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Model of Community's Wastewater Purification before it was Channeled in to River

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ABSTRACT

The high rates of urbanization and the rapid development in urban areas causes the more densely populated that require water in large enough quantities. Water that has been used by the people in general is thrown back into the waterbody or river under conditions that have been contaminated (wastewater), so it would pollute the riverwater, while at the downstream area peoples still use the riverwater for daily use. To overcome this problem we need a model of how wastewater purification performed before wastewater is channeled into the river. This study aims to plan a Purification model for community wastewater before it channeled into the river, to find out how much the rate of decrease in turbidity of the riverwater after passing through the filter water purification, and to determine the effect of water level that flows in the channel of the river onto the discharge of wastewater out past the filter. By using the experimental method in the laboratory of Hydraulics, made a physical model of the river where the bottom line sand filter fitted with a thickness variation of 4cm, 8cm, 12cm, 16cm, and 20cm on the gradation of 2.3mm, 1.8mm, and 1.5 mm pipes connected to the source of wastewater.
The results showed that the model used wastewater treatment can reduce wastewater turbidity to 30-40 %, and the height of the riverwater flowing on give effect onto the purification of wastewater discharge out past the filter.

Keywords: *Water Purification, Wastewater, Riverwater*

1. INTRODUCTION

Water and its sources are natural resources that must be used by living things to carries on its survival and maintain their well-being. It can be said that the water can not be separated from life and without water there can be no life.

The rapid development in various sectors and high population growth rate requires large enough water, which is often not available, but although it is available but the quality is still not eligible. Wastewater carrying pollutants flowing into the river causing the riverwater is also polluted so that the riverwater quality is no longer suitable for a variety of purposes, including for purposes of domestic and industrial water. Soemarwoto Otto (2009), The use of resources for development is always accompanied by pollution, Bahtiar, Ayi (2007), one of the pollution that may occur as a result of the presence of construction activities is contamination of water sources.

Urban wastewater is one of the water resources that can be used for various purposes. Some of the constraints faced in the reuse of wastewater due to urban wastewater quality does not meet with the water quality requirements for the various purposes ie, it contains sizeable element of pollutants, therefore before re-use, it needs to be done the processing to achieve the allowed requisite quality, Notoatmodjo S (2003), Although wastewater just a residual water but it has a large volume because approximately 80% of the water used for human's daily activities thrown back into the waterbody under conditions that have been contaminated (wastewater). Furthermore, the waste water will eventually flow into rivers and the sea to be used again. Therefore, this wastewater must be managed and treated well using the appropriate technology.

Selection of wastewater treatment technology should consider a few things, among others the amount of wastewater to be treated, the expected water quality processed, ease of management, availability of land and energy resources, as well as operation and maintenance costs be kept considerable low. Each type of wastewater treatment technologies have some advantages and disadvantages in each specific case, therefore in terms of the selection of these technologies need to be considered technical aspects, economic aspects and environmental aspects, as well as human resources that will manage the facilities.

Many developed and developing cities located around the watershed. Initially these rivers can ensure the needs of the community's clean water. However, due to the more dense population, previously land used as a commercial sewer, now become the settlement so that an alternative society with government facilities disposing the generated wastewater in to the nearest water bodies such as rivers. So the riverwater becomes dirty and polluted. This study examines the model of community wastewater treatment before it flows into the river.

2. LITERATURE REVIEW

2.1. Wasterwater

According to Ehless and Steel in: Chandra Budiman (2007), wastewater is used water from households, restaurants, industrial, and other public places that usually contain organic stuff or substances that can be detrimental to health and human life as well as disturbing the environmental sustainability. Djajadiningrat AH (1995), Wastewater is the concentration of pollutants in water within a period of time which can cause certain effects that can be detrimental to health and the environment. According to the decree of the Minister of State for Environment, No. 112 of 2003 Domestic wastewater is wastewater from businesses and or settlement activities (real estate), restaurant, office, commercial, apartments, and dormitories. Domestic wastewater quality standards appropriate with the decree of Minister of State for Environment. No. 112 of 2003 as shown in Table 1.

Table 1 : Quality standard of domestic wastewater

Parameter	Unit	Maximum levels
pH	-	6 - 9
BOD	mg/l	100
TSS	mg/l	100
Oils and Fats	mg/l	10

Source: Minister of State for Environment, No. 112 of 2003

2.2. Wastewater Characteristics

Sugiharto (1987), Determination of the degree of impurities for wastewater greatly influenced by the physical properties that is easily seen on the water. The important physical properties of water are solids as the effect of aesthetic and clarity, smell, color, and temperature as well.

Chandra Budiman (2007), suggests that the physical characteristics of wastewater consist of 99.9 % water, 0.1 % contains suspended solids, the volume of solid material varies between 100-500 mg / l. If the volume of solid materials is less than 100 mg / l, the wastewater is called weak, while if the solid material is more than 500 mg / l is called strong.

2.3. Wastewater Treatment

Djajadiningrat AH (1995), The process of any wastewater treatment may not be able to eliminate at all levels of contaminants, but can only be lowered until the limits permitted by the applicable regulations. (Sugiharto 1987), The main purpose of wastewater treatment to reduce Biology Oxygen Demand (BOD), mixed particles, as well as the organism of pathogen killer.

Joubert L, et al (2005), The wastewater must be treated to reduce pollution. Wastewater treatment can be done by making the tub drains and infiltration by observing the following conditions;

1. Not contaminate drinking water sources in the surrounding area.
2. Did not pollute the soil surface.
3. Not cause annoying odor.
4. Construction is made simple with easily available materials
5. Minimum distance between the water source to the catchment basin is 10 m.

Djajadiningrat AH (1995), There are three things to note in the system that is used in wastewater treatment as follows: 1. Characteristics of wastewater, 2. Assymilative capacity of the receiving waterbody, 3. Regulations concerning the applicable wastewater for the concerned waterbody. (Sugiharto 1987) Choosing an appropriate wastewater treatment technologies to note the following information: 1. Characteristics of wastewater and its source, 2. Quality and quantity of wastewater, 3. Use of land. 4. Environmental conditions, 5. Regulation of wastewater disposal.

Sugiharto (1987), Principles and selection technology procedure for wastewater treatment into account: 1. Conformity processing technology with the characteristics of the waste water. 2. System reliability, 3. Investment and maintenance fee, 4. The type of equipment and parts used for wastewater treatment technologies.

2.4. Water filtration

2.4.1. Water filter

Water filtration is a process of separating solids from water that brought it uses a porous medium or other porous materials to remove the fine suspended solids and colloids as much as possible. Besides reducing the solids content, water purification can also reduce bacterial content, removes color, taste, odor, iron and bacteria.

2.4.2 Filter Media and Sand Distribution

filter media may be composed of natural silica sand, anthracite, or garnet sand. Selection of filter media that will be used is done by sieve analysis

Effective size of filter media is a filter media size that is considered the most effective in separating impurities in the amount of 10% of the total depth of filter media layer or 10% of the heavy fraction, this is often expressed as P_{10} (10th percentile). P_{10} can be calculated from the ratio of it average size and standard deviation.

Uniformity coefficient is the number of filter media uniformity expressed by the ratio between the diameter size of filter at 60% weight fraction

2.4.3. Filters hydraulics

In principle the flow of granular media (sand filter) is considered as the flow of water through many pipes at once, The pressure loss in the pipe due to friction of flow following the Darcy - Weisbach equations as follows:

$$h_l = f\frac{LV^2}{D_c 2g} \quad (1)$$

Where :
h_L = pressure loss due to friction of flow
L = length or depth of the media.
V = flow velocity.
D = diameter of the canal.

The portion of the pressure loss at the filter media can be determined by using a Piezometri experiments in the scale of laboratory.

If r is a hydraulic radius size on the pipeline channel, so

$$= \frac{\text{pipe volume}}{\text{wet circumference of pipe}} = \frac{\pi D_c^2 L}{4\pi D_c L} = \frac{D_c}{4} \quad (2)$$

Medium porosity ε can be expressed as a ratio:

$$\varepsilon = \frac{\text{media cavity volume}}{\text{Cavity volume} + \text{volume of media granular}} \quad (3)$$

If Vp is media particle volume, Np is the number of media particles, so Vv as the total volume of voids can be expressed as follow:

$$V_v = \left(\frac{\varepsilon}{1-\varepsilon}\right) N_p V_p \quad (4)$$

If Ab is the grain surface area so, the hydraulic radius r is:

$$r = \left(\frac{\varepsilon}{1-\varepsilon}\right)\frac{N_p V_p}{N_p . A_b} = \left(\frac{\varepsilon}{1-\varepsilon}\right)\frac{d}{6} \quad (5)$$

From equation (4) obtained r = Dc / 4, so that:

$$D_c = \frac{2}{3} d \left(\frac{\varepsilon}{1-\varepsilon}\right) \quad (6)$$

This approach to the flow rate = Va (discharge /tub area), so the velocity of water in the pipe v can be calculated:

$$v = \frac{q}{\varepsilon} \quad (7)$$

If in the case of calculating the pressure loss using the Bernoulli equation, then to calculate the volume flow rate (discharge) can be used the following formula:

$$Q = V \; x \; A = V\frac{\pi d^2}{4} \quad (8)$$

The above formula states that the discharge of water flowing in the pipe is depended very much on the flow velocity (V) and the diameter of the pipe (d).

3. RESEARCH METHODOLOGY

3.1. Research Design

As per the final goal of this research, so the type of this study emphasizes on the experiments design model conducted in the laboratory with create a model of the river that resemble the original shape in the field consist of : a river model, a flow model equipped with the purification of wastewater before it enters the river. This study was conducted with the following variables:

3.1.1. Variables that determine the physical quality of the riverwater mixes with wastewater which has been cleared up include: (1). Turbidity of wastewater before filtered, (2). Discharge of wastewater to be disposed (3). The level of riverwater turbidity (4). Discharge of riverwater flowing in the river, (5). Purification material and its thickness.

3.1.2. Model of wastewater filter before it flows into the river

3.1.3. Turbidity level of filtered wastewater as a determinant of the effectiveness of the used filter model.

River model equipped with the wastewater purification as seen in picture 1

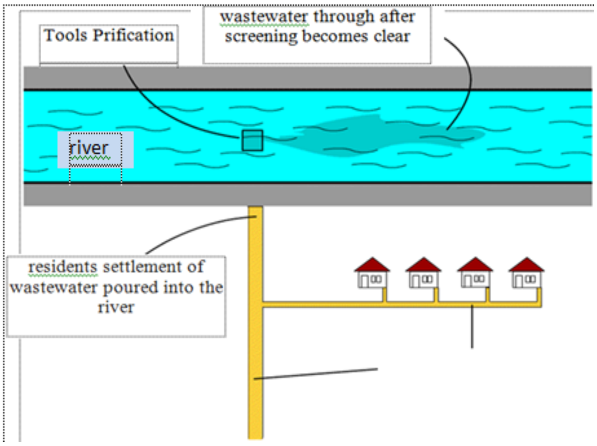

Figure 1: Model of research design

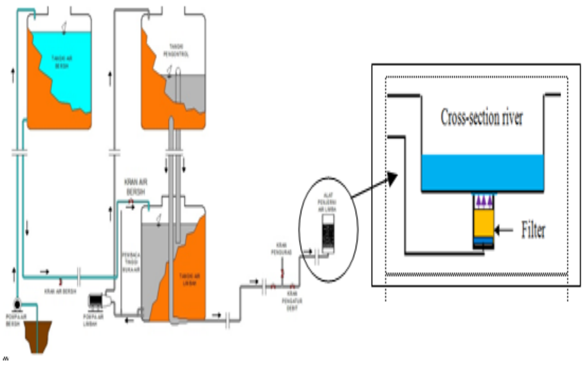

Figure 2. Wastewater treatment plant

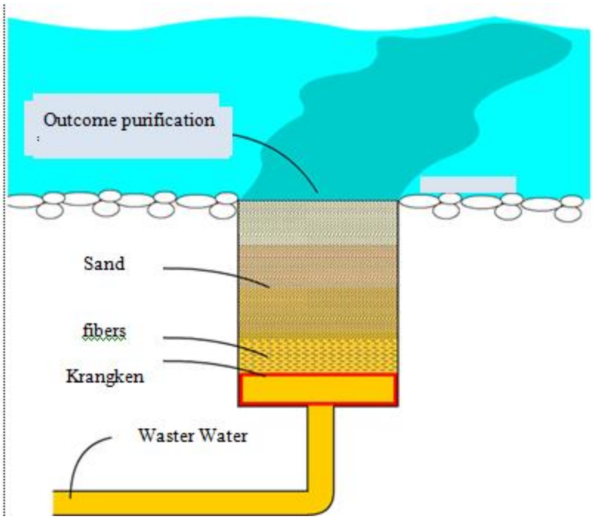

Figure 3. Wastewater filtration

Figure 4. Filters wastewater in the riverbed

Figure 5. Water flow of the river at a height of 60 cm

3.2. Data Collection Techniques.

Phases of activities carried out in this study, starting from the manufacture of tools, open channel, where in the middle at the channel's bottom is made water filtration and linked to the wastewater sources. To drain the water in the river model performed with using 2 pumps with a capacity of 2,200 liters/minute. The collection of turbidity data as the filtered water was conducted as many as 12 samples each of the variables done under study for 60 minutes with intervals of 5 minute.

4. RESULTS AND DISCUSSION

Determination the turbidity of filtered wastewater done with flowing wastewater in the sand filter with variation of graded 2.3 mm, 1.8 mm, and 1.5 mm with a thickness variation of each filter 4 cm, 8 cm, 12 cm, 16 cm, and 20 cm in cross-section filter respectively 20 x 20 cm, 20 x 30 cm, and 20 x 40 cm.

Determination of average discharge of wastewater that passes through the filter with the sand thickness of 5 cm, 10 cm, 15 cm, 20 cm, 25 cm, and 30 cm, taken after the water level of the river that flows in the channel at the height of 10 cm, 20 cm , 30 cm, 40 cm, 50 cm, 60 cm, 70, cm, and 80 cm. and stabilized for 2 minutes, the results in the table below.

Table 2: Gradation Filters (D) 0.0023 M; Thick Filters (t) = 0.20 m; cross section of A 20 x 20 cm

Turbidity (NTU)	Debit L/Sec	Time (Sec)	V = Q/F (m'/Sec)	$\frac{T.D.t}{V}$
Y	Q	T	V	X
300	0,25	0	0,0063	0,0
217,6	0,222	300	0,0056	24,6
215,4	0,221	600	0,0055	50,2
213	0,22	900	0,0055	75,3
210,8	0,219	1200	0,0055	100,4
208,6	0,218	1500	0,0055	125,5
205,9	0,217	1800	0,0054	153,3
203,3	0,216	2100	0,0054	178,9
200,3	0,215	2400	0,0054	204,4
197,7	0,214	2700	0,0054	230,0
195,3	0,213	3000	0,0053	260,4
192,7	0,212	3300	0,0053	286,4
189,2	0,21	3600	0,0053	312,5

Table 3: Gradation Filters (D) 0.0018 M; Thick Filters (t) = 0.20 m; cross section of A 20 x 20 cm

Turbidity (NTU)	Debit L/Sec	Time (Sec)	V = Q/F (m'/Sec)	$\frac{T.D.t}{V}$
Y	Q	T	V	X
300	0,25	0	0,0063	0,0
215,2	0,22	300	0,0056	19,3
212,9	0,219	600	0,0055	39,3
210,6	0,218	900	0,0055	58,9
208,3	0,218	1200	0,0055	78,5
206	0,217	1500	0,0055	98,2
203,6	0,216	1800	0,0054	120,0
201,2	0,215	2100	0,0054	140,0
198,8	0,214	2400	0,0054	160,0
196,3	0,213	2700	0,0054	180,0
193,8	0,212	3000	0,0053	203,8
191,3	0,211	3300	0,0053	224,2
188,8	0,21	3600	0,0053	244,5

Table 4: Gradation Filters (D) 0.0015 M; Thick Filters (t) = 0.20 m; cross section of A 20 x 20 cm

Turbidity (NTU)	Debit L/Sec	Time (Sec)	V = Q/F (m'/Sec)	$\frac{T.D.t}{V}$
Y	Q	T	V	X
300	0,25	0	0,0063	0,0
213,7	0,214	300	0,0056	16,1
211,1	0,213	600	0,0055	32,7
208,5	0,211	900	0,0055	49,1
205,8	0,21	1200	0,0055	65,5
203	0,209	1500	0,0055	81,8
200,2	0,207	1800	0,0054	100,0
197,4	0,206	2100	0,0054	116,7
194,4	0,205	2400	0,0054	133,3
191,3	0,203	2700	0,0054	150,0
188,2	0,202	3000	0,0053	169,8
185,1	0,201	3300	0,0053	186,8
181,9	0,199	3600	0,0053	203,8

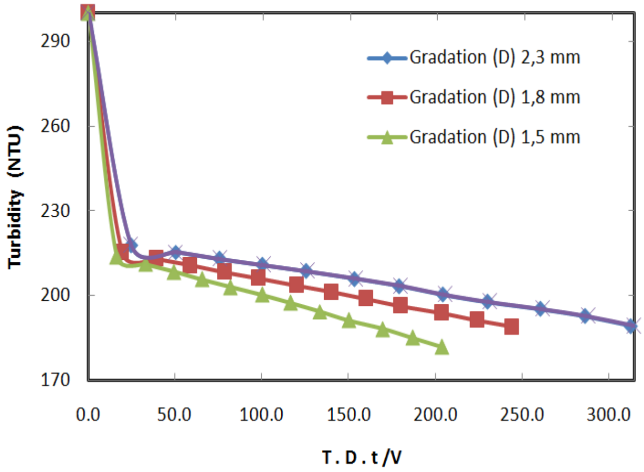

Figure 6 Graph showing the relationship between filter results with the sieve.of gradation

Wastewater with turbidity of 300 NTU, after passing through the sand filter thickness (t) of 0.20 m in cross-section filter (A) 20 x 20 cm with a gradient of 2.3 mm, the data obtained filtered wastewater, at 5 minutes filtration turbidity decreased to 217.6 NTU, was obtained at 60 min filtering 189.2 NTU turbidity, being in gradations of 1.8 mm sieve, filtered water obtained at 5 min filtering 215.2 NTU, was obtained at 60 minutes filtering 188.8 NTU turbidity , and the 1.5 mm sieve gradation obtained filtered water in 5 minutes filtering 213.7 NTU, was obtained at 60 minutes filtering 181.9 NTU turbidity.

By using the wastewater treatment plant that puts the filter in the bottom of the river channel is connected to the sources of wastewater covered, the results indicate that the filter is used to decrease the wastewater turbidity between 30-40%

Table 5: The relationship between the water level of the river (T) of the water discharge (Q) which pass through 2.3 mm sieve gradation.

Debit Q lt/sec	The water level of the river (m')	Ø Filter (m')	Thick filter (m')
Q	T	D	T
0,209	0	0,0023	0,3
0,208	0,1	0,0023	0,3
0,204	0,2	0,0023	0,3
0,201	0,3	0,0023	0,3
0,198	0,4	0,0023	0,3
0,194	0,5	0,0023	0,3
0,19	0,6	0,0023	0,3
0,187	0,7	0,0023	0,3
0,185	0,8	0,0023	0,3

Table 6: The relationship between the water level of the river (T) of the water discharge (Q) which pass through 1,8 mm sieve gradation.

Debit Q lt/sec	The water level of the river (m')	Ø Filter (m')	Thick filter (m')
Q	T	D	T
0,203	0	0,0018	0,3
0,2	0,1	0,0018	0,3
0,197	0,2	0,0018	0,3
0,194	0,3	0,0018	0,3
0,191	0,4	0,0018	0,3
0,188	0,5	0,0018	0,3
0,185	0,6	0,0018	0,3
0,181	0,7	0,0018	0,3
0,178	0,8	0,0018	0,3

Table 7: The relationship between the water level of the river (T) of the water discharge (Q) which pass through 1,5 mm sieve gradation.

Debit Q lt/sec	The water level of the river (m')	Ø Filter (m')	Thick filter (m')
Q	T	D	T
0,201	0	0,0015	0,3
0,199	0,1	0,0015	0,3
0,197	0,2	0,0015	0,3
0,193	0,3	0,0015	0,3
0,189	0,4	0,0015	0,3
0,187	0,5	0,0015	0,3
0,183	0,6	0,0015	0,3
0,18	0,7	0,0015	0,3
0,178	0,8	0,0015	0,3

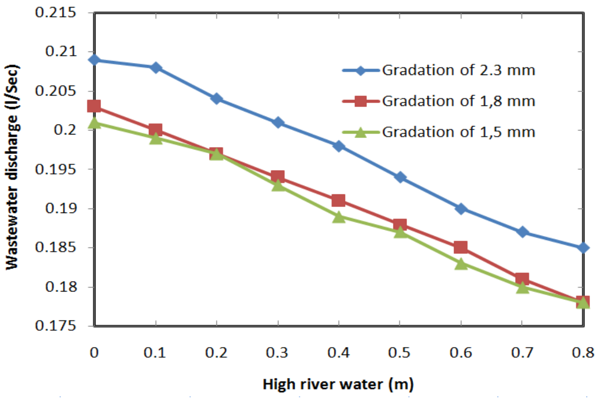

Figure: 7 Graph showing the relationship between discharges of filtered water on to the height level of riverwater flowing over the filter.

Discharge of wastewater flowed without filter is 0.25 liters/sec, after passing through a filter with a gradation of 2.3 mm, 30 cm thick without riverwater flow, discharge past out passing the filter 0.209 liters/second, after the water is flowed as high as 10 cm discharge of water channel passing through the filter is 0.208 liters/second, and at a height of 80 cm the discharge that passes through the filter 0,185 liters/second. At gradation, 30 cm thick without water flow, discharge coming out past the filter 0,203 liters / second, the flowing water discharge height of 10 cm of water through a sieve of 0.20 liters / second, and the water level in 80 cm discharge channel that passes through the filter 0,178 liters/second. . At 1.5 mm filter gradation, 30 cm thick without water flow, discharge coming out past the filter 0,201 liters/second, the flowing water as high as 10 cm discharge of water through the filter 0,199 liters / second, and the water level in the channel 80 cm discharge that passes through the filter 0,178 liters/second.

The results above show, that beside there is an influence of the gradient filter on the discharge also affects the height of water flowing in the channel out past the filter, the higher level of water flowing in the channel, the smaller discharge of flow passed out of the filter.

5. CONCLUSION

1. The Model of created wastewater filtration is a filter that is placed in the middle of the river bed which is connected through a closed channel to the source of wastewater of the city.
2. Model wastewater purification as the result of this research can effectively decrease the turbidity 30% to 40%
3. There is an influence of the height level of riverwater flowing over the filter to the flow of water out past the filter. The higher level of the water that flows over the filter, the smaller discharge of water out past the filter placed in the middle of the river bed.

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