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Use of Bio filter Reactors to Increase the Quality of Liquid Waste at Dr. Soetomo Hospital Surabaya in 2015

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Abstract- Liquid waste from hospital is one of the sources of water contamination. Hospital liquid waste is containing organic and an organic contaminants as COD and BOD, suspended solids (TSS) and nutrients such as Phosphate (PO4). The first reactor using silica sand (diameter 2-5 mm) and gravel (diameter 2-3 cm), the second reactor using bio ball (diameter 4 cm) and the third reactor using a combination of silica sand-gravel and bio ball. Study results were first bio filter reactor for content of TSS removal efficiency of 57%, the content of BOD5 removal efficiency of 71%, the content of COD removal efficiency by 67% and decrease the efficiency of the content of phosphate (PO 4) by 12%. Second bio filter reactor to produce content of TSS removal efficiency of 46%, the content of BOD5 removal efficiency of 62%, COD content removal efficiency by 55% and decrease the efficiency of the content of phosphate (PO 4) by 12%. For the third bio filter reactor produces content TSS removal efficiency of 74%, the content of BOD5 removal efficiency of 73%, the content of COD removal efficiency by 70% and decrease the efficiency of the content of phosphate (PO_4) by 14%. The results conducted that third reactor parameters studied were able to lower TSS, BOD, COD and PO4, but the value is still above of the standard quality of hospital liquid waste by East Java Governor Decree No. 72 in 2013.

Keywords: WWTP Bio filter, hospital liquid waste

1. INTRODUCTION

1.1 Background

Hospitals are health service institutions that provide full range of personal health services providing inpatient, outpatient and emergency care services. Therefore, the hospital has a close relationship with the existence of a collection of people or society. In the past, a hospital was built in an area far enough away from a residential area, and usually close to a river with the consideration that liquid waste management would not have a negative impact on the population, or if there was a negative impact it could be minimized. Wastewater from hospital waste is one of the potential sources of water pollution. This is because hospital wastewater contains a fairly high organic compound, it is also likely to contain other chemical compounds and pathogenic micro-organisms that can cause illness to the surrounding community. Because of the potential impact of hospital waste on public health is very large, then every hospital is required to treat its waste water to meet the requirements of standard or standard quality of waste water. According to the Ministerial Decree No. 58 of 1995, on the quality standard of hospital liquid waste, liquid waste is all liquid waste derived from hospitals that are likely to contain pathogenic microorganisms, toxic chemicals and radioactive, so that hospital liquid waste must be done by using the Processing Treatment Water Treatment Waste (WWTP). This is done to reduce the concentration of pollutants before they are thrown into the water body

Dr. Soetomo Hospital Surabaya is one of the provincial government-owned hospitals that already have Waste Water Treatment Plant (WWTP). The resulting waste water discharge of + 500 m^3/day, resulting from clinical and domestic activities [10]. Dr. Soetomo Hospital Surabaya has a central wastewater treatment plant (Central WWTP) with processing method of activated sludge (active sludge). Based on secondary data from laboratory examination conducted by BLH East Java Province in September 2014 that the liquid waste at the location of Central WWTP Inlet Dr. Soetomo Hospital for TSS parameters of 109 mg / l, BOD_5 of 154 mg / l, COD of 376 mg / l, and PO_4 of 1.92 mg / l, that some parameters have not met the liquid waste quality standards for hospital activities based on Regulation East Java Governor No. 72 Year 2013. Based on the background, the researchers are interested to conduct research with the title of the use of bio filter reactor to improve the quality of liquid waste in the Dr Soetomo hospital Surabaya in 2015

1.2 Purpose

To know the efficiency of TSS content reduction, BOD, COD, PO_4 on liquid waste Central WWTP Dr. Soetomo hospital Surabaya using a bio filter reactor that compares 3 reactors

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2. LITERATURE REVIEW

The basic principle of wastewater treatment is to remove and even reduce the contaminants contained in wastewater[8]. Such wastewater treatment methods can produce adequate levels of decline for different categories of pollutants such as BOD, COD, TSS, N, P and pathogen organisms [9]. This research uses liquid waste from Dr. Soetomo hospital is treated with biofilter technology, where biofilter is a term from a reactor developed with microbial principles growing and growing attached to a filter media and forming biofilm (attached growth) [4]. This processing is very easy processing and very cheap in terms of operational. Biofilter can be used for waste water with a considerable BOD load and can remove suspended solids (SS) well[12]. Sources of liquid waste in Dr. Soetomo hospital, among others, comes from the medical service unit which includes: Inpatient, outpatient, emergency, intensive care, haemodialysis, central surgery, isolation, medical and laboratory support unit covering: radiology, pharmacy, sterilization, mortuary, Supporting non medical services include: logistics, laundry, medical records, public facilities ie mosque / mosque and canteen, secretarial / administration and kitchen nutrition [7]. Liquid waste processing technology with biofilter is a biological processing technology by using attached culture, ie liquid waste processing where the microorganism used is bred on a medium, so that the microorganisms grow and develop on a filter media and form a layer of biofilm colonies with Air supply [11]. The success of liquid waste treatment with biofilter technology is highly dependent on the rate of microbiological growth. For microbiological growth requires a medium (eg gravel / gravel), therefore the biofilter system is used in gravel or gravel media (sizes 1 "and 2.5") in which the microbe grows and forms a thin layer on the surface of the medium [6] . Liquid waste processing (biofilter) using sand media with up flow flow system has advantages, among others, does not require chemicals, so the operating costs are cheap, can remove iron, manganese, and color and turbidity, can eliminate ammonia and oganik pollutants, because the filtration process Runs physically and biochemically, it is easier to do media washing, not too affected by water turbidity levels or raw waste[15]. While the weakness of the sand media upstream flow system that is: more complicated because it requires special pressure settings to be able to drain water or waste upward, the filtration speed of low sand media, thus requiring a large enough space. The biological growth rate in biofilter is strongly influenced by several factors, such as fluctuation level of quality of influent liquid (pH), temperature and residence time on bed part (medium)[6] Some advantages of wastewater treatment process with biofilter include: the processing is very easy, the operating cost is low, compared to the active sludge process, the sludge produced is relatively small, can eliminate the nitrogen and phosphor that can cause eutrophication, air supply for aeration is relatively small, Can be used for waste water with a considerable BOD load, can remove suspended solids (SS) well [15]. The purpose of this research is to know the efficiency of decreasing the content of TSS, BOD_5, COD, PO_4 on liquid waste Central WWTP Dr. Soetomo Hospital Surabaya using a biofilter reactor that compares the 3 reactors. The first reactor used silica sand and gravel media, second reactor using bioball media and third reactor using silica-gravel sand media and bioball media

3. RESEARCH METHODS

3.1 Kind of research

This research is an experimental research with laboratory test using bio filter reactor to process liquid waste from central WWTP Dr. Soetomo hospital that will be engineered to resemble the condition of the field and made in the form of mini. The research design used is liquid waste from Central WWTP before treatment is done by measurement (Pre test / A1), then given treatment (Treatment / X) by using bio filter media in the form of silica sand and gravel and bio ball media, and after treatment done again measurement (Post Test / B1). In the "Post test / B1" position 5 wastewater measurements were made after the effluent was passed through the silica-gravel sand filter medium and the addition of oxygen and the second was done after through the bio ball media and the addition of oxygen and the third measurement was made after the waste Liquid through a medium of silica sand - a pebble combined with a bio ball medium given the addition of oxygen

3.2 Population and Sample

3.2.1 Population

The population in this research is liquid waste from Central WWTP Dr. Soetomo hospital Surabaya from various health service units in each room.

3.2.2 Sample

The sample studied is a liquid waste derived from Central WWTP Dr. Soetomo Hospital Surabaya that accommodated in the water reservoir of each size + 40 liters and distributed continuously 24 hours with the assisted submersible pump and through the liquid waste treatment instrument that has been made. The number of samples taken at the location of pre test and post test that is 5 times sampling In pre-test position, 5 sampling times after silica-gravel sand medium (post test) and oxygen addition, 5 sampling times after bio ball (post test) media and oxygen addition and 5 sampling times after through silica-gravel And bio ball media (Post test) and addition of oxygen

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3.3 Tools and Materials

At the inlet position to the bio filter media (silica sand size 2-5 mm and gravel size 2-3 cm) connected with 0.5 cm diameter PVC pipe along 50 cm equipped with faucet and at the bottom of the tube equipped with faucet size 0 , 5 inches. From the bio filter tube (silica sand and pebbles) to the tube containing a 4 cm-size bio ball medium connected to a 0.5 inch PVC pipe with up flow water position and equipped with a 0.5-inch tap, The bottom of the bio ball is also equipped with a 0.5 inches faucet at the bottom made a hole to inject oxygen to the bio ball medium, to increase the filter media in the reactor to the liquid waste, then at the bottom of the filter with nylon filter. From the tube bio ball then in out through the outlet that has been provided.

The image of the liquid waste treatment with the bio filter reactor is presented in Figure 1, Figure 2 and Figure 3 below.

3.3.1 Silica Sand and Gravel Media (Reactor I)

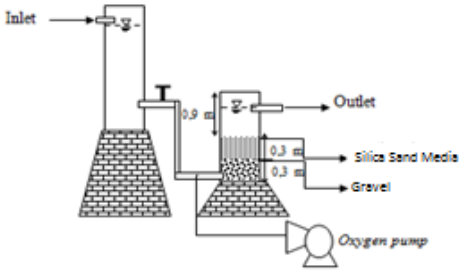

Figure 1. Bio filter Silica Sand and Gravel Media

3.3.2 Bio Ball Media (Reactor II)

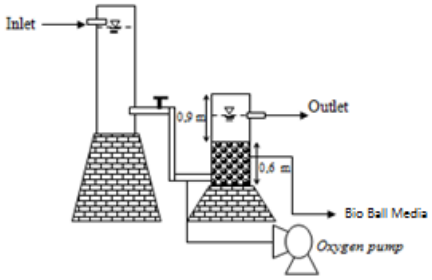

Figure 2. Biofilter Bio ball Media

3.3.3 Silica Sand-Gravel Media and Bio ball (Reactor III)

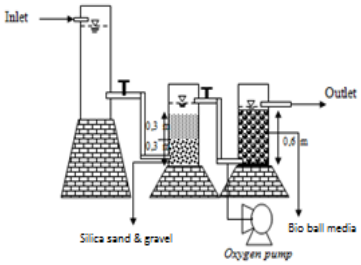

Figure 3 Bio filter Silica sand – Gravel and Bio ball

3.4 Activation of Bio filter Reactor Media

For bio filter activation using silica sand media and gravel by way of media is soaked in Central WWTP Dr.Soetomo Hospital which aims to grow bacteria or microbe characterized of bio film on the surface of silica sand and gravel indicating that bacteria or the microbes have been in the media. As for the activation of bio filter by using bio ball media that is by way of media is soaked in central WWTP Dr. Soetomo Hospital which aims to grow bacteria or microbes that are characterized of biofilm on the surface of bio ball media

3.5 Data Collection Method

Methods of data collection is done by observation is by looking directly to the location of the study by making observations that use the five senses and stationery as a tool to record the volume and discharge of waste water and sampling for laboratory tests and other data collection methods with The way of documentation is to collect secondary data from laboratory analysis of liquid waste Central WWTP from Dr. Soetomo Hospital and photos related to the processing of liquid waste at the location of Dr. Soetomo Hospital.

3.6 Data Analysis

Data analysis was done by comparing the results of the initial sample test with the final sample test to determine the efficiency level of BOD_5, COD, Phosphate (PO_4) and TSS and the liquid waste quality of the hospital based on East Java Governor Regulation No. 72 Year 2013.

4 RESEARCH RESULTS AND DISCUSSION

4.1 Research Results

Result of analysis of liquid waste quality before and after liquid waste treatment with bio filter reactor on TSS parameter as shown in table 1 below

Table 1: Results of TSS Parameter Examination

No.	Inlet	Reactor I	Efficiency Decrease (%)	Reactor II	Efficiency Decrease (%)	Reactor III	Efficiency Decrease (%)
1	43,23	16	62,9	19	56	12	72,2
2	49,24	8	83,7	15	69,5	18	63,4
3	56,21	26	53,7	22	60,8	6	89,3
4	35,15	20	43,1	26	26	8	77,2
5	46	27	41,3	38	17,4	16	65,2
Average			57		46		74

Note : Inlet raw water
Reactor 1: gravel-sand silica media
Reactor 2: Bio ball media
Reactor 3: Combined medium of reactor I and reactor II

Based on table 1 above, it can be described the efficiency of TSS content reduction with the graph in figure 4 below

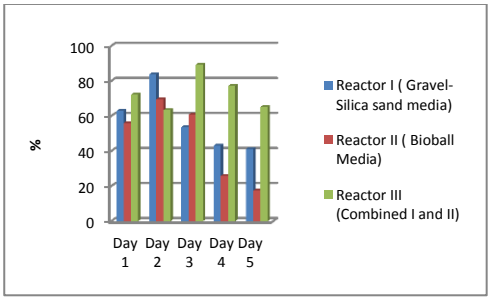

Figure 4 Graph of TSS Decrease Efficiency

Based on the graph in figure 4 above, the efficiency of TSS content reduction in the 1st reactor is bio filter reactor with gravel and silica sand between 41% to 83% with mean efficiency 57%, while the 2nd reactor is bio filter reactor with Medium bio ball TSS efficiency between 17% to 69% with an average efficiency of 46%, and a 3rd reactor bio filter reactor with combined medium of reactor medium I and medium of reactor II TSS efficiency between 63.4% to 89.3 % With an average efficiency of 74%.

For the result of quality analysis of liquid waste before and after wastewater treatment with bio filter reactor on BOD parameter as shown in table 2 below.

Table 2: Results of BOD_5 Parameter Examination

No.	Inlet	Reactor I	Efficiency Decrease (%)	Reactor II	Efficiency Decrease (%)	Reactor III	Efficiency Decrease (%)
1	125,21	47,88	61,76	58,57	53,22	37,02	70,43
2	122,5	26,01	78,76	37,01	69,78	30,04	75,47
3	115,23	28,91	74,91	47,49	58,78	22,92	80,1
4	89,62	26,36	70,58	31,63	64,7	29,21	67,41
5	99,15	28,46	71,29	36,17	63,51	26,14	73,63
Average			71		62		73

Note : Inlet raw water
Reactor 1: gravel-sand silica media
Reactor 2: Bio ball media
Reactor 3: Combined medium of reactor I and reactor II

Based on table 2 above, we can illustrate the efficiency decrease of BOD_5 content with graph in figure 5 below.

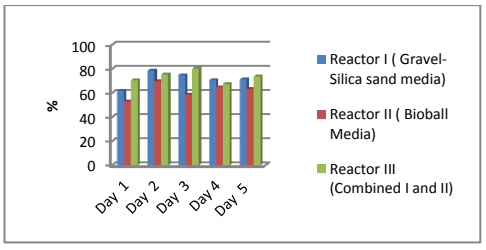

Figure 5 Graph of BOD_5 Decrease Efficiency

Based on the graph of figure 5 above, the efficiency of the BOD_5 content decrease in 1st reactor is the bio filter reactor with gravel and silica sand between 61.76% to 78.76% with average efficiency of 71% decrease, 2nd bio filter reactors with bio ball media BOD_5 reduction efficiency was between 53% to 69% with an average efficiency of 62% reduction, and the 3rd reactor of bio filter reactor with combined medium of reactor medium I and reactor II efficiency decrease BOD5 was among 67 ,% Up to 80% with average efficiency decreased 73%

The results of liquid waste quality analysis before and after liquid waste treatment on COD parameters as shown in table 3 below.

Table 3: Results of COD Parameter Examination

No.	Inlet	Reactor I	Efficiency Decrease (%)	Reactor II	Efficiency Decrease (%)	Reactor III	Efficiency Decrease (%)
1	289,03	140,13	51,61	155,71	46,12	141,53	51,13
2	268,21	97,239	63,74	102,82	61,66	87,742	67,28
3	272,41	105,52	61,26	123,49	54,66	76,949	71,75
4	143,31	29,624	79,32	56,505	60,56	35,182	75,45
5	157,15	34,542	78,02	74,191	52,78	27,78	82,32
Average			67		55		70

Note : Inlet raw water
Reactor 1: gravel-sand silica media
Reactor 2: Bio ball media
Reactor 3: Combined medium of reactor I and reactor II

Based on table 3 above, it can be described the efficiency of COD content reduction with the graph in figure 6 below.

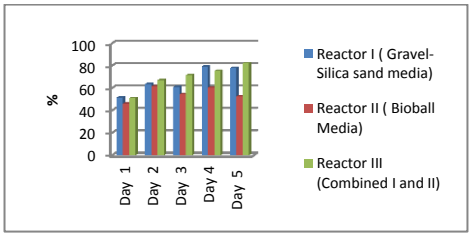

Figure 6 Graph of COD Decrease Efficiency

Based on the graph in figure 6 above, the efficiency of COD content reduction in the 1st reactor is bio filter reactor with gravel and silica sand between 51% to 79% with average efficiency of 67% decrease, while the 2nd reactor of bio filter reactor With bio ball media the efficiency of COD decrease was between 46% to 61% with an average 55% efficiency decrease, and the 3rd reactor of bio filter reactor with combined media medium of reactor I and reactor II COD reduction efficiency was between 51% 82% with average efficiency decreased 70%

The results of liquid wastewater quality analysis before and after liquid waste processing on PO_4 parameters as shown in table 4 below.

Table 4: Results of PO_4 Parameter Examination

No.	Inlet	Reactor I	Efficiency Decrease (%)	Reactor II	Efficiency Decrease (%)	Reactor III	Efficiency Decrease (%)
1	2,23	1,82	18,38	1,892	15,15	1,618	27,4
2	2,24	2,239	4,1	2,019	9,86	2,029	9,41
3	2,34	2,097	10,38	2,028	13,3	2,203	5,85
4	2,69	2,09	22,3	2,13	20,81	2,010	25,27
5	2,26	2,16	4,42	2,21	2,21	2,160	4,42
Average			12		12		14

Note : Inlet raw water
Reactor 1: gravel-sand silica media
Reactor 2: Bio ball media
Reactor 3: Combined medium of reactor I and reactor II

Based on table 4 above, it can be described the efficiency of the reduction of PO_4 content with the graph in figure 7 below

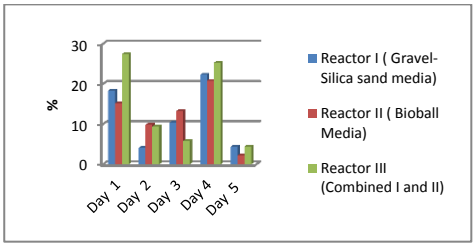

Figure 7 Graph of PO_4 Decrease Efficiency

Based on the graph in figure 7 above, the efficiency of PO_4 decrease in the 1st reactor is bio filter reactor with medium gravel and silica sand is between 4% to 22% and average efficiency decrease 12%, while at 2nd reactor Bio filter with bio ball media PO_4 decreasing efficiency is between 2% to 20% with average 13% reduction efficiency, and at the 3rd reactor bio filter reactor with combined medium of reactor medium I and reactor II PO_4 decrease efficiency is between 4% Up to 27% with average efficiency decreased 14%.

4.2 Discussion

Based on the result of the research, there has been a decrease of TSS, BOD_5, COD and Phospat (PO_4) content in liquid waste processing system with bio filter technology using silica gravel media, bio ball media and silica gravel media mix and bio ball media.

The results showed that in the reactor with silica sand-silica media, for TSS content there was an average decrease of 24 mg / l with an average efficiency reduction of 57%, bio filter reactor with bio ball medium decreased average TSS content 22 mg / l With an average efficiency reduction of 46%. For the bio filter reactor using combine of silica sand medium and bio ball media there was a decrease of average TSS content of 34 mg / l with an average reduction efficiency of 73%

For BOD_5 content in reactor with silica sand-silica media, there was an average decrease of 78 mg / l with an average efficiency reduction of 71%, bio filter reactor with bio ball medium decreased average BOD_5 content 68 mg / l with efficiency decrease - 62% average. The bio filter reactor using a combination of silica-sand media silica and bio ball media has decreased the content of BOD_5 averaging 81 mg / l with an average reduction efficiency of 73%

For the COD content of reactor with silica sand pebble medium, there was an average decrease of 144 mg / l with an average efficiency reduction of 67%, bio filter reactor with bio ball medium decreased the average COD content of 123 mg / l with an efficiency decrease - 55% average. The bio filter reactor using a combination of silica sand medium and silica bio ball media decreased the average COD content of 152 mg / l with an average reduction efficiency of 69%

For PO_4 content in the reactor with silicone sand-silica media, an average decrease of 0.91 mg / l with an average downtime efficiency of 12%, bio filter reactors with bio ball medium decreased PO_4 content averaging 0.29 mg / l With an average downtime efficiency of 12%. As for the bio filter reactor using the combined media of gravel-silica sand and bio ball media there was an average decrease in PO_4 content of 0.348 mg / l with an average reduction efficiency of 14%.

In the three bio filter reactors studied it has been shown to decrease the content of TSS, BOD, COD and Phospat (PO_4). However, in the reactor containing the combined medium of silica-gravel sand and bioball media the efficiency of the decrease in the content of all parameters studied was higher than that of the reactor with silica sand medium and bio ball media only. This is because the effluent treated by the first reactor has been shown to decrease the content of TSS, COD, BOD_5 and PO_4 and if followed by a second reactor, the processing efficiency will be even higher. This is in line with the research conducted by Wahyu Hidayat & Nusa Idaman Said (2005) and research conducted by Sugito (2009) that the treatment of hospital liquid waste by using anaerobic-aerobic bio filter can decrease the content of TSS, COD, BOD_5, and Phospat (PO_4).

5 CONCLUSION

Based on the results of research that has been done that is by using 3 of bio filter reactor that uses different media with continuous liquid waste discharge and residence time more than 5 hours, it can be concluded as follows:

1. Bio filter reactor with silica sand-gravel media can reduce average TSS content by 57%, lower average BOD_5 content by 71%, reduce COD content by 67% and decrease Phosphate (PO_4) content by 12% on average.
2. Bio filter reactor with bio ball media can decrease TSS content by 46%, reduce BOD_5 content by 62%, reduce COD content by 55% and decrease Phosphate (PO_4) content by 12% on average.
3. Bio filter reactor with combined media that is media of silica-gravel sand with bio ball media able to decrease average TSS content 73,46, decrease BOD_5 content average 73,40% and lower COD content 69%.

6. SUGGESTION

Based on the results of the research, it is found that bio filter reactor is very effective in reducing the pollutant content such as TSS, BOD_5, COD, and Phosphate (PO_4) but it is recommended some things as follows:

1. To obtain a better result of wastewater treatment at bio filter reactor using silica sand-gravel media, it is necessary to conduct research related to the size and thickness of effective media to treat hospital wastewater
2. Need to do research related to the size and thickness of bio ball media that is effectively used to treat hospital wastewater by using bio filter reactor
3. Need to do research related to other types of media that are effectively used as a medium on bio filter reactor in conducting hospital liquid waste processing.

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