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Biofilter Processing Method Of Reducing The BOD / TSS, Oil / Fat, pH in Liquid Waste at an Orphanage

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The orphanage's liquid waste contains organic substances and oil/fat. If it cannot be processed, it can be released using oxygen and sunlight and is transferred to living things in the water. Because oxygen needs are not sufficient it increases the risk of rot and enhances environmental pollution. The aim is to understand the process of the wastewater processing method using a biofilter with an operating time of 12, 18 and 24 hours for the reduction of BOD (biological oxygen demand), TSS (total suspended solids), oil/fat, and pH. The research method uses the factor of variation in the length of operation with the biofilter method. Perform initial measurements and complete processing with the T-test difference analysis on BOD, TSS, oil/fat levels, and pH of the liquid waste. The results of the study with filtration time 12 hours: decreased BOD 46.60%, 80.99% TSS, oil/fat 81.33%, and the pH to 6.5. Eighteen hours: decreased BOD of 57.29%, TSS 91.15%, oil/fat 81.29%, and the pH to 6.7. 24 hours: 76.24% reduction in BOD, TSS 99.10%, oil / fat 97.57% and the pH to 6.9. The results of the treatment of the institution's liquid waste using the aerobic biofilter methods are effective and efficient. The material used to make WWTP was used drums with a volume of 200 litres. The processing system uses the aerobic biofilter with wasp nest models as the inherent growth media.

Keywords: *BOD, TSS, pH, Oil/Fat, Biofilter.*

Introduction

The orphanage is a social welfare institution that has the responsibility to provide welfare services to neglected children, orphans, and children from low-income families. It plays a massive role in the community in meeting the needs of orphans' lives and all the activities that fulfil health and sanitation concerns. There are 30 orphanages in the city of Bandar Lampung,

which cause an increasing volume of waste, thus requiring the establishment of wastewater treatment that meets health requirements.

Activity of orphans – like the process of washing cookware/dishware, processing of food/beverages, and other activities are factors causing liquid waste generated to also increase. This waste is classified as domestic waste. Because the discharge of processed foods contains protein and amine groups, when degraded it will decompose into volatile and malodorous compounds (Irmanto, Suyata, & Zusfahair, 2013). In addition to organic substances, oils/fats contained in the liquid waste float to the surface and cover the surface of a body of water, hindering the exchange of oxygen and penetration of sunlight. The microorganisms are then aerobically unable to degrade the waste to the maximum, so the pollution load is getting heavier (Warlina. L, 2004). Also, the orphanage waste generates chemical waste material, such as soaps, detergents, and other cleaning materials, characterised by the emergence of soap bubbles on the water surface. The liquid waste will change colour to dark brown and is foul-smelling. If not treated, it can have negative impacts on the environment and public health. The orphanage does not have wastewater treatment facilities, often causing public complaints concerning environmental pollution problems. If the wastewater is discharged into the river without first processing, it will pollute the river (Effendi H, 2003). Several studies in the biological wastewater treatment have been carried out, as shown in Table 1 below.

Table 1. Some research Biological Wastewater Treatment at Diner and a decrease in BOD and COD

No.	sources of waste and researchers	Processing	Early (mg / l)		End (mg / l)	
			COD	BOD	COD	BOD
1.	Artificial Diner (Ismanto, 2005)	Water Hyacinth (Eichhornia crasippes)	613.02	291.76	192.81	155.23
		wood Apu (Pistia stratiotes)	192.81	155.23	129.87	113.45
		Air kale (Ipomoea Aquatika)	129.87	113.45	89.43	87.71
2.	Artificial canteen (Ulfah, 2009)	Air kale (Ipomoea Aquatika)	1520.23	994.63	696.00	174.65

In this study, the rate of reduction in BOD and COD are sound. They just need a location/land area for wastewater treatment. Parasmita Research (2012) shows wastewater leachate treatment by the method of aerobic-anaerobic biofilter with a residence time of 17.5 hours can

reduce BOD by 65%, 29.21% COD, and 39.50% TSS. Therefore, this study wanted to do the biofilter wastewater treatment processing method with a residence time of 12 hours, 18 hours and 24 hours; biofilter does not require a large area. *Biofilter* is a development of bioremediation (Juherah & Mangiri, 2019; Ratnawati & Kholif, 2018; Knight, Rahmawati, and Prasetya, 2019). However, the constraints in the implementation of this biofilter is that the diameter is a less suitable filter media and used to process wastewater, necessitating a modification of the filter media so that it is more effective for the treatment of sewage. The advantages of using biofilters are they do not need a large area, are inexpensive, require little maintenance, and operate by gravity. From the description above, it will be developed for the orphanage wastewater treatment using a grease catcher unit (grease trap), collector well (sump well) and a biofilter *(Firmansyah & Razif, 2016; Prasad & Caesar, 2018)*.

This Research then will research the effect of the orphanage wastewater treatment with biofilter method to reduce BOD, TSS, oil/grease, and Ph.

Methods

Type experimental study with the variant factor long operating times with biofilter method. In this research, the initial measurement is before treatment (pre-test) on levels of BOD, TSS, oil/grease, and pH of the liquid waste in the orphanage and after treatment (post-test). This research was conducted in the laboratory of the environmental health department of the Ministry of Health Polytechnic Tanjung Karang with samples of wastewater from the orphanage in Bandar Lampung. The study was from June 2017 - November 2017. The population in this study are all liquid waste from the orphanage in the city of Bandar Lampung. The sample in this research is the total orphanage liquid waste in Bandar Lampung.

Data used in this study is an interview with the manager of the orphanage in the city of Bandar Lampung. The results of analysis of BOD, TSS, oil/grease, and pH of the liquid waste orphanage were analysed using analysis of T. Different test goal to determine the effect of time differences in the treatment of wastewater in the biofilter with a residence time: 12 hours, 18 hours and 24 hours to the reduction of BOD, TSS, oil/grease, and pH of the orphanage's liquid waste.

Results and Discussion

The results of the analysis of orphanage wastewater in-Bandar Lampung after processing in the reactor with a biofilter method and process filtration with sand on the residence time to 12 hours can be seen in Table 2. Outcome analysis residence time of 18 hours can be seen in Table 3, and the results of the analysis of wastewater parameters on the residence time 24 hours can be seen in Table 4. The results of the study of wastewater parameters at the time of stay, 12 hours, 18 hours and 24 hours can be found at Table 5.

Table 2. Mean Parameter Analysis of Orphanage Liquid Waste in Bandar Lampung For Time Live 12 Hours

No.	Parameter	before Treatment	after Treatment	% Efficiency reduction	Standard Quality standards
1.	BOD	471.5 mg / l	251.8 mg / l	46.60	100 mg / l
2.	TSS	1210 mg / l	230 mg / l	80.99	100 mg / l
3.	Oils / fats	509 mg / l	95 mg / l	81.33	10 mg / l
4.	pH	5.6	6.5		6.0 - 9-0

Standard: Lampung Governor Regulation No.7 of 2010 on the quality standard of wastewater for business or activity in the Province Lampung.

Table 3. Mean Parameter Analysis of Orphanage Liquid Waste in Bandar Lampung For Time Live 18 Hours

No.	Parameter	before Treatment	after Treatment	% Efficiency reduction	Standard Quality standards
1.	BOD	521.7 mg / l	222.8 mg / l	57.29	100 mg / l
2.	TSS	1130 mg / l	100 mg / l	91.15	100 mg / l
3.	Oils / fats	497 mg / l	93 mg / l	81.29	10 mg / l
4.	pH	5.6	6.7		6.0 - 9-0

Table 4. Results of Analysis Parameters Orphanage Mean Wastewater in Bandar Lampung For Time Live 24 Hours

No.	Parameter	before Treatment	after Treatment	% Efficiency reduction	Standard Quality standards
1.	BOD	421.7 mg / l	100.2 mg / l	76.24	100
2.	TSS	1080 mg / l	10 mg / l	99.10	100
3.	Oils / fats	412 mg / l	10 mg / l	97.57	10
4.	pH	5.7	6.9		6.0 - 9-0

Table 5. Results of Analysis of Average% Efficiency Decrease BOD, TSS, Oil / Fats, and Improved wastewater pH di Bandar orphanage Lampung with a biofilter Methods, Time Live 12 hours, 18 hours and 24 hours

The residence time	BOD (Mg / l)	% Efficiency	pH	TSS (Mg / l)	% Efficiency	pH	Oil/ Fat (mg / l)	% Efficiency	pH
12 hours	251.8	46.60	6.5	230	80.99	6.5	95	81.33	6.5
18 hours	222.8	57.29	6.6	100	91.15	6.7	93	81.29	6.7
24 hours	100.2	76.24	6.8	10	99.1	6.9	10	97.57	6.9

BOD Reduction

The mechanism of the process of aerobic wastewater treatment are (with oxygen), aerobic decomposition reaction is as follows:

Organic material + O2 = CO2 + H2O + new cell + energy (Said, 2002).

The ability to get food or the metabolic capabilities of microorganisms in the environment varies. A microorganism that has adaptability and gets food in bulk with maximum speed will multiply rapidly and will become dominant in the background (Jasmiati, 2010; (Augustine, Sembiring, & Effendi, 2014; Daulay, Dhani, and Yulianti, 2011; Selviana, 2019. Also in line with the opinions of Astuti (2007), a decrease in the BOD concentration that often occurs at the start of the addition of nutrients causes a need for microorganisms to adjust to these additions. Still, after the microorganisms have changed, the removal efficiency will be stable. Therefore, we need to set the appropriate time in adaptation to obtain more effective results. In general, the decline in BOD continues by increasing the time of the bioremediation process. For more details on the processing method, BOD reduction biofilter on the residence time 12 hours, 18 hours, and 24 hours in the biofilter can be seen in Figure 1 below.

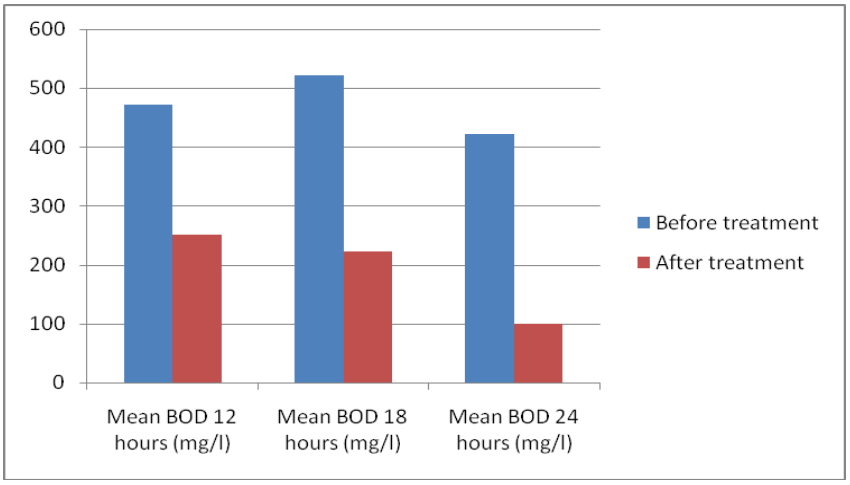

Figure 1. The mean decreased levels of orphanage effluent BOD with biofilter methods

According to Arsil and Supriyanto (2007), the TSS reduction is caused by the deposition process and the degradation of organic matter on each filter so that the small particles contained in the liquid waste attach to the screen used. It is also by the opinion of Putro (2008), the thicker the layer filters, the zone of filtration will be higher, so the ability to withstand the insoluble materials (suspended solids) in wastewater gets more prominent. In this case, the small distance between the particle filter will hold suspended solids that are large in order for them not to be carried into the waste stream. Then microorganisms (EM4) inhibit the growth and development of pathogenic microorganisms by secreting anti-biotic compounds which are also contained in it (Moersidik, 1994; Zalfiatri, Restuhadi, & Maulana, 2017). The mean treatment effect at 12 hours, 18 hours and 24 hours in the biofilter can be seen in Figure 2 below.

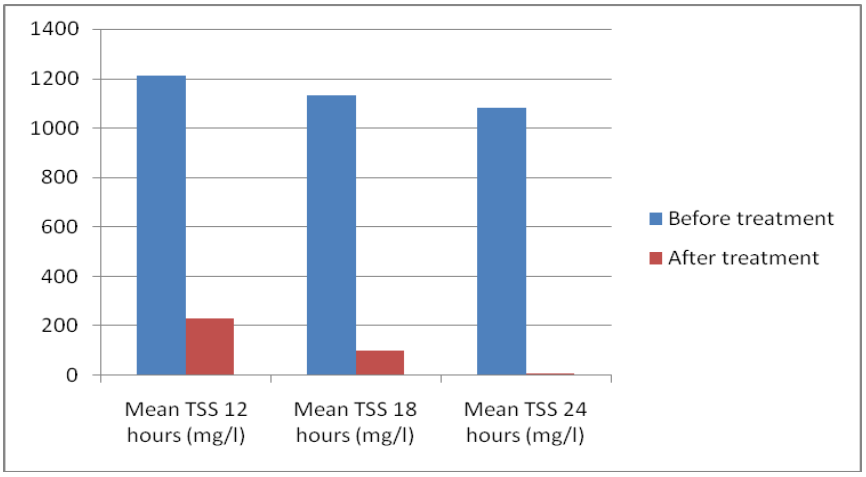

Figure 2. The mean decreased levels of orphanage effluent TSS with biofilter methods

Reduction of oil/fat

Oil/fat will separate by gravity along with the used water. The water-in-oil emulsion is formed when water droplets are covered by a layer of oil. Most of the oil emulsion is to be degraded

through photo spontaneous oxidation and oxidation by microorganisms (Fardiaz, 1992; Khaer, 2018). Fat including organic compounds are stable and relatively difficult to be broken down by bacteria. Fat can be reformed by acid compounds that produce fatty acids and glycerin. In the alkaline state, it would be released, and glycerin fatty acid salt formed from the base (KES Manik, 2003). Therefore, the attempted processing of oil/fat is done at the beginning of the treatment of wastewater (Sugiharto, 1987).

For more details, a drop in oil/fat in the processing method of the biofilter at a residence time of 12 hours, 18 hours, and 24 hours in the biofilter can be seen in Figure 3 below.

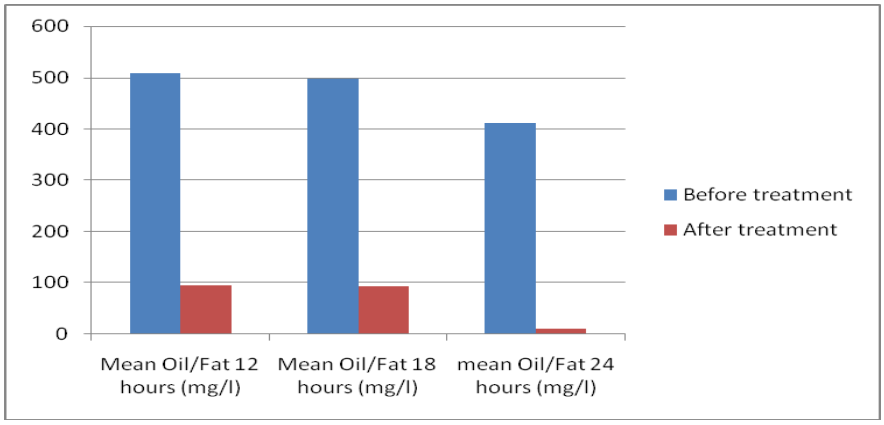

Figure 3. The mean decrease in the amount of orphanage oil/grease wastewater with biofilter methods

pH (acidity Degrees)

Table 5 shows the change in pH from the results of the treatment of wastewater in the biofilter method; changes in pH indicate the range where significant changes range from an average of 5.6. But at the times 12 hours, 18 hours, and 24 hours the resulting change in pH indicates a relatively constant change that is 6.5- 6.9.

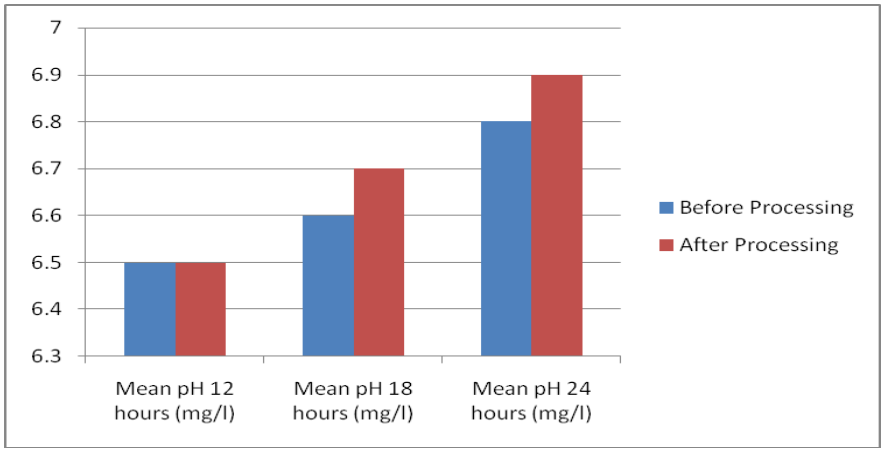

Figure 4. The mean increase in the pH of the orphanage liquid waste with biofilter methods

From this research, pH is likely to increase. Raising the pH at any time of stay is influenced by the amount of lactic acid-forming microorganisms. Both of these microorganisms in a mutual symbiosis decompose organic matter in the wastewater (Sami, 2016; Rosyadi, 2010). The pH value associated with the activity of microorganisms in the processing of organic waste, microorganism activity will affect the value of pH and vice versa – pH value also affects the activity of microorganisms that live mostly in the neutral pH range. Still, some microorganisms are capable of living at low pH (acidic). The increase in pH from 5.6 to 6.5 to 6.9 at the time of only 12 hours, 18 hours and 24 hours, is caused by microorganisms that exist in the EM4 remodel residual organic material from wastewater with the following reaction:

$$C_xH_yO_zN_2S + O_2 \longrightarrow CO_2 + H_2O + NH_4^+ + SO_4^{2-} + \text{energy}$$

The decomposition reaction of organic compounds can generate ammonia.

For more details, a drop in oil/fat on the processing method of the biofilter at a residence time of 12 hours, 18 hours, and 24 hours in the biofilter can be seen in the picture.

According to the Lampung Governor Regulation No. 7 of 2010 and KepMenLH 112 of 2003 on domestic wastewater quality standard, an aerobic biofilter wastewater treatment was installed at the orphanage with field-scale processing using the reactor from a plastic drum with a volume of 200 litres, and filtration with sand. Though reduction of BOD figures only 100.2 mg / l or BOD reduction percentage reached 76.24% at the operating time 24 hours, and the default is 100 mg / l (not meeting the quality standards according to Regulation Lampung Governor in 2010). Still, the quality of wastewater after treatment was better. Several studies are similar to this research, among others the Filliazati study (2013) of domestic wastewater treatment (eating house) with aerobic biofilter system with continuous use and crop threshold bio ball media.

Likewise, the research of Amri and Wesen (2015), domestic wastewater treatment using plastic anaerobic biofilter, have media (bio ball) Surabaya, with a laboratory scale with residence time. Five days COD removal efficiency of 90.29% and BOD allowance amounting to 92.93% at the time of stay 5th day with a recirculation rate of 100%. Research by Sugito (2007); the application biofilter wastewater treatment plants to reduce the content of pollutants BOD, COD, and TSS in the hospital, the mother Surabaya, 51.17% decrease BOD, COD 43.5%, and 49.54% TSS. (Journal ISBN No. 978-979-18342-0-9). According to Aid (2002), BPPT Water and Waste Management Research Technology using anaerobic-aerobic submerged biofilters for the treatment of domestic wastewater, with a residence time between 1-3 days, and the process of circulation with hydraulic recirculation ratio, (HRR = 1), obtained a reasonably high processing efficiency from 84.7 to 91%, i.e., BOD, COD 79.6 to 95.3%, SS 94.1 - 95%, Ammonia (NH_4-N) 89.3 - 89.8%, Detergents (MBAs) 83 - 87% and phosphate ($P0_4$) 44.4 - 47.3%.

Wastewater treatment research results of the orphanage with this method of aerobic biofilter, when compared with previous studies had better results. Cost is quite effective because the materials used to make the WWTP is drums with a volume of 200 litres. Method using aerobic processing biofilter with a honeycomb model, the inherent growth media (attached growth) and the scale of the field with a residence time of 24 hours can reduce the number of BOD was 100.2 mg / l (76.24%), TSS 10 mg / l (99.10 %), oil/fat, 10 mg / l (97.57%) and the pH to 6.9. Although the numbers are still above BOD quality standards, but TSS and oil/fat can be reduced to below the quality standard, and the pH number to normal, according to the Minister of Environment Decree No. 112 of 2003, and Lampung Governor Regulation No. 7 of 2010 concerning the quality of domestic waste.

Conclusion

The results of orphanage wastewater treatment with aerobic biofilter method have been good, effective and efficient because of the materials used to make the WWTP are drums with a volume of 200 litres. System processing uses aerobic biofilter with a model of honeycomb, the inherent growth media (attached growth).

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