www.sphinxsai.com

PharmTech

International Journal of PharmTech Research

CODEN (USA): IJPRIF, ISSN: 0974-4304
Vol.8, No.4, pp 702-708, 2015

The Effectiveness of EM_4 Addition into Biofilter to Reduce of *BOD, COD* and *MPN Coliform* of Hospital Wastewater

Pitriani

Public Health Department, Medical and Health Science, Faculty Tadulako University, Indonesia

Abstract: Hospital wastewater is a potential environmental pollutant because it contains high organic compounds, other chemical compounds and pathogenic microorganisms, and if released to the environment without prior treatment will affect the quality of the environment. This Study aims to find out the effectiveness of EM_4 addition on biofilter anaerob-aerob to reduce BOD, COD and MPN Coliform levels from wastewater at Hasanudd in University Hospital. The research was a pra-experimental study with pretest-posttest design. The basic principle of biofilter is to use of microorganism with amobile process in certain mediun to produce biofilms. In normal condition, it needs one month (30 days) for the biofilms to degrade a pollutants in wastewater. The result reveal that after 18 days, there was a change in the pollutan levels. The decrease of BOD level reached 91,22% (322,65 mg/l to 28,30 mg/l), which fulfilled the allowed maximum level as the Regulation of the South Sulawesi Governor No. 69/2010. Futhermore, while the reduction percentages were relatively high, the level of COD and MPN Colfiorm had not fulfilled the threshold value. The study describe addition of EM_4 was able to generate the formation and maturation of biofilms so that the efficiency of biofilters can increase in terms of time needed.
Keywords: Biofilter, EM_4, BOD, COD, Wastewater.

Introduction and Experimental

Wastewater which is generated of the hospital activities is one of the sources potential of water pollution because it contains high organic compounds, other chemical compounds and pathogenic microorganisms. Metcalf and Eddy (1979)proposed the production standard of liquid waste is 650 liters /bed/day[1].HasanuddinUniversityHospitalproviding218beds, that estimated produces ± 141.7 m^3 wastewater per day. Based on the data can be imagined how potential of wastewater to pollute the environment. Earlier investigation found that wastewater describes that BOD, COD, and MPN Coliform parameters is commonly remained above thethreshold value.

Abiofilter system applied with utilizes natural microorganisms in wastewater with amobile on certain media in order to form biofilms[2,3].The reactor use honeycomb media models based PVC 2 cm. Related research, proven anaerobic-aerobic biofilter system is capable to reduce BOD 84.93% and COD 72.22% (16 hours time release) after 1 month treatment in the Christian Tayu hospital[3].A similar study in the Elizabeth Situbondo hospital found anaerobic-aerobic biofilter system is able to reduce BOD of 100 mg/l to 12 mg/l and COD of 170 mg/l to 30 mg/l, with 2 months treatment all the parameters is down to fulfill the standards that have been set[4].Combination of anaerobic-aerobic biofilter system is efficient on processing wastewater hospital, but it takes a long time to form biofilms. In the ideal conditions microorganisms take ± 1 month that process of biofilms was optimal, so it is necessary to accelerate this process[1,5].

Utilization of EM_4 in hospital wastewater treatment based on the fact that 70% component of it is a domestic wastewater with a high content of organic pollutants[5].EM_4 is a constituents several types of microorganisms that live in artificially symbiosis with each other[6].EM_4consists of a vary microorganisms, each of it has a specific function and cooperate synergy to decompose organic pollutants and capture the odor gases (H_2S, NH_3, etc.) as a source of energy to perform its activities, in addition to the *lactic acid bacteria* and *Actinobacteria* in EM_4 suppressed the pathogenic bacteria significantly[7].

The addition of EM $_4$ (5%) is expected to accelerate the formation and maturation of biofilms, therefore is increase gradually of the biofilter efficiency. The usage of 5% dose is based on the previous studies[8,9]. This study aims to determine the effectiveness of EM_4addition (5%) in the anaerobic-aerobic biofilter in reducing BOD, COD and MPN Coliform of wastewater in Hasanuddin University Hospital.

Research Design

This research was a paraexperimental study with pretest-posttest design[10]. It was conducted in some steps including literature review, preliminary study, and main study (creating the biofilter anaerobic-aerobic reactor). The study was done in April-August, 2014.

Data Collection

Examination of BOD, COD and MPN Coliform carried out at the Laboratory of Makassar Health Polytechnic based on *the American Standard Method.* pH and temperature measurements performed in the location of study using the pH meter and thermometer. Data analysis was analyzed descriptively and presented in data tables, graphs and narrative.

Sampling

Sampling was done by *grab sampling* (samples moment) every 9:00 to 10:00 am. Sampling was carried out at the time based on the average daily fluctuations of wastewater hospital highest between 09:00 to 10:00 pm[11].Sampling was carried out at the inlet to *the pretest*, done while at the outlet *to the posttest* after the biofilter operation for 24 hours. Sampling was carried out respectively 6 times, from the first day until the eighteenth.

Experimental Procedure

Wastewater treatment is done by operating the anaerobic-aerobic bio-filter reactor consisting of tanks, initial sedimentation tanks, first anaerobic tanks, aerobic tanks and second anaerobic tanks, and last sedimentation tanks. The scheme process of hospital wastewater treatment anaerobic-aerobic biofilter system can be seen in Figure 1.

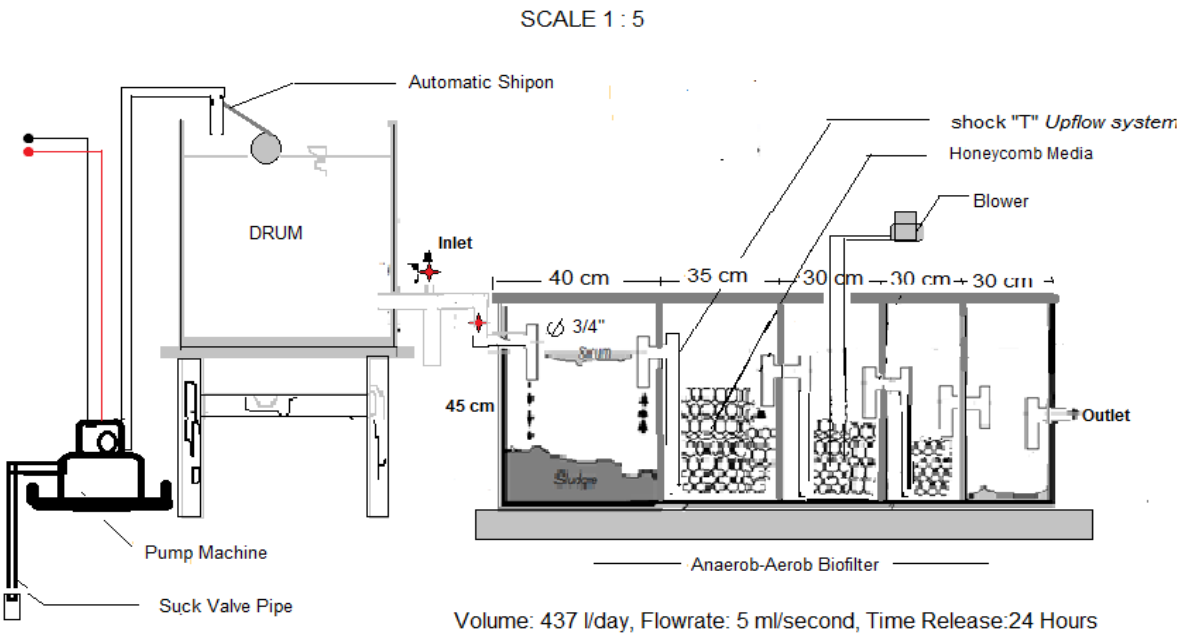


Figure 1. Reactor Sceme :Anaerob-AerobBiofilter

The Microorganisms Breeding Process (Seeding)

Before putting into the reactor, firstly activate EM_4 by mixing 1 liter of EM_4 with 20 liters of water and 5 tablespoons of brown sugar liquid, then fermented in a sealed condition 2-4 days. Furthermore, seeding process in honey combmedia is conducted naturally by flowing continuously wastewater into the reactor with 24 hourstime release and debit 5 ml/second. At the same time, add the activated EM_4 into biofilter with debit of 0.25 ml/sec, additions were made with drip system in the initial sedimentation tank in 5%.

Core Experiment

In this experiment the reactor is operated continuously. During the operation carried out pH and temperature measurements as environmental factors that can affect the reproduction of microorganisms. pH and temperature measurements are done every day (9:00 to 10:00 am) while observe the formation of biofilm on media. At this core experiment was also done to measure BOD, COD and MPN Coliform to see the removal efficiency of pollutants.

Results and Discussion

Characteristics of Wastewater Hasanuddin University

Waste water being sampled in this study is the wastewater of Hasanuddin University Hospital. Based on laboratory analysis, the quality of waste water before it is processedat the initial examination shows that almost all the parameters tested has exceeded thethreshold valueas specified in the South Sulawesi Governmental Law No.69 on 2010 (Table 1).

Table 1. Main Characteristic of Hasanuddin University Hospital Wastewater

Parameters	Unit	Value	Treshold Value
FISIKA			
Temperature	ºC	29	30
KIMIA			
Ph		*6,8*	6,0-9,0
TSS	Mg/l	42,07	30
BOD	Mg/l	*446,81*	30
COD	Mg/l	*892,47*	70
NH_3	Mg/l	*2,39*	0,1
BIOLOGIS			
MPN Coliform	Per 100 ml	*240.000*	10.000

Sources :Primary Data 2014

Environment Conditions and Biofilms Formation

The pH and temperature results of the wastewater are a major environmental factor in the proliferation of microorganisms. During the 18 day measurement, the pH is within the range of optimum value for the proliferation of microorganisms, is 6.4 - 7.4.Likewise, the temperature value is still in the optimum range, it is 26-29 ° C.

Observations on the proliferation of microorganisms, which are demonstrated by the formation of biofilms is done directly. The addition of EM_4 (5%) is proven to accelerate the formation of biofilms which become visible during the fifth day and more clearly on the eighth day, looks increasingly thick biofilm on the next days. More detail on table 2.

Table 2. Observation Data of Environmental Condition and Bacterial Growth inAnaerobic-Aerobic Biofilter Hasanuddin University Hospital.

Day	pH	Temperature (°C)	Biofilms Formation
1	6,6-6,8	29	-
2	6,6-6,8	28	-
3	6,6-6,8	26	-
4	6,8-7,0	29	-
5	6,6-6,8	27	Thin membranes began to appear
6	6,4-6,6	29	
7	6,4-6,6	29	Increasingly obvious membranes
8	6,6-6,8	29	
9	6,6-6,8	29	
10	6,6-6,8	27	Thicker membranes
11	6,8-7,0	27	
12	7,2-7,4	29	
13	6,6-6,8	29	
14	6,8-7,0	29	
15	6,8-7,0	27	
16	7,2-7,4	27	Maturation of Biofilms
17	6,8-7,0	29	
18	6,8-7,0	29	

Sources : Primary Data 2014

This study describe that the addition of EM4(5%) in anaerobic-aerobic biofilter which supports ideal environment capable of facilitating the formation and maturation of biofilm, from one month (30 days)to 18days. The range pH value of the wastewater throughout the operation of reactor account for 6.4-7.4, at this range, the bacteria are more dominant than other microorganisms[7]. The optimum pH on the environment greatly affects the biological wastewater treatment process, generally microorganisms require pH between6.5–9.0[12]. Too high pH (>9) will inhibi the activity of microorganisms, while below pH 6.5will result in the growth of fungi and bacteria in competition with the metabolism of organic matter[13].

The temperature in wastewater throughout the operation of reactor account for 26-29°C, it shows the microorganisms were properly breeding. The ideal temperatureis25-30°C, too high temperature will damage the process through inhibit the enzyme activity in cell. Increases 1°C of temperature from the ideal range may cause a decrease in the efficiency of treatment[14]. Observations on the breeding of microorganisms, which are demonstrated by the formation of biofilms is done directly. Addition ofEM4which is a collection of various kinds of bacteria is proven to accelerate the seeding of microorganisms, biofilms form thin membranes become visible during the 5 day and with the passage of time the operation of the reactor, the biofilm is getting thicker. In contrast to khaer research with the same methods and bio-filter, the process of biofilm formation is slower, whereas biofilm is visible after the 11 day[15]. Decrease concentration of organic pollutants increase since the measurements of samples I to samples VI also show the microorganisms seeding in reactor are getting better.

Allowance efficiency of BOD, COD and MPN Coliform

Table 3. Value of BOD, COD and MPN Coliform Before and After Processing of Anaerobic-Aerobic Biofilter System With Addition of EM_4 (5%)

Sample	BOD (Mg/L)		COD (Mg/L)		MPN (Per 100 ml)	
	S1	S2	S1	S2	S1	S2
I	424,10	407,25	703,80	655,67	240×10^3	240×10^3
II	396,42	327,62	688,12	597,70	240×10^3	240×10^3
III	408, 68	244,75	621,46	401,82	280×10^3	240×10^3
IV	348,50	106,78	652,75	288,40	240×10^3	180×10^3
V	441,84	88,15	706,45	176,24	280×10^3	170×10^3
VI	322,65	28,30	586,32	98,12	280×10^3	130×10^3
Treshold Value	**30**		**70**		**10×10^3**	

Sources : Primary Data 2014

Decreasing levels of wastewater parameters before and after treatment are shown in Table3.Based on the value of each parameter reduction, determine the efficiency of biofilter descriptively. Determination of biofilter efficiency in designated wastewater parameters, can be calculated based on the formula that has been determined by calculating between difference the influent parameter value minus effluent concentration divided further influent parameter values multiplied 100%.

***S1 = Value Before Treatment**
S2 = Value After Treatment

Laboratory analysis result in Table3showsthat the concentration of organic pollutants is illustrated through BOD and COD levels decrease after treatment. The decrease is because the degradation process of microorganisms is going better if the contact between the wastewater and microorganisms in biofilm layer are longer[4]. BOD and COD are declined since the first day, though not significant. The removal process of BOD has been started at the beginning of the settling basin due to the deposition of particles suspended organic matter[1,16]. The presence of organic matter deposition of particles is detected by the silt bottom equalization basin.

Elimination process of BOD takes place in then extanaerobic basin, at the time of the wastewater passes through this medium inorganic substances is retained by the filter and will be degraded by microbes that attach to the filter so that the amount f diminishing returns and the reduction of organic matter in the wastewater levels of BOD and COD is dropped[17].In anaerobic process of complex organic substances such as carbohydrates, fats and proteins decompose to produce methane and carbondioxide, as follows:

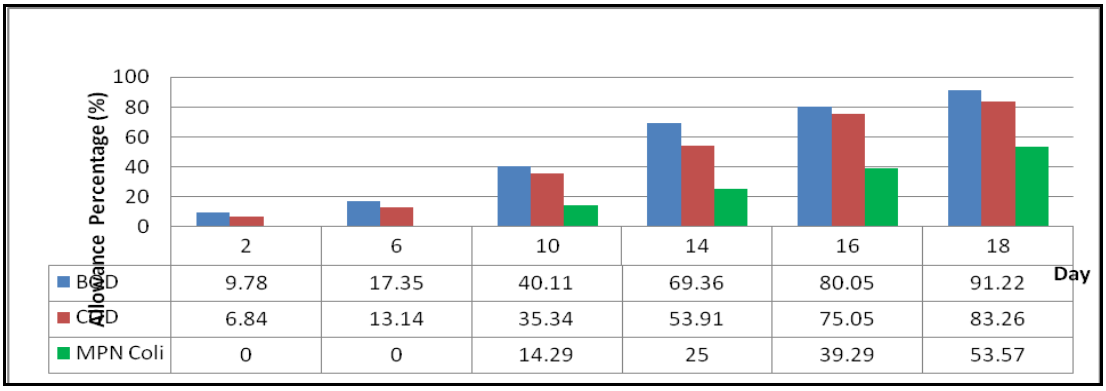
Organic Compounds----------->CH4+CO2+H2+NH3+H2S

The reduction process of BOD is continued in the aerobic treatment, organic compounds and nutrients residue on anaerobic process will decompose so the aerobic treatment process is usually placed after anaerobic process. In this tank also takes a nitrification process[3].

Organiccompounds+O2---------->CO2+H2O+Energy+New cells

After aerobic processing resumes with the anaerobic process, in this process, BOD reduction is little considering the availability of organic matter decreases. This process is more on denistrifikasi efforts so the removal of nitrogen wastewater compounds does not only stop in nitriteornitrate[18]. The final partof biofilter is last sedimentation, with a similar process at the initial deposition. Last sedimentation is needed to accommodate access sludge generated from the previous process where aerobic processes produce enough mud. Parameters removal efficiency of BOD, COD and Coliform MPN of the whole time is varied (Figure 1).

Figure 2. The Graph Percentage of Allowance Parameters on The Wastewater After Treatment



	2	6	10	14	16	18
BOD	9.78	17.35	40.11	69.36	80.05	91.22
COD	6.84	13.14	35.34	53.91	75.05	83.26
MPN Coli	0	0	14.29	25	39.29	53.57

Sources : Primary Data 2014

The effectiveness of biological treatment in anaerobic-aerobic bio-filter system with the addition of EM4(5%), generally afford to reduce BOD and COD levels with up 91.22% and83.26%in18days. The amount of removal efficiency further confirms that the addition ofEM4(5%) were able to increase the efficiency of biofilter by shortening the processing time, though the level of COD is still above the threshold value.

Processing methods that are applied is also not able to reduce MPN Coliform well. On 18 day, the efficiency is onlyreached53.57% ($280x10^3$to $130x10^3$per100ml of sample), this value is higher than the threshold value($10x10^3$per100mlsample). The high value of MPN Coliformis an indicator of a bad bacteriological water quality. The existence of *Ecoli* is an indicator of human fecal contamination and is always accompanied with presence of other pathogenic bacteria, especially *Vibrio cholera* and *Salmonella typhi*[19]. Besides, the virus *Rotavirus sp* that causes diarrhea in children and *Entamoeba histolitica* sp cause dysentery often found in wastewater hospital[6,13].

This research prove that addition of *EffectiveMikroorganism*4 (EM_4) is able to accelerate the formation and maturation of biofilms thus improving the biofilter efficiency in terms of time. With the addition 5% of $EM_4$the needed time to reduce organic pollutants of wastewater is getting short. After 18 days treatment, BOD down so it fulfills the quality standards. Despite the COD and MPN Coliform removal is not optimal, this is due to the initial value parameters are very high and still found some deficiency in its application methods. Water delivery system of hospital waste should be separated based on itswaste characteristics, and each of it is equipped with a pretreatment before it is processed using biofilter, so the reduction process of wastewater pollutants parameters can run up.

Bibliography

1. Metcalf and Eddy.(1979). Wastewater Engineering Treatment, Disposa, and Reuse (2 nd Edition).New York;McGraw-Hill Book Company, Inc.
2. Prayitno, Hospital Wastewater Treatment Technology. J-PAL, 2011, 1(2),72-139.
3. Nurdijanto, Stephanus A et al.,Design and Engineering Wastewater Treatment Hospital.Indonesian Journal of Environmental Health, 2011, 11(8): 42-55.
4. Said, Nusa Idaman et al., (2011). Technology Hospital Wastewater Treatment with Anaerobic-aerobic biofilter System Case Study: Hospital Elizabeth Situbondo.Jakarta: Directorate of Environmental Technology.
5. Amouei, A et al.,Investigation of hospital wastewater treatment plant efficiency in north of Iran during 2010-2011, International Journal of Physical Sciences, 2012,7 (31), 5213-5217.
6. Feng, Lin et al.,Quorum Sensing in Water and Wastewater Treatment biofilms, Journal of Environmental Biology,2013, 34, 437-444.
7. Muliawan, Sylvia Y. (2012).Textbook of Medicine: Bacterial Pathogens Spiral. Accessed: Makassar, May 14, 2014. (http/// 2F.2Ftekpan.unimus.ac.id 3A).
8. Jasmiati et al., Bioremediation of tofu Industrial Liquid Waste Using Effective Mikroorganism (EM_4), Journal of Enviromenral Science,2010, 52, 2(4).

9. Munawaroh et al., Allowance parameter Environmental Pollutants in Wastewater Industry Know Using Effective Microorganisms 4 (EM $_{4)}$ And Utilization.Journal of the National Institute of Technology (Itenas), 2013, 2 (1), 12-21.
10. Notoatmoedjo, Soekidjo.(2010).Revised Edition: Health Research Methodology.Rineka Copyright: Jakarta.
11. Sugiharto.(2011). Application of wastewater treatment plants biofilter to Reduce pollutant content of BOD, COD and TSS in the hospital the mother Surabaya (Thesis).Environmental Engineering Program PGRI AdiBuana University of Surabaya.
12. Flathman, Paul E et al., (1994). Bioremediation Field Experience. Accessed: Makassar May 12, 2014. (http://books.co.id/Bioremediation//Exp.html).
13. Waluyo, Lud.(2009). Environmental Microbiology. UMM Press: Muhammadiyah University, Malang.
14. Saraswati, Rastiet et al., (2010). Microorganismsperombak Organic Materials.Participatory Technology Assessment Project.The research Center for Land.Research Center for Soil and Agro-climate. IAARD (Unpublished).
15. Khaer, Ain.(2014). Effectiveness Analysis of Anaerobic-aerobic biofilter media in the Hornet's Nest Model Parameters Wastewater Reduce Hospital UNHAS (Thesis).Department of Environmental Health Graduate Program Hasanuddin University, Makassar.
16. Ramadan, Ishaq.(2010).Submerged Biofilter Process Technology Guidelines (Submerged Biofilter). London : Faculty of Civil and Environmental Engineering, ITB.
17. Satrawidana, DK et al., Testing Technology Consortium Bacterial Biofilms on anaerobic-aerobic reactor Semi for Wastewater Treatment Hospital of Small and Medium Scale, Journal of Science and Technology, 2013, 2,23-31.
18. Nugroho, Rudi,Waste denitrification Nitrate at Different Levels of acidity by Utilizing Microbial autotrophs,JAI, 2009,1(1), 87-84.
19. Sumantri, Arief.(2013).Revised Edition: Environmental Health. PT.Dawn Interpratama Independent: Jakarta.

*****