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The Modification of Communal Wastewater Treatment Plant (IPAL) Tlogomas Malang Using Sand Filter

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Abstract— *The process of blackwater treatment at Tlogomas WWTP still needs to be developed in order to improve the quality of the result, therefore it can be reused and not pollute the environment. This research used concrete sand as filter material to remove the pollutants contained in blackwater. Concrete sand is chosen because it is easily obtained at a relatively cheap price, thus it is suitable to be applied in developing countries like Indonesia. Hopefully, the method of blackwater remediation applied in this research can be re-applied by the community. This way, all parties can contribute to the wastewater management program. Based on the result, visually, the output water of the sand filter method has low turbidity, which indicates that the pollutant content in blackwater has been optimally filtered. Aside from being reused, the processing water also does not have the potential to pollute the environment if it is discharged into the river body.*

Keywords— *Blackwater, Filtration, Sand.*

I. INTRODUCTION

Waste is a substance that is useless and has no economic value, thus will be disposed of. Basically, there are two types of wastewater, namely industrial waste and domestic waste. Wastewater which includes household (domestic) waste only contains organic substances with simple processing that can remove pollutants contained in it (Perdana, 1992). The most wastewater that is disposed of and pollutes the river is wastewater that comes from domestic activities. Around 50-75% of the organic load inside the river comes from domestic waste (Nelwan, 2011). As a result of the disposal of waste that is not in place, this will lead to the emergence of various types of digestive tract diseases, respiratory diseases, and other diseases.

Domestic wastewater is divided into two, namely blackwater wastewater and greywater wastewater (Muti, 2011). Blackwater wastewater comes from human waste which needs to be processed before being discharged because it contains pathogenic bacteria. In general, blackwater is accommodated into septic tanks or directly channeled to sewage systems to be processed in a domestic wastewater treatment plant (WWTP). For greywater, wastewater comes from the activities of the kitchen (sink), water used to wash clothes, and bath water which is usually directly discharged into the drainage channel (sewer) or to public waters (rivers). Fir instance, the communal wastewater treatment plant in Tlogomas, Malang, in which the waste after going through the sediment in several ponds is then immediately dumped into the river.

Tlogomas is a sub-district in Malang City that has communal wastewater treatment plant (IPAL) facilities to overcome the problem of blackwater waste pollution. Tlogomas integrated MCK is a village within the city of Malang, which is inhabited by 120 families with a land area of 25m x 15m provided to accommodate the blackwater with a fairly good arrangement. The working principle of communal WWTP is to drain blackwater waste into one location behind the village, just on the edge of the Brantas River. The integrated MCK area measures 15 meters x 25 meters. The area does not look dirty and dirty at all, it is more visible as a garden or garden. In fact, the community-style WWTP is made open, not closed like a septic tank in general. There are nine ponds covered with water hyacinth, septic tanks are in the corner of the area, and there is a kind of bamboo seat under the starfruit trees that are often used by residents for chatting. Various flower and fruit plants thrive, starting from citrus fruits, star fruit, papaya, chili, and red shoots and various types of a croton. On the wall, the integrated MCK area is full of various encouraging writings, such as' neatly arranged environment.

Fig. 1. The condition of communal wastewater plant (IPAL) Tlogomas Malang

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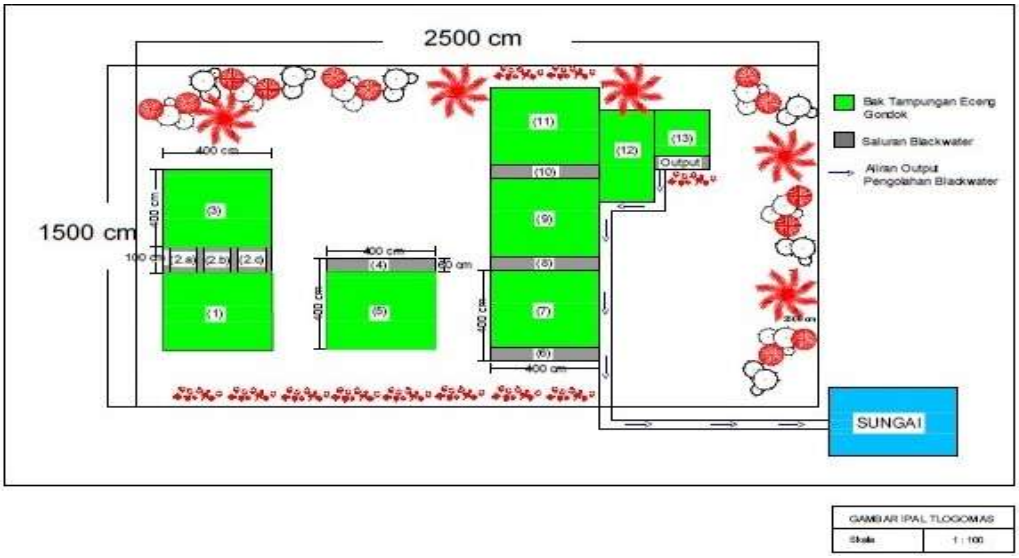

Fig. 2. Site plan of communal wastewater plant (IPAL) Tlogomas Malang

The communal WWTP Tlogomas is considered good. It is even widely known in several countries. However, researchers feel the need for development so that the results of wastewater treatment can be improved. Nowadays, the condition of IPAL Komunal Tlogomas is managed by the surrounding residents with very limited funds. There are funds from several parties who are visiting or interested in the development of the wastewater treatment plant. This community service program is aimed to help improving the technology of communal wastewater treatment plant in Tlogomas Malang by adding the process of blackwater treatment. researchers used concrete sand as filter material to improve the quality of the plant output. Researchers also expect that the concept can be widely implemented by the community.

II. METHOD

Community Service Program (Abdimas) were obtained at communal WWTP of Tlogomas Malang. In other words, blackwater wastewater samples were taken directly from the communal WWTP of Tlogomas Malang directly. This activity includes setting the flow from the first sewage pool to the filtering pool, the initial and final water analysis, the water analysis of the output from the filter and the adjusted final water analysis in the field.

A. Tools and Materials

The tools used in this implementation includes Horiba water sampler, jerry cane, stopwatches, cameras, stationery, and others. Furthermore, the materials used in the implementation included blackwater taken from Communal Tlogomas MCK. In addition, other materials used was concrete sand with a particle diameter of 2 mm.

Sand is included in the very rough category if it has a grain size of 1-2mm. Coarse sand measuring 1 / 2-1mm, medium sand measuring 1 / 4-1 / 2mm, fine sand measuring 1 / 8-1 / 4mm, and very fine sand measuring 1 / 16-1 / 8mm. The average size of sand grains in sediments is 0.125 mm-1 mm and is composed of granules of minerals and fractional stones.

B. Procedures

The procedures of this community service research are explained by the following figure:

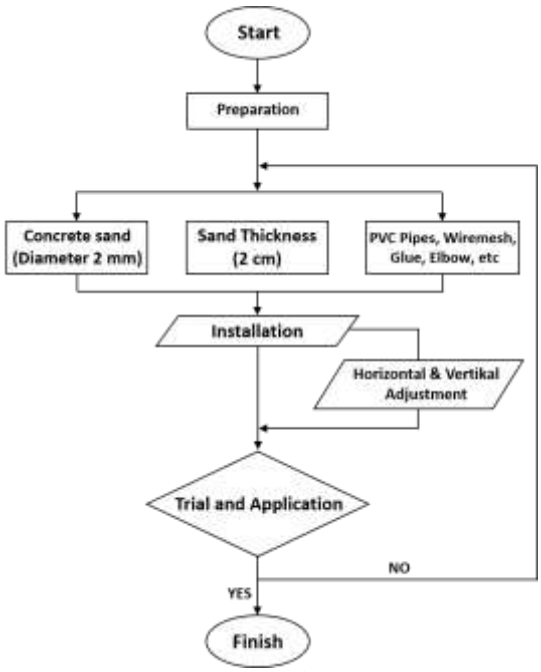

Fig. 3. Research flow chart

C. Material Preparation

The main materials that need to be prepared are concrete sand and blackwater. Blackwater was directly collected from communal wastewater treatment plant Tlogomas, Malang.


Fig. 4. The collection of concrete sand as filter material


Fig. 5. Blackwater in the sewage pool in communal wastewater treatment plant Tlogomas

D. Plant Designing and Implementation

The concept of a filter model that will be applied in the field is illustrated in figure 6.

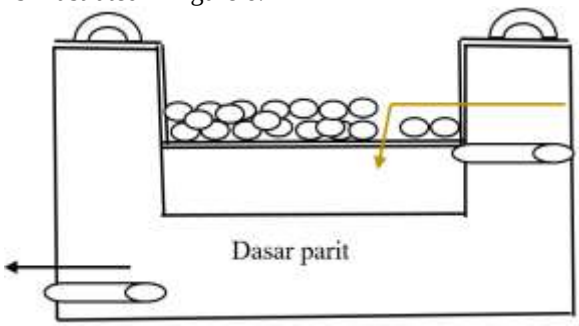

Fig. 6. The concept of the filtration process

In the model, tools are used, such as wire mesh screen 18, plate as a frame, and PVC pipe as a distributor of water. This development method certainly considers the condition of the Communal Tlogomas WWTP, so that it can be applied and produce good external water. The results of the manufacture are displayed through the following photos:


Fig. 7. Filter Pipe (Scale 1:2)


Fig. 8. Input pipe


Fig. 9. Output Pipe


Fig. 10. Output Tap


Fig. 11. Input filter


Fig. 12. Output Filter


Fig. 13. Packed concrete sand (to be put into the filtering pipe)

Furthermore, the design above is applied in the sewage pool in communal wastewater treatment plant (IPAL) Tlogomas Malang. The application is showed by the following photos:


Fig. 14. Sewage well


Fig. 15. The installation of filter


Fig. 16. Finished installation


Fig. 17. The operation of blackwater filtration


Fig. 18. The result of filtration

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III. Result and Discussion

A. The Decrease of Turbidity Level

Table I presents the results of measuring the turbidity level of blackwater treated with sand filters with a treatment thickness of 20 cm. the screening process is carried out from day 1 to day 9 to determine the best processing time.

TABLE I. The reduction process of blackwater turbidity

No	Turbidity (NTU)		Duration (Days)	Standard
	Morning Sample	Evening Sample		
1	1000	800	0	5
2	300	320	1	
3	250	280	2	
4	200	230	3	
5	180	200	4	
6	150	175	5	
7	130	155	6	
8	100	120	7	
9	95	110	8	
10	90	105	9	

This research is a further study which previously tested the ability of sand filters of various thicknesses. From the results of previous studies, 20 cm sand thickness is the most optimal treatment in reducing turbidity of blackwater wastewater. This can be seen from the final turbidity level reaching 90 NTU in blackwater waste obtained in the morning. This figure is the lowest when compared with the results of other treatments. In wastewater obtained in the afternoon, the final turbidity level after filtering for 9 days is 105 NTU.

B. The Effect of Sand Filter on Turbidity Level

Regression analysis on morning data sample

Table II presents a summary of the results of Linear Regression analysis on blackwater data obtained in the morning, specifically related to the effect of sand thickness and turbidity level.

TABLE II. The result of Regression analysis on morning data sample

Independent var.	Coef.	Sig.	R^2	Equation
Sand thickness	-11.847	0.126	8.1%	Y= 523.386–11.847 X+e

It can be seen that the results of the Linear Regression analysis between sand thickness and turbidity in the morning data show a regression coefficient of -11.847, with a significance value of 0.126 (> α 0.05). So, it can be stated that the thickness of the sand has a negative and not significant effect on the turbidity of treated wastewater. In other words, the thicker the sand layer is used for filtration, the more potential it will be in reducing turbidity levels. The coefficient of determination obtained from regression analysis is 8.1%, where this number represents the effect of the treatment of sand thickness applied to the turbidity level of treated wastewater. The rest (91.9%) is the percentage effect of variables or other factors, apart from the treatment of sand thickness applied.

Regression analysis on evening data sample

The results of the linear regression analysis between sand thickness and turbidity of waste water obtained in the afternoon can be seen in the following table:

TABLE III. The result of Regression analysis on evening data sample

Independent var.	Coef.	Sig.	R^2	Equation
Ketebalan Pasir	-10.129	0.079	10.6%	Y= 493.143–10.129 X+e

The summary of the results of the Linear Regression analysis above shows that in the afternoon observation data, a regression coefficient of -10.129 was obtained, with a significance value of 0.079 (> α 0.05). Thus, the interpretation obtained here is in line with the results of the analysis in the morning data. The thickness of the sand is statistically proven to have a negative and not significant effect on turbidity. The thicker the layer of sand, then the turbidity level of filtered wastewater will decrease. If you see the coefficient of determination generated from the regression analysis, you can know that the percentage of the effect of the treatment of sand thickness is 10.6% on the turbidity level of waste water. In other words, the remaining 89.4% represents the influence of variables or other factors, other than the thickness of the sand applied.

C. Discussion

The use of sand as a filter material is one of the wastewater treatment solutions that is very easy to apply even though the general public. The reason is none other than the ease of obtaining materials at once in making filter models. In theory it is said that sand has promising potential to be used as a water purifier, both filtration with rapid sand (slow sand filtration) and slow sand (slow sand filtration). Blackwater wastewater is high in organic matter, so its characteristics tend to be muddy and black. In this case, the use of sand is considered very appropriate for filtering mud load and reducing turbidity of waste water.

Based on the data from the measurement of turbidity levels during the treatment process, it can be seen that turbidity of wastewater decreases with the length of the screening process. When compared between the three sand thickness treatments, it can be stated that the sand thickness of 25 cm is the most optimal treatment in reducing the turbidity level of waste water. This finding is indicated by the final turbidity level reaching 90 NTU (morning blackwater). That is, descriptively it can be seen that the thicker the sand layer is used, the more potential it will be in reducing turbidity of waste water.

The results of Linear Regression analysis confirm what is seen in the descriptive data presentation. Both in the morning and evening blackwater samples, it was found that each had a negative and insignificant coefficient. So, in broad outline similar to the previous description, where the thicker the sand layer is used, the turbidity level of waste water will decrease further. In other words, the filter is considered to be more potential in filtering mud and other loads so that the output of the water produced will be lower in turbidity.

According to Dubey and Omprakash (2013), the method of filtering wastewater with sand is one of the traditional methods that can be used as an alternative. Sand filters can be used to treat domestic waste into water that is suitable for use in agricultural activities. Furthermore, Gusdi et al. (2015) added that in the method of treating wastewater with a filtration system, the sand layer is a layer of filter material that should be made thick. It is said that sand is able to purify water

optimally, where the thicker layers of sand are used, the clearer water released from processing will be. When referring to the research of Adhibaswara et al. (2011), a layer of sand is used to filter mud and other materials contained in water.

This research is in line with the results of research conducted by Dewi and Yanti (2016) which uses several filter materials, including one of them is sand, to reduce COD and TSS levels in tofu waste. In his research, it was found that sand with a thickness of 7 cm was able to reduce TSS levels well. In connection with this study, TSS is a parameter that is closely related to turbidity, where turbidity itself is the result of the level of suspended solids (TSS) in wastewater. Thus, it can be said that the results of this study are in line with the theory and previous researchers. The thickness of the sand and sufficient residence time will produce clear water output.

IV. CONCLUSION

Based on the results, it can be concluded that sand can be used as a filter material. In general, the results of implementation in the field show promising results, but the results obtained are still not maximal and need to be developed again. The level of turbidity of wastewater decreases as the length of stay is applied. The most optimal residence time to reduce turbidity of wastewater is 9 days, with a decrease in turbidity to 80%. Further researchers are advised to use other materials for wastewater filters, both applied singly or in combination. Further research is expected to produce better water output.

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