Nusa Tenggara. 83127. The object of this research is the liquid wastewater from Astra Workshop activities that originates from the sink. This type of research is an experimental study. Sampling used a purposive sampling technique, namely a sampling technique with certain considerations from the researcher. The waste sample used for research was 15 liters. It used three processing units for one experimental vessel of 5 liters and treatment in the piping section with one filtration media, which was carried out in duplicate to anticipate and minimize the possibility of errors that could occur during the process.

Research tools are a pH meter, Treatment tub, materials, Samples of wastewater from workshop activities, Activated Carbon/Coconut Shell Charcoal, Sand, palm fiber, Pebbles, Coconut husk, PVC pipe 3 inc and PVC pipe ¾ inc.

The data analysis technique was carried out using a qualitative descriptive approach to describe the decrease in the concentration of BOD, COD, pH, TSS, Oil and Fat, Ammonia, and Total Coliform obtained by the experimental filtration apparatus that was made. The decrease is calculated by comparing the influent and effluent values expressed in percent (%) [5].

$$\text{Efisiensi (E)} = \frac{\text{Influent} - \text{Efluent}}{\text{Influent}} \text{ x } 100\%$$

RESULTS AND DISCUSSION

In the manufacture of Appropriate Technology for Wastewater Treatment Systems for the Operation of this Workshop, local materials which are widely available are used, such as sand, palm fiber, coconut shell charcoal, coir head, gravel, and chlorine. These local materials will turn the murky and smelly wastewater into clear, odorless water.

Figure 1. Tool experiment and wastewater sample

From the results of the trial use of the tool, three jerry cans or 15 liters of test water were taken from the operational activities of the Astra workshop; then, the water was put into a holding tank compared to a sink. After that, it will go through a filter in the pipe; then it will go through another filtering stage in 3 treatment tanks, and in the last tub, the chlorine will be added so that clear and odorless water is obtained.

The wastewater, which was initially cloudy in color, turned clearer. It often happens because of the materials used, such as sand, coconut fiber, activated carbon, palm fiber, coconut shell charcoal, and small stones. The sand, coconut coir, and palm fiber used in this water-based decontamination tool are.

The arrangement of double-decker pipes was modified from research [6], which consisted of palm fiber adsorbents, sand, gravel, and charcoal. The abundance of natural adsorbents can be used to reduce rainwater and wastewater impurities. Sand is one of the most abundant natural adsorbents compared to zeolite, fly ash, charcoal, and corn husk adsorbents. That sand can be grouped into three categories. These include terrigenous sand, carbonate sand, and pyroclastic sand [7].

According to SNI 3981:2008, a slow sand filter is a filter that uses sand as a medium filter with a very small grain size but has a high content of sulfur. The filtering process takes place by gravity very slowly and simultaneously on the entire media surface. The filtering process combines physical, biochemical, and biological processes (filtration, sedimentation, and adsorption). Slow sand filters are more suitable for treating raw water with moderate to low turbidity and moderate to high dissolved oxygen concentrations [8].

Sand has a composition that is a combination of SiO_3, Fe_2O_3, Al_2O_3, TiO_3, CaO, MgO, and K_2O [9].

Some of these compounds bind to one another, and these bonds will eliminate the physical properties of water, such as odor and turbidity. These quartz sand grains have pores and gaps that can absorb and hold particles in water. Sand has a powerful function: to remove physical properties such as turbidity or mud, or odors by filtering dirt and water, separating floc remnants, and separating iron particles that form after contact with air. During filtering, colloids suspended in water will be retained in the porous media to improve the quality of the water.

Coconut coir has great potential as a biosorbent because it contains cellulose which in its molecular structure contains carboxyl groups, and lignin which contains phenolic acids, which participate in metal binding. Cellulose and lignin are biopolymers associated with metal-metal separation processes [10]. Coconut coir has great potential as an adsorbent because it contains carbon.

Charcoal is a porous solid with an elemental component of free carbon with covalent bonds. The surface of activated charcoal is nonpolar. The adsorption process is influenced by the type of adsorbent, the adsorbent's composition, and the adsorbent's surface area. It was also that the greater the surface area and total pore volume, the smaller the average pore radius, so it is very good to be used as an adsorbent [11]. The function of palm fiber and gravel is generally used as natural adsorbent.

Chlorine dioxide has been widely used as a primary disinfectant and a taste or odor control in drinking water. Chlorine is the result of the reaction of chlorine gas with NaClO2. In water, chlorine dioxide is more effective than chlorine at a pH of 8-9, thereby reducing the effect of a low pH on the disinfection process of chlorine, namely corrosion. The advantage of chlorine is the length of time that chlorine dioxide remains in the distribution network, thereby saving chemicals. The reaction with organic substances does not produce trihalomethanes, so treated water is safe for consumption [12].

The workshop is a wastewater source; the workshop business's liquid waste can be in the form of used oil, spilled materials, solvents or cleaners, or diesel oil. Wastewater from heavily contaminated workshops will flow following the existing channels so that water easily spreads contaminants and can cause environmental pollution [13].

Motor vehicle repair and maintenance activities potentially negatively impact the surrounding environment, especially those generated by liquid waste from workshop activities, such as water pollution, irritation, and skin disorders in people who use water for bathing and washing. And workshop liquid waste is classified as industrial waste, which contains fatty oil, COD, and BOD, which, if the waste is not treated first, will be very harmful to the environment and water bodies [14].

Table 1. Results of Percentage Reduction of Waste from Astra Workshop Operations Before and After Processing

No	Parameter	Before mg/L	After mg/L	Permenlh No.68 Th.2016	Drop Efficiency (%)
1.	pH	7.2	8.5	6-9	-15.29
2.	TSS	2.45	1	30	59.18
3.	BOD	2.9	0.8	30	72.41
4.	COD	58	20	100	65.51
5.	Oil and fat	8.702	4.75	5	45.41
6.	Amonia ($NH^{3+}N$)	0.027	0.014	10	48.14
7.	Total *Coliform*	2000	0	3000	100

pH

The pH value of water shows the level of acidity or the amount of hydrogen ions in a solution that will affect the biological life in it. The degree of acidity of the water should be neutral, not too acidic or too alkaline. The pH range of the quality standard, which is around 6-9, indicates a neutral pH which will be safe if domestic waste is safe to be discharged into the environment. The pH value of domestic wastewater will affect where the waste is disposed of; in this case, the waste treatment results are discharged into the river. Disposal of domestic waste will change the acidity of the water, either alkaline or acidic, so it will greatly disrupt the life of fish and other aquatic animals. In addition, pH conditions can also affect a chemical compound's toxicity level, aquatic biochemical processes, and metabolic processes of aquatic organisms. The degree of acidity is an important factor in water treatment to improve water quality [15].

The results of the pH analysis of wastewater from Astra workshop operations show that the pH before processing is (7.2). At the same time, after going through the processing stage, the pH value becomes 8.5, and based on this analysis, according to the Minister of Environment and Forestry Regulation No. 68 of 2016 concerning Quality Standards for Domestic Wastewater maximum pH value of 6-9. The pH before processing is smaller than the pH after processing. It happens because the residence time (td) is not considered when adding disinfectant or chlorine. In general, the nature of disinfectants is

alkaline; therefore, the wastewater samples taken at the outlet are still alkaline. However, the decrease in pH between the samples before and after processing is not very significant, but this does not affect the quality of the domestic wastewater produced because it is still within safe limits.

Total solid suspended (TSS)

TSS is the total weight in milligrams per liter (mg/l) of dry sludge in wastewater after being filtered with a 0.45-micron membrane [16]. The liquid waste laboratory test results for Astra workshop operations for the TSS parameters show different results. The measurement results for the average TSS content before processing is 2.45 mg/l and shows that the TSS level is still below the standard quality limit required by Minister of Environment and Forestry Regulation No. 68 of 2016 concerning Domestic Wastewater Quality Standards because the maximum limit for TSS content allowed is 30 mg /l. However, measuring TSS levels after processing decreased by 1 mg/l, so the TSS content is still below the quality standard.

The measurements of TSS levels before and after processing showed that they had decreased by 59.18%. Filtration is a process of separating solids from a solution in which the solution is passed through a porous medium or other porous material to remove as much of the fine suspended particles as possible. This process is used in drinking water treatment plants to filter coagulated and precipitated water to produce drinking water of good quality [17] And in this experiment, filtration is used in wastewater treatment, which has the same function as drinking water treatment to remove suspended particles so that the TSS value in the liquid waste parameters from Astra workshop operations can decrease.

BOD

Another important parameter to determine water quality, especially wastewater, is BOD. BOD indicates the amount of organic matter in water that can be biodegraded. BOD is the amount of biological oxygen in ppm or mg/l needed to decompose organic matter by bacteria so that the wastewater becomes clear again [18]. Bacteria will use oxygen to oxidize these organic matter. To measure oxygen demand, BOD units are needed, and with this BOD, the pollution load is determined. The higher the BOD number, the lower the water quality. The results of the liquid waste laboratory test for Astra workshop operation activities for the BOD parameter showed different results. The results of measuring the average BOD content before processing is 2.9 mg/l and shows that the BOD value is still below the standard quality limit required by Minister of Environment and Forestry Regulation No. 68 of 2016 concerning Domestic Wastewater Quality Standards because the maximum allowable BOD level is 30 mg /l. However, measuring BOD levels after processing showed a significant decrease of 0.8 mg/l. So that the BOD level after processing is still below the quality standard, the measurements of BOD levels before and after processing showed that it had decreased by 72.41%.

COD

COD is the oxygen needed to oxidize organic substances in water samples. COD is a measure of water pollution by organic substances, which naturally can be oxidized through microbiological processes, resulting in reduced dissolved oxygen in the water. COD is the amount of oxygen in ppm or milligrams per liter (mg/L) needed under special conditions to decompose organic matter chemically [19]. The results of the liquid waste laboratory test for Astra workshop operation activities for the COD parameter showed different results. The results of measuring the average COD level before processing is 58 mg/l and shows the COD value is still below the standard quality limit required by Minister of Environment and Forestry Regulation No. 68 of 2016 concerning Domestic Wastewater Quality Standards that the maximum allowable limit for COD levels is 100 mg/l. If the COD concentration is high, it can cause the dissolved oxygen content in the water to become low and even depleted. The oxygen used as a source of life for aquatic creatures decreases, resulting in non-fulfillment of the needs of aquatic creatures and causing death [19]. The results of measuring COD levels after processing decreased to 20 mg/l, so the COD level is still below the quality standard.

The results of measuring the levels of Oil and Fat before and after processing showed that it had decreased by 45.41%. The decrease in Oil and Fat content is due to the filtration process, which is the first processing stage located in each tub. Filtration is a process of separating the solid components contained in water by passing it through a porous medium or other porous material to separate the solids in the water, both in the form of suspensions and colloids. In addition, filtering can also reduce the content of bacteria, odor, taste, manganese, and iron [20].

The CO_2 content in the water is used to dissolve lime, that is, to change compounds into calcium bicarbonate $Ca(HCO_3)$. So that the amount of bicarbonate becomes steady, a certain amount of carbon dioxide (CO_2) must remain in fixable solutions and retain calcium. Carbon dioxide levels (CO_2) are good for aquatic organisms, namely approximately 15 mg/l. If more than that very dangerous because it inhibits binding oxygen (O_2) [21]

Ammonia ($NH^{3+}N$)

Based on the Regulation of the Minister of Environment No. 68 of 2016, the level of Ammonia that is safe for the environment is 5 mg/L. The concentration of Ammonia before processing is generally below the required quality standard, which

is 0.027 mg/l, but the results of measuring ammonia levels after processing show a significant decrease, namely to 0.014 mg/l. So that the ammonia level after processing is still below the quality standard. If the ammonia concentration is high, it can indicate organic matter contamination from domestic wastewater [22-24]. Sources of Ammonia are urine, feces, and the oxidation of organic matter by bacteria naturally [25].

The results of measuring ammonia levels before and after processing showed that it had decreased by 48.14%. Ammonia content decreases due to adding disinfectant or chlorine, the last processing stage. A decrease in ammonia levels occurs because chlorine will react with Ammonia to produce a series of ammonia chlorination compounds called chloramines which then oxidize Ammonia to N_2, a harmless substance. Because hypochlorous acid is a very active oxidizing agent, it will react quickly with ammonia in wastewater [26].

Total Coliforms

The results of the analysis of wastewater from the operation of the Astra workshop showed that there was a very large decrease from before and after processing. It means that the waste treatment process in the WWTP is running well, one of which is in the chlorination tub, which disinfects wastewater before disposal. Chlorine can kill bacteria by destroying or inactivating the main enzymes resulting in wall damage; with chlorination of bacteria, in this case, E. coli will die, and MPN Coliform levels will also decrease because currently, E-coli is a microorganism that threatens river water bodies. The bacteria in the intestines of humans and warm-blooded animals have contaminated river water bodies. After feces enter the water bodies, E-coli will contaminate the waters. Even under certain conditions, E-coli can defeat the body's defense mechanisms and live in the kidney and liver pelvis [27].

CONCLUSION

The concentration of liquid waste from Astra workshop operations before processing was pH 7.2, BOD content 2.9 mg/l, COD content 58 mg/l, TSS content 2.45 mg/l, oil and grease content of 8.702 mg/l, the ammonia content was 0.027 mg/l, and the total coliform content was 2000 MPN/ml. The TSS concentration can be reduced by 59.18% from an initial concentration of 2.45 mg/l to 1 mg/l, and the pH concentration may be reduced by -15.29% from an initial concentration of 7.2 to 8.5 by using a filtration medium and treatment in the piping section. BOD decreased from a starting concentration of 2.9 mg/l to 0.8 mg/l at a 72.41% rate. From a starting concentration of 58 mg/l to 20 mg/l, COD was 65.51 percent. From an initial concentration of 8.702 mg/l to 4.75 mg/l, fatty oil decreased by 45.41%. Ammonia concentration decreased by 48.14%, from 0.027 mg/l to 0.014 mg/l, while total coliform concentration decreased by 100%, from 2000 MPN/ml to 0 MPN/ml.

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