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Sanitation Modeling of Communal WWTP in Domestic Liquid Waste Management Efforts in Karanganyar Regency

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Abstract:- Domestic waste is the most waste produced every day by varioushousehold activities that have a level of COD (chemical Oxygen Demand), BOD (Biological Oxygen Demand), TSS (Total Suspended Solid), pH, Temperature, Oil and E. Coli which are very high and harmful to the environment. Therefore this problem cannot be ignored and requires special attention so that water pollution can be minimized by using the Communal WWTP (Water-waste Treatment Plant) management model. This is done by treating the inlet-outlet water discharge factors, giving biofilter media, and administering decomposing bacteria. Data analysis was performed by using a three way ANOVA statistical model to prove whether the influence was partial or simultaneous. The conclusions the sanitation modeling behavior are as follows: 1) water discharge, media, bacteria and their interaction do not affect the pH of the water; 2) water discharge and bacteria affect the water temperature, while the media and their interactions do not affect the water temperature; 3) water discharge, media, bacteria affected BOD, while the interaction did not affect BOD; 4) water discharge, media, bacteria affect COD, while the interactions do not affect COD; 5) water discharge, media, bacteria affect oil, while the interactions do not affect oil; 6) water discharge and bacteria have an effect on E. Coli, while the media and their interactionshave no effect on E. Coli; 7) water discharge affects Temperature, BOD, COD, TSS, Oil, and E. coli; 8) media affect BOD, COD, and Oil; 9) Bacteria affect temperature, BOD, COD, Oil and E. coli; 10) Interaction between media * water discharge * bacteria only affects TSS; 11) pH parameter of water cannot be affected by water discharge, media or bacteria.

Keywords:- *WWTP Communal, Domestic Liquid Waste, Water Discharge, BiofilterMedia, Bacteria*.

I. INTRODUCTION

Domestic waste is the most waste produced every day by various household activities that have a level of COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), TSS (Total Suspended Solid), pH, Temperature, Oil and E. Coli which are very high and harmful to the environment. Therefore this problem cannot be ignored and requires special attention so that water pollution can be minimized.

Microorganisms, in this case, are naturally able to degrade organic matter in domestic waste so that it can improve the quality of domestic waste. One of the alternatives in processing domestic wastewater is by using microorganisms,namely adding bacteria to Communal WWTPs of domestic waste. In this study two treatments were given, namely Communal WWTPsin which anaerobic bacteria Pseudomonas putida was added and Communal WWTPsin which there were no additional bacteria.

The inflow and outflow water discharge in the Communal WWTPs can physically improve the inflow and outflow water quality so that the communal WWTP sanitary wastewater, which is in accordance with water quality standards, does not pollute the environment. The water discharge studied was grouped into two categories, which were less than 100 ml / second and the water discharge between 100 ml / second to 500 ml / second so that the most optimal discharge in improving water quality was found in the Communal WWTP system.

The use of biofilter media aims to grow microorganisms so that they are attached to the surface of the contact media, namely honeycomb media from plastic aqua bottles. The advantage of wasp nest media is that it is lightweight, it is easily rewashed, and has the larger specific surface area than any other type of biofilter media. Honeycomb media / Wasp Nest are media made from PVC plastic with a size of 30 cm x 25 cm x 30 cm and a hole size of 2 cm x 2 cm with a thickness of 0.5 mm with a specific area of ± 226 m2 / m3 weighing 30-35 kg / m3, hollow porosity 0.98 and transparent clear color. This surface cross-sectional area serves as a living place for bacteria needed to maintain water quality (Said, 2005).

Based on these three factors, the effect on water quality parameters, namely COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), TSS (Total Suspended Solid), pH, Temperature, Oil and E. Coli is then observed either partially or simultaneously(interaction) on inlets and outlets.

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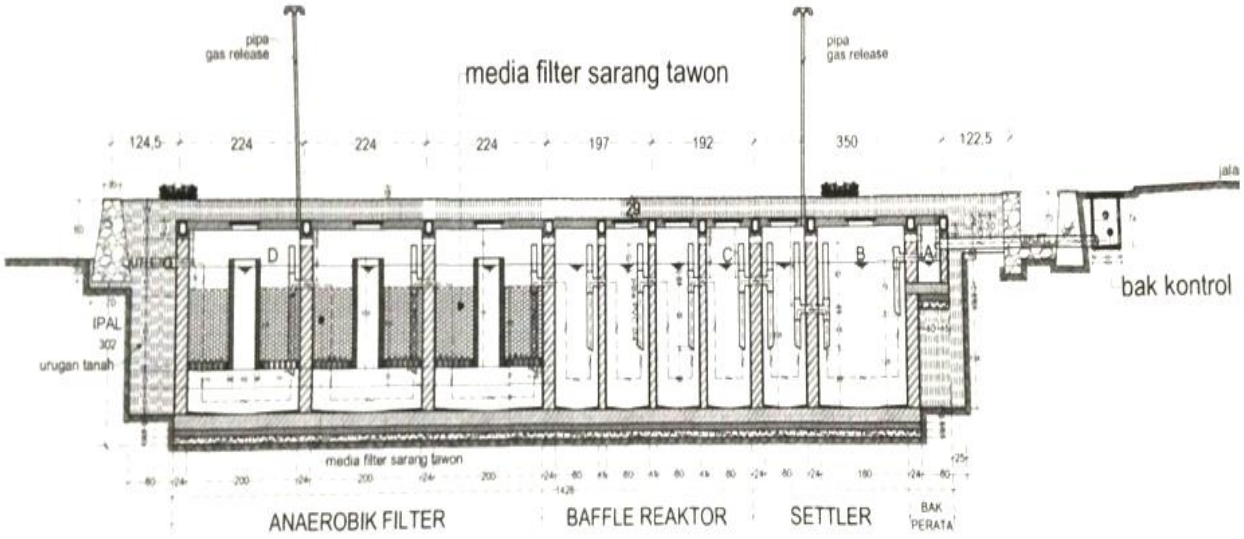

Fig 1:- Diagram of Wastewater Treatment Process by using Anaerobic Biofilter Process

II. RESEARCH METHOD

A. Equipment

Water sampling was taken in the WWTP inlet and outlet and is used to determine the type of efficient and effective domestic waste treatment filter media.

B. Research Procedure

This research was the development of a domestic waste processing sanitation model by using filter media in which bacteria was added to the Communal WWTPsand then the outlet water discharge was observed.

C. Sampling

The population in this study was domestic wastewater in Karanganyar Regency with a sample of 33 Communal WWTP networks in 10 sub-districts namely Colomadu (2), Jaten (7), Jumantono (1), Karanganyar (10), Karangpandan (1), Kebakkramat (2), Matesih (3), Mojogedang (2), Tasikmadu (3), and Tawangmangu (2).

D. Data Analysis Method

To test whether there were any differences in consumer perceptions in each experimental group, the average different test were carried out by using Three Way Analysis of Variance (Three Way ANOVA) statistic, whose steps were:

Average Balance Test by using formula $\boldsymbol{t} = \frac{(\overline{X_1}-\overline{X_2})-(\mu_1-\mu_2)}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}$,

Normality test by using formula$L= \max |F(Z_i) - S(Z_i)|$, Homogeneity test by using formula

$$X^2 = \frac{2{,}303}{G}(f \log RKG - \sum f_j \log S_j^2 G,$$

Three way variance analysis test with Free Cell Frequency$X_{ijkl}=\mu+\alpha_i+\beta_j+\gamma_k+\alpha\beta_{ij}+\alpha\gamma_{jk}+\beta\gamma_{jk}+\alpha\beta\gamma_{ijk}+\varepsilon_{ijkl}$ Double comparison test by using formula$Fi..-j.. =$

$$\frac{\left(\overline{X}_{i..}-\overline{X}_{j..}\right)^2}{RK_g\left(1/n_{i..}+1/n_{j..}\right)}$$

where as the layout of the data was described in the form of research design as follows:

B / A / C		B			
		b_1		b_2	
		c_1	c_2	c_1	c_2
A	a_1	$a_1b_1c_1$	$a_1b_1c_2$	$a_1b_2c_1$	$a_1b_2c_2$
	a_2	$a_2b_1c_1$	a_2b1c_2	$a_2b_2c_1$	$a_2b_2c_1$

Table 1:- Design of research data

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III. RESULTS AND DISCUSSION

Domestic waste sanitation conditions in Karanganyar Regency are a description of the environment of sewage disposal from the results of household activities, especially black water which is influenced by the type of sanitation facilities and the quantity of domestic waste produced by each person ± 90 liters / person / day. The sanitation sector is one of the public services related very much to poverty which adversely affects health and environmental conditions, especially in dense, slum and poor residential areas.

Karanganyar Regency is one of the districts that has many sanitation-prone areas, namely: 177 villages / sub-districts whose sanitation conditions are 6 Villages at very high risk, 77 villages at high risk, 54 villages at moderate risk, and 40 villages at less risk. Sanitation Facilities of the community in Karanganyar Regency are on site sanitation with a latrine in each household. There are two types of sanitation facilities, namely: healthy latrines (latrines with goosenecks and septic tanks), unhealthy latrines (simple and straight latrines) and,even, some do not have one. Those who do not have latrines usually defecate on rivers, gardens and hitchhikes in neighbors. There are 47% of the population served and 53% not served.

This condition can result in a decrease in water quality not only due to industrial waste, but also due to household waste both liquid and solid waste (Lallanilla, 2013). The decline in water quality is caused by pollution from household waste and industrial wastes that do not heed the proper disposal and treatment of waste conditions in the surrounding environment, so that it has an impact on the condition of residents' well water, river water and groundwater.

With the Communal WWTPs, it is expected that household waste can be managed before being discharged into nature in order not to pollute the environment. Some indicators that can be used as environmentally friendly water parameters are temperature, pH, BOD, COD, TSS, Oil, and E. Coli. These seven indicators can be managed technically so that the results of the household waste disposal do not pollute the environment.

Effective and efficient domestic waste sanitation modeling will produce clean and not polluting the quality of wastewater. The quality of waste water is influenced by 3 factors as follows:

A. Water Discharge

Some domestic waste management efforts can be in the form of a settlement model by providing special treatment such as controlling water discharge, providing media, and adding liquid bacteria in order to improve the quality of waste water. According to (Sumantry, 2012) water discharge can improve water quality carried out by the float method. This is in accordance with the research of (Ayubi, Dzulkiflih, & Rahmawati, 2015) which states that the measurement of water in-pipe discharge can effectively improve water quality in BOD, COD, TSS, and E. Coliparameters.

According to (Sarasdewi, Antara, & W, 2015), water discharge can reduce contamination of domestic wastewater treatment plants. Water discharge or flow rate of 50 ml / minute effectively reduced ammonia, COD, BOD, and TSS content by 91.42%, 74.77%, 52.95% and 72.76% respectively. This is in line with the data analyzed in this study which can be tabulated as in Table 2 below.

Parameter	Inlet		t test	Outlet		t test
	Discharge (Q1)	Discharge (Q2)				
pH	7,07	6,85	0,74	7,12	6,97	0,53
Temperature	25,91	26,70	-0,92	25,21	26,57	-1,28
BOD	137,23	134,72	0,09	20,34	26,54	-2,76
COD	257,16	231,47	0,54	34,28	39,99	-2,07
TSS	172,29	166,89	0,14	24,88	32,00	-2,57
Oil	2,91	2,82	0,38	1,88	2,24	-1,82
E.Coli	190.416.666.666.667	175.555.555.555.556	0,73	14.743,5	26.000,0	-2,46

Table 2:- Test t and the average value of parameters in the Water Discharge group

Parameter	F	Sig	Description
pH	0,162	0,690	Water discharge has no effect onpH
Temperature	7,312	0,012	Water discharge affects temperature
BOD	48,532	0,000	Water discharge affects BOD
COD	6,084	0,021	Water discharge affects COD
TSS	6,774	0,015	Water discharge affects TSS
oil	9,003	0,006	Water discharge affectsoil
E.Coli	10,347	0,004	Water discharge affects E.Coli

Table 3:- Recapitulation of the influence of Discharge on research parameters (pH, Temperature, BOD, COD, TSS, oil, and E. Coli)

Table 3 shows that the water discharge in the Communal WWTP affects temperature, BOD, COD, TSS, oil and E. coli content, but it does not affect pH.

B. Bio Filter Media

The research of (Filliazati, Apriani, & Zahara, 2011) states that the use of bioball media can improve the quality of domestic waste (greywater) according to water quality standards. Efforts to manage domestic waste with bioball media can reduce BOD by 68.98% from the initial concentration of BOD 785.5 mg / l to be 235.29 mg / l. At the same time, the efficiency of decreasing fat oil was 96.60% from the initial concentration of 5213 mg / l to be 177.5 mg / l. According to (Case, Tahu, & Tempe, 2001) the use of honeycomb biofilter / Wasp Nest with dimensions of 28 cm x 25 cm x 30 cm can reduce BOD levels with an efficiency level of 51% to 91% in 1 to 14 days.

According to(Nugroho, Sumiyati, & Hadiwidodo, 2014), media use can reduce concentration and efficiency of COD by 60.76%, and oil by 62.26%. These results are in accordance with field observations in which biofilter can reduce the concentration of BOD, COD, and oil shown in Table 4 below:

Parameter	Inlet		t test	Outlet		t test
	Media (M1)	Media (M2)		Media (M1)	Media (M2)	
pH	7,12	6,85	1,03	7,13	7,01	0,47
Temperature	26,07	26,19	-0,14	26,13	24,83	1,35
BOD	128,32	147,70	-0,77	19,25	25,81	-3,40
COD	233,03	273,39	-0,95	32,66	40,14	-3,26
TSS	156,32	190,50	-0,98	24,42	30,07	-2,21
oil	2,94	2,81	0,61	1,72	2,33	-3,91
E.coli	195.789.473.684.211	173.571.428.571.429	1,23	13.454,9	23.728,6	-2,50

Table 4:- Test t and average parameter values in the BioFilter Media group

Parameter	F	Sig	Description
pH	1,864	0,184	Media has no effect onpH
Temperature	2,806	0,106	Media has no effect on temperature
BOD	8,929	0,006	Media affects BOD
COD	4,178	0,052	Media affects COD
TSS	3,356	0,079	Media has no effect on TSS
Oil	8,031	0,009	Media affectsOil
E.Coli	1,42	0,245	Media has no effect on*E.Coli*

Table 5:- Recapitulation of the influence of the Media on research parameters (pH Temperature, BOD, COD, TSS, oil, and E. Coli)

Based on the analysis of ANOVA, it can be seen that the biofilter media have a significant effect on BOD, COD, Oil and do not affect pH, temperature, TSS, and E. coli.

C. Bacteria

According to(Evdokimova, Gershenkop, & Fokina, 2012)bacteria can reduce levels of BOD and COD in given standards and can reduce the number of bacteria e.coli. Even,(Arief, 2010)states that bacteria improve water quality by 61.21% to 97.81%, and reduce TSS levels to 90.77% so that the water meets quality standards.

(AlpHonsus Yospy Guntur D (1), AlpHonsus Wibowo N Jati (2), L Indah Murwani Yulianti(3); 2017), state that giving bacteria can reduce the level of Dissolved Oxygen Density (BOD) by 52.69%, the level of Chemical Oxygen Demand (COD) by 69.29%, and the level of Total Suspended Solid (TSS) by 73.87%. This is in line with the empirical conditions in the management of Communal WWTP in Karanganyar Regency that the administration of bacteria effects temperature, BOD, COD, oil and E. Coli, as the results of ANOVA analysis in Table 6 below:

Parameter	Inlet		t test	Outlet		t test
	Bacteria (B1)	Bacteria (B2)		Bacteria (B1)	Bacteria (B2)	
pH	7,04	6,97	0,25	6,96	7,24	-1,12
Temperature	25,82	26,54	-0,93	25,07	26,27	-1,25
BOD	140,19	131,60	0,34	19,27	25,79	-3,37
COD	247,80	253,34	-0,13	33,45	39,07	-2,29
TSS	174,84	165,36	0,27	24,58	29,86	-2,04
Oil	2,90	2,86	0,18	1,79	2,23	-2,50
E.Coli	180.526.315.789.474	194.285.714.285.714	-0,75	12.270,7	25.335,7	-3,40

Table 6:- Test t and average parameter values in the Biofilter Media group

Parameter	F	Sig	Description
pH	0,214	0,648	Bacteria has no effect onpH
Temperature	6,974	0,014	Bacteria affects temperature
BOD	47,124	0,000	Bacteria affects BOD
COD	3,603	0,069	Bacteria affects COD
TSS	3,31	0,081	Bacteria has no effect on TSS
Oil	8,936	0,006	Bacteria affectsOil
E.Coli	8,377	0,008	Bacteria affects*E.Coli*

Table 7:- Recapitulation of the effect of Bacteria on research parameters (pH Temperature, BOD, COD, TSS, oil, and E. Coli)

The results of the ANOVA analysis prove that the administration of bacteria in the communal IPAL network system can improve the output quality standards of domestic wastewater, especially in the parameters of Temperature, BOD, COD, oil and E. Coli.

*D. Interaction (water discharge * media * bacteria)*

Parameter	F	Sig	Description
pH	1,931	0,177	Interaction of water Discharge*Media*Bacteriahas no effect onPH
Temperature	2,518	0,125	Interaction of Water Discharge*Media*Bacteriahas no effect on temperature
BOD	1,369	0,253	Interaction of Water Discharge*Media*Bacteriahas no effect on BOD
COD	0,005	0,946	Interaction of Water Discharge*Media*Bacteriahas no effect on COD
TSS	4,336	0,048	Interaction of Water Discharge*Media*Bacteriaaffects TSS
Oil	0,68	0,417	Interaction of Water Discharge*Media*Bacteriahas no effect onOil
E.Coli	1,146	0,295	Interaction of Water Discharge*Media*Bacteriahas no effect on*E.Coli*

Table 8:- Recapitulation of the effect of the interaction of water discharge * media * bacteria on the parameters of the study (PH Temperature, BOD, COD, TSS, oil, and E.coli)

The results of the ANOVA analysis prove that the interaction between water discharge, media, and the administration of bacteria on the communal WWTP system can improve the output quality standards of domestic wastewater, especially on TSS (Total Suspended Solid) parameter.

IV. CONCLUSION

Base on the above results of the discussion on sanitation modeling in an effort to manage domestic waste to produce clean and non-polluting quality of wastewater, it can be concluded thatWater discharge, media, bacteria and their interaction do not affect the pH of water; Water discharge and bacteria affects the water temperature, while the media and their interaction does not affect water temperature; Water discharge, media, bacteria affect BOD, while their interaction does not affect BOD; Water discharge, media, bacteria affect COD, while the interaction does not affect COD; Water discharge, media, bacteria have an effect on oil, while the interaction does not affect oil; Water discharge and bacteria have an effect on E. Coli, while the media and their interaction has no effect on E. Coli; Water discharge affects temperature, BOD, COD, TSS, oil, and E. coli; Media affects BOD, COD, and Oil; Bacteria affect temperature, BOD, COD, oil and E. coli; Interaction between bacteria * Water discharge * media only affects TSS; Water pH parameters cannot be affected by water discharge, media or bacteria.

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