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WASTEWATER TREATMENT WITH AEROBIC FILTRATION PROCESS BY ROCK LAYER

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ABSTRACT

Wastewater of residential buildings, which people inhabited more than 100 people, was treated with aerobic filtration process. The rock layers were used in the filtration model. The objective of this research was the study of wastewater treatment with physical process. The wastewater treatment process was the rapid filter rate for improve water quality before release into natural waters. This study simulated the steady flow of wastewater in glass tank 2 units. They have width of 50 cm, length 150 cm. and height 60 cm. The first glass tank was filled small rocks that were size 2.5 - 5 cm. and the second glass tank was filled large rocks that were size 5 - 10 cm. This study sampled wastewater at inlet and outlet of filtration model to determine the parameters. Parameters analyzed by the standard method in the laboratory were pH, DO, BOD, TS, TDS. The results of this study showed the wastewater was treated with the filtration model that it was within the standard parameters of the effluent. The results also showed the comparison between filter with small rocks and large rocks were the porosity decreasing of large rock layer (5-10 cm.) and small rock layer (2.5-5 cm.) was 2.13% and 0.87%, respectively. The small rocks filter was effective in the treatment of sewage over the large rocks filter. However, the large rocks filter should be chosen for wastewater treatment of these residential buildings. Because the wastewater quality was treated within standard and the large rocks filter could be used for longer than the small rocks filter.

Keywords: rapid filtration, wastewater treatment, rock layer.

INTRODUCTION

Current water pollution was more severe. Although public and private sectors have worked on solve the wastewater problems. Water pollution was a major problem of the country right now. Wastewater problems occur with the growth of the community for the purpose of activities. When developing community and industrial development increases, the amount wastewater was increased. In this study, it was modeling of wastewater treatment from residential homes generally have the densities of more than 100 people. Wastewater from residential buildings contained garbage, food waste, paper, soap and many other campsites in the effluent that they were contributing to water pollution and turbidity.

The objective of this research was the study of wastewater treatment with physical process. The rock layers were used in the filtration model. The wastewater treatment process was the rapid filter rate for improve water quality before release into natural waters. This study also evaluated the performance of wastewater treatment from the rock filtration model. Wastewater treatment was the removal of various contaminants in the water, depending on the sources of wastewater such as wastewater from residential, industrial, agriculture. Wastewater treatment requires knowledge of biochemical, microbiological, chemical and physical. Filtering process using the rock as a filter could trap suspended solids that cannot be precipitated. Wastewater flowed through the rock filter layer of the model. Rocks arranged in layers that they could to trap sediments, debris and night soil that did not decompose at the filter layer. The suspended solids such as sediments, sludge, bacteria, algae, and colloids that they were trapped with rock filter layer. Let the water flowed through the spaces of the rock. This study described the physical and chemical characteristics of wastewater. Wastewater samples were collected at inlet and outlet of model and brought it to the analysis in the laboratory.

Wastewater treatment by filtering could be done in several ways, such as rapid filter and slow filter. Rapid filter was used to filter with large rock or gravel. Typically, rapid filter tank was opening where the water would flow by gravity. Slow filter was used to filter with sand that was smaller than rapid filter. If the water had low turbidity, slow sand filter could eliminated turbidity without the use of chemicals aid in precipitation. The filtration process was studied that was rapid filter with using two sizes of rocks in the filter.

Wastewater quality analyze was the process for monitoring and determine the amount of compounds in wastewater. Physical characteristics of wastewater were total solids, odor, color, turbidities. Each character would have a reciprocal relationship to help indicate the quality of the wastewater. Chemical characteristics of wastewater were pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), oil and grease. Oil and grease affects the efficiency of wastewater treatment.

RESEARCH METHODOLOGY

Filtration was commonly the mechanical or physical operation which was used for the separation of solids from wastewater by interposing a medium through which only the wastewater could pass. This study installed the rock filtration model for wastewater treatment within residential buildings as shown in Figure-1. Wastewater from buildings would be entered into the rock filtration model without changing the chemical properties of wastewater. The material was used as a filter in the model,

which consists of rocks were two sizes as small rocks (2.5-5 cm.) and large rocks (5-10 cm.).

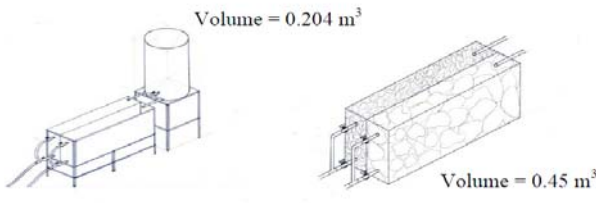

Figure-1. The model of wastewater treatment with rock layers.

The analysis of filtration efficiency considered parameters that they were density, porosity of filter rocks, and flow rate of wastewater through the rock filtration model. Wastewater analysis examined water qualities that were determined the concentration of contaminants in the wastewater. The parameters were pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), Total solids (TS) and Total dissolved solids (TDS). The pH was a measure of the acidity or alkaline of an aqueous solution. Solutions with a pH less than 7 were said to be acidic and solutions with a pH greater than 7 were alkaline. Pure water has a pH very close to 7. Dissolved oxygen (DO: mg/L) makes to know that water is the suitable for the living of a life in the water and use to control wastewater treatment process and water pollution. Biochemical oxygen demand (BOD: mg/L) was the amount of dissolved oxygen needed by aerobic biological organisms in water to break down organic material present in a given water sample at 25 degree Celsius over a specific time period. BOD determined difference of the DO at the first day and fifth day in laboratory and calculated with equation as follow:

$$BOD\ (mg/L) = DO_0 - DO_5$$

Total solids (TS: mg/L) were the sum of suspended solids (SS: mg/L) and total dissolved solids (TDS: mg/L) as equation.

$$TS = SS + TDS$$

Total solids analyses were important for assessing wastewater treatment processes such as digester efficiencies and sludge cake processing parameters. Total dissolved solids (TDS: mg/L) were a measure of the combined content of all inorganic and organic substances contained in wastewater.

RESULTS

This study analyzed parameters that were necessary to evaluate the efficiency of the wastewater treatment process of the rock filtration model. The parameters were densities, ratio of total air voids to total volume of the filtration system, and porosities of the rock filters at inlet, outlet, and middle of the rock filtration model by air replacement with water. The results of this study were shown in Tables 1-3 and Figure-2. Analysis of the flow rate of wastewater flowing through the rock filtration model was step that was necessary. It could analyzed with let the wastewater flow through the rock filtration model, and then measured the volume of wastewater at the inlet and outlet of this model as shown in Figure-3.

Table-1. The physical qualities of rock layer to filtration.

Sizes of rock layer (cm)	**Rock weights** (kg)	**Areas of rock layer** (cm^2)	**Densities** (kg/liter)
Large rock layer (5-10 cm)	1.72±0.18	509.67±60.85	3.46±0.31
Small rock layer (2.5-5 cm)	1.04±0.07	352.60±23.82	3.92±0.47

Table-2. The average of porosity changes of filtration model.

Sizes of rock layer (cm)	**Average of porosity**		**Porosity changes**	**Porosity decreasing**
	Before	**After**		
Large rock layer (5-10 cm.)	52.06 %	50.95 %	1.11 %	2.13 %
Small rock layer (2.5-5 cm.)	50.70 %	50.26 %	0.44 %	0.87 %

Table-3. Efficiency of filtration at positions of model.

Sizes of rock layer (cm)	**Filtration**	**Porosity at positions in the filtration model**		
		Inlet (0.00 m)	**Middle** (0.75 m)	**Outlet** (1.50 m)
Large rock layer (5-10 cm)	Before	52.51 %	52.51 %	51.16 %
	After	51.47 %	50.90 %	50.48 %
	Porosity changes	1.04 %	1.61 %	0.68 %
	Porosity decreasing	1.98 %	3.07 %	1.33 %
Small rock layer (2.5-5 cm)	Before	51.48 %	50.62 %	49.99 %
	After	51.27 %	50.21 %	49.31 %
	Porosity changes	0.21 %	0.41 %	0.68 %
	Porosity decreasing	0.41 %	0.81 %	1.36 %

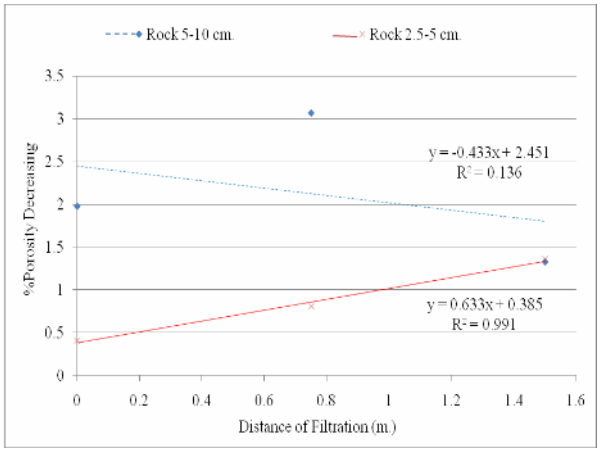

Figure-2. Relation of % porosity decreasing and distance of filtration.

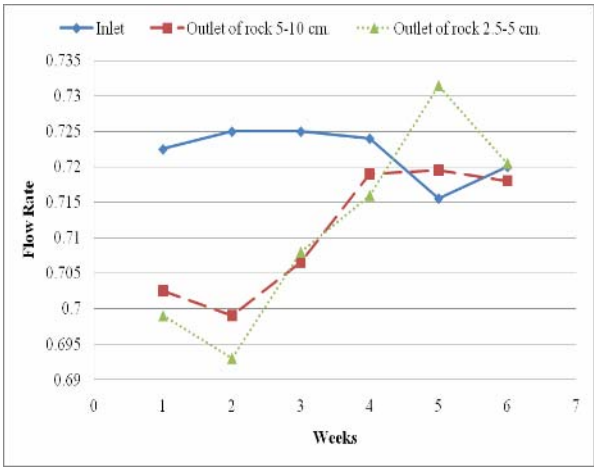

Figure-3. Flow rate of filtration with rock layer.

This experiment determined the physical and chemical properties of wastewater both inflow and outflow from the filtration model. This study also evaluated the efficiency of wastewater treatment with simulations. The parameters were dissolved oxygen (DO), pH, total solid (TS), total dissolved solid (TDS), and biochemical oxygen demand (BOD). The results of this study showed as follow.

Dissolved Oxygen (DO) was very important to living things that live in water. Oxygen gas is very little soluble and do not react chemically with water. It makes to know that water is the suitable for the living of a life in the water and use to control wastewater treatment process and water pollution. Measurements and analysis of dissolved oxygen was shown in Table-4 and Figure-4.

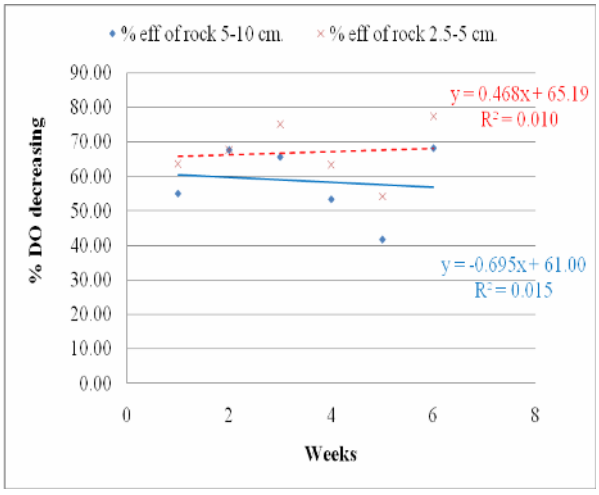

Figure-4. Percentage of DO decreasing of rock layer.

Table-4. The results of DO measurement (mg/L) at inlet and outlet of rock layer.

Weeks	DO at inlet	Outlet of rock 5-10 cm	Outlet of rock 2.5-5 cm
1	1.40	0.63	0.51
2	1.70	0.55	0.55
3	1.60	0.55	0.4
4	1.50	0.70	0.55
5	1.20	0.70	0.55
6	1.10	0.35	0.25

The pH was really a measure of the relative amount of free hydrogen and hydroxyl ions in the wastewater. Wastewater that had more free hydrogen ions was acidic, whereas wastewater that had more free hydroxyl ions was base. Since pH could be affected by chemicals in the wastewater, pH was an important indicator of wastewater that was changing chemically. The results of this study determined with pH meter as shown in Table-5.

Table-5. The average of pH per week.

Weeks	Inlet	Outlet	
		rock 5-10 cm	rock 2.5-5 cm
1	7.75	7.80	7.75
2	7.64	7.79	7.77
3	7.66	7.70	7.77
4	7.73	7.77	7.72
5	7.67	7.70	7.72
6	7.66	7.70	7.70

Total solids were a measure of the suspended and total dissolved solids in wastewater. Total dissolved solids passed through the rock filter. Suspended solids were those that could be retained on the rock filter and were capable of settling out of the column onto the bottom of model when flow velocities were low. The results of study showed efficiencies of the removal TS and TDS of the small and large rock filters as Figure-5. The graphs in Figure-5 showed rock layer filters were effective in the removal of TS than TDS. Rock layer 2.5-5 cm. was the best of effective in the removal TS. While the rock layer 2.5-5 cm. and rock layer 5-10 cm. had effective in eliminating TDS were similar.

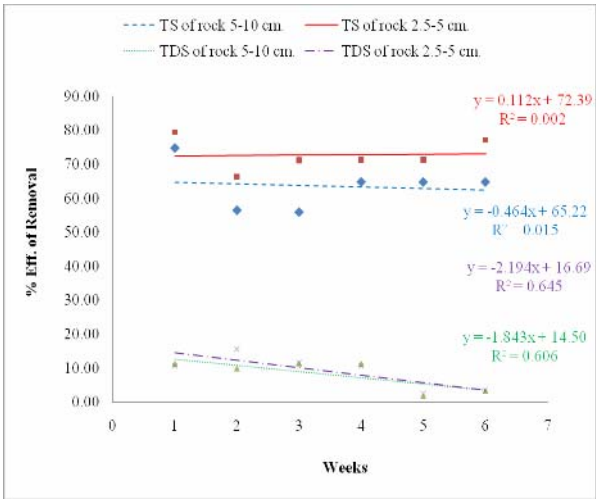

Figure-5. Efficiency of TS and TDS removal in filtration with rock layer.

The Biochemical Oxygen Demand (BOD) analysis was one of the most common applications for wastewater laboratories. It was a measure of the oxygen used by microorganisms to decompose waste in water. The results of the BOD removal efficiencies of filtration with rock layer showed that rock layer 2.5-5 cm. had BOD removal efficiency was better than rock layer 5-10 cm. as shown in Figure-6.

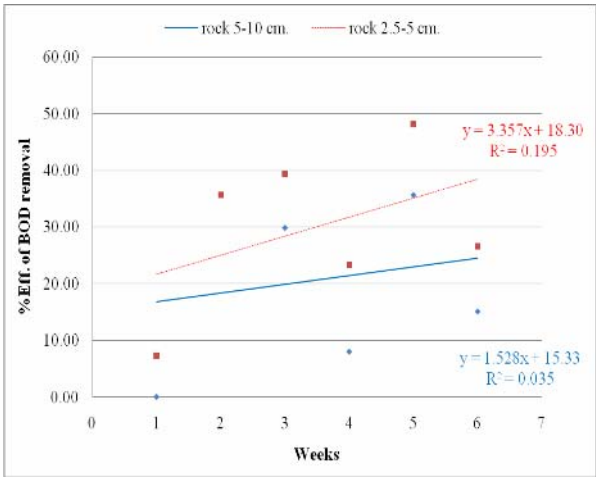

Figure-6. Efficiency of BOD removal in filtration with rock layer.

CONCLUSIONS

This study was wastewater treatment process with the rock filtration model. This study installed the rock filtration model for wastewater treatment within residential buildings and the rock layer model was rapid rate filter. Wastewater from buildings would be entered into the rock filtration model without changing the chemical properties of wastewater. The material was used as a filter in the model, which consists of rocks were two sizes as small rocks (2.5-5 cm.) and large rocks (5-10

cm.). The results of this study showed that the flow rate of wastewater at inlet, rock layer 2.5-5 cm., rock layer 5-10 cm. were 0.722±0.004 liters/second, 0.711±0.014 liters/second, and 0.711±0.009 liters/second, respectively. The results also showed the comparison between filter with small rocks and large rocks were the porosity decreasing of large rock layer (5-10 cm.) and small rock layer (2.5-5 cm.) were 2.13 % and 0.87 %, respectively. The result also showed that the dissolved oxygen of wastewater at inlet of the rock filtration model was 1.25 mg/L that it was more than at outlet. The results also showed the comparison between filter with small rocks and large rocks were the dissolved oxygen of large rock layer (5-10 cm.) and small rock layer (2.5-5 cm.) were 0.775 mg/L and 0.587 mg/L, respectively. Total solids and BOD of wastewater decreased with the rock filtration model. The results of this study showed the wastewater was treated with the filtration model that it was within the standard parameters of the effluent. The small rocks filter was effective in the treatment of sewage over the large rocks filter. However, the large rocks filter should be chosen for wastewater treatment of these residential buildings. Because the wastewater quality was treated within standard and the large rocks filter could be used for longer than the small rocks filter.

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