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Detecting the Reduction of TSS in Domestic Wastewater Through Addition the EM_4

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(Abstract) TSS is one of the pollutants contained in domestic wastewater. One technology that can reduce the concentration of TSS in the domestic waste water effectively is biofilm. The aim of this study was to analyze the effect of addition bio-activator EM4 to the reduction of the TSS concentration in domestic wastewater by using biofilm technology in anaerobic and aerobic conditions. The media used is honeycomb tube. The wastewater used in the processing is original waste. The results of this study demonstrate that the addition of EM4 bio-activator able to reduce the TSS concentration in the domestic wastewater effectively, just at the aerobic reactor conditions. (Abstract)

Keywords: biofilm; domestic wastewater; EM_4; TSS (key words)

1. INTRODUCTION

Domestic wastewater contains many pollutants including BOD, COD, TSS, ammonia, pH and temperature. One of pollutant frequently observed is Total Suspended Solid (TSS). The concentration of TSS that exceeds the quality threshold will harm the environment. Therefore, the domestic wastewater with high concentration of TSS is necessary for treatment before its disposal to the environment.

The TSS has a negative impact on the environment, in particular on water quality. When the wastewater is disposed to water body with high TSS, it will hamper sunlight entering into the water, leading to decrease in quality of water supply, even the death of organism living beneath. The death of microorganisms in the water body will disturb the life cycle of aquatic ecosystem. Besides, the TSS-containing wastewater will visually be in a low opacity so that decreasing the aesthetic aspect of the waters. When the suspended materials contained in the water possess a concentration beyond the quality threshold, there will be sedimentation in the bottom of the water body. Such condition will lead to sludge accumulation and sediment at the water basin. Sludge and sediment slow the water flow of the water to the receiving water body. Further impact will by decreasing water volume at the receiver.

One of technologies that can be applied to domestic wastewater is biofilm. The biofilm technology has many advantages, including easy operation, low sludge production, and applicable to high pollutant concentration [Said, 2002]. The media used for the biofilm include gravel, ceramic, bioball, honeycomb, PVC, and brillo pads. The application of the biofilm technology currently in practice has resulted in dairy wastewater treatment using PVC rings. The study indicates that the biofilm reactor has high performance stability [Karadag et al 2015]. Another study [Munoz et al 2016] report that the user of Ceramic Raschig Rings revealed that the desorption efficiency was close to 100%. Furthermore, a study using Sponges and Polyethylene Rings reported that COD and NH4+-N decreased to 99.5 + 1.1 and 93.6 + 2.3%, respectively.

In the current study, an additional bioactivator of Effective Microorganism (EM4) was performed to accelerate the formation of the biofilm layer and the time of acclimatization, which, in turn, make the pollution degradation time more efficient. This study had a purpose of analyzing the effect of EM4 bioactivator addition on the efficiency of the decrease in TSS concentration in the domestic wastewater.

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2. MATERIAL AND METHODS

A. Experiment Procedure

Wastewater used for the study was original wastewater collected from water disposal in Semarang Municipality. The sampling procedure followed the SNI 6989.59:2008 requirement. In this study, initial test of the wastewater characteristics was done at the Environmental Laboratory of the Environmental Engineering Department, the Faculty of Engineering, Diponegoro University. Pollutant parameters examined for the characteristics test consisted of BOD, COD, TSS, pH and temperature. The measurement of the BOD followed the Standard SNI 6989.72.2009 on Guide for Biochemical Oxygen Demand/BOD Testing. The measurement of DO followed the SNI: 06-6989.14-2004 on the Guide for Dissolved Oxygen Test with Iodometric Technique (Azida modification). Whereas, the COD was measured according to the Standard SNI 6989.2:2009 on Water and Wastewater – Part 2: Manuals for Chemical Oxygen Need Test. To measure the TSS, the study followed the requirement of the SNI 06-6989.3-2004 on the Guide for the Total Suspended Solid (TSS) test. To measure the pH, a pH meter was used according to the Standard SNI 06-6989.11-2004 on pH testing. Whereas for temperature, the thermometer used was according to the Standard SNI 06-6989.23-2005. This SNI standard procedure used the reference of the internationally recognized Standard Methods for the Examination of Water and Wastewater, 21st Edition, editors L. S. Clesceri, A. E. Eaton, APHA, AWWA, WPCF, Washington, D. C. (2005).

B. Reactor Design

The biofilm reactor was made of 4-mm wide glass. It was a rectangular reactor with dimension of 30cm x 20cm x 18cm. There were four reactors built with the following details: the anaerobic reactor with additional EM4 (RnE), the aerobic reactor without additional EM4 (RaE), anaerobic reactor without EM4 (Rn), and aerobic reactor without EM4 addition (Ra). These reactors were conditioned at anaerobic and aerobic states, as illustrated by Figure 1 whereas the honey comb tube media was showed in Figure 2.

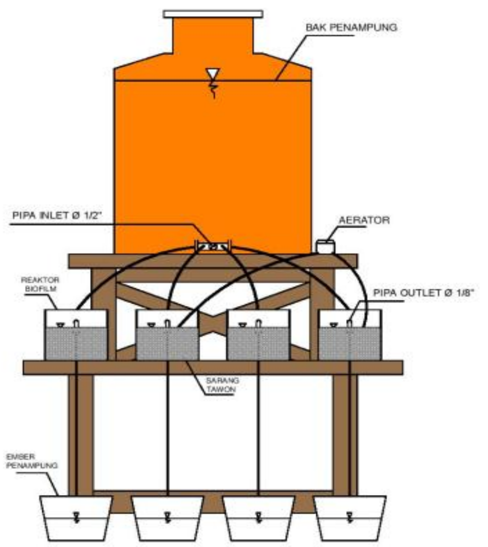

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Figure 1. Biofilm Reactor Design

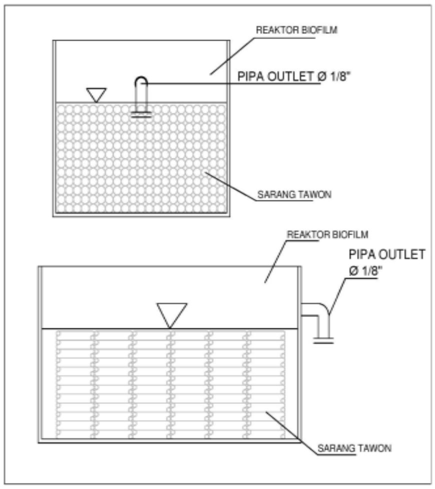

Figure 2. Honeycomb Tube Media

C. Media Biofilm Honey Comb Tube

Honeycomb tube was made of PVC pipe. The pipe is cut into smaller sizes (5 cm long) and then it was mingled, forming a honeycomb. The main purpose of this media was to allow microorganisms to stay close to the surface of the PVC to form the biofilm layer. Figure 3 illustrates the honeycomb biofilm.

Figure 3. Honeycomb biofilm media

D. EM_4 Bioactivator

In the current study, either anaerobic or aerobic reactors were equipped by bioactivator in the form of fluids with the brand of Effective Microorganism (EM_4). The purpose of the bioactivator addition (EM_4) was to enrich the number of the microorganisms in the wastewater, so that the biofilm layer would be immediately formed for degrading the pollutants. The bioactivator addition was performed in both anaerobic and aerobic reactors with the volume of 10 ml.

3. RESULTS AND DISCUSSION

This study was divided into three stages, i.e. seeding, acclimatization, and running. Data and analysis reported here were derived from the running stage only. The initial characteristics of the domestic wastewater in this study consisted of the followings: COD concentration 147.45 mg/l; BOD concentration 107.02 mg/l; TSS concentration 504 mg/l; ammonia concentration 24.94 mg/l; pH rate 7.56; and temperature of 28^0 C.

A. Decrease in TSS at Anaerobic Reactor with and without EM_4 addition

The graphic of removal efficiency of TSS based on the duration of waste sampling in anaerobic condition with and without the addition of EM_4 are presented in Figure 4.

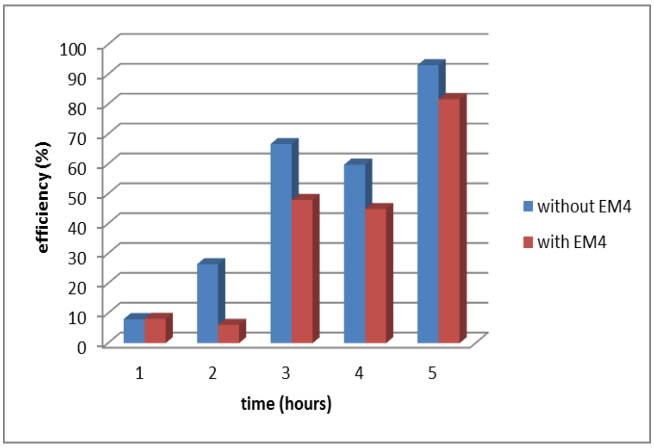

Figure 4. Decrease in TSS concentration at the anaerobic reactor with and without EM4 addition.

Figure 4 indicates that at the beginning of the running process (operating time = 3 hours), in the reactors with or without EM4, the efficiency rate obtained was similar (8.05% and 8.01%). Such condition occurred because at the beginning of the process the biofilm layer was still thin, so that the pollutant degradation by the microorganism was still countable. At the operation of five hours, the anaerobic reactor without EM4 increased the efficiency rate of 26.44% whereas that of with EM4 had the efficiency rate of 6.12%. The pattern of the decreasing in the TSS concentration was similar, even though there was an increase in the efficiency as high as 93.10% (without EM4) and 81.63% (with EM4). Therefore, the anaerobic condition without or with EM4 proved increasing over time. In the anaerobic reactor without EM4 the pattern had an equal efficiency rate, but higher than that of with the EM4 addition.

B. Decrease in TSS at Aerobic Reactor with and without EM4 addition

The graphic of removal efficiency of TSS based on the duration of waste sampling in aerobic condition with and without the addition of EM_4 are presented in Figure 5. The Figure indicates that the addition of EM4 to the aerobic reactor resulted in an increase in efficiency of the TSS concentration. At the beginning of the running process (operation time = 3 hours), the efficiency rate of the decrease in TSS concentration in the reactor without EM4 was 27.17%, compared to that of without EM (2.77%). In the operation times of 5, 7, 9, and 11 hours, the pattern of the decrease in TSS concentration in the aerobic reactor with EM4 addition tended to rise with a stable value. Whereas in the aerobic reactor without EM4 addition, the efficiency of the decrease at the beginning of the process tended to be low, but entering the operation time of 9 hours the efficiency rate increased to 71.29%. By the operation time of 11 hours, in the aerobic reactor with EM4 addition showed an increase in the efficiency rate of the decrease in TSS concentration over time. It did not take a long time (less than three hours) for reaching the efficiency rate of more than 20%.

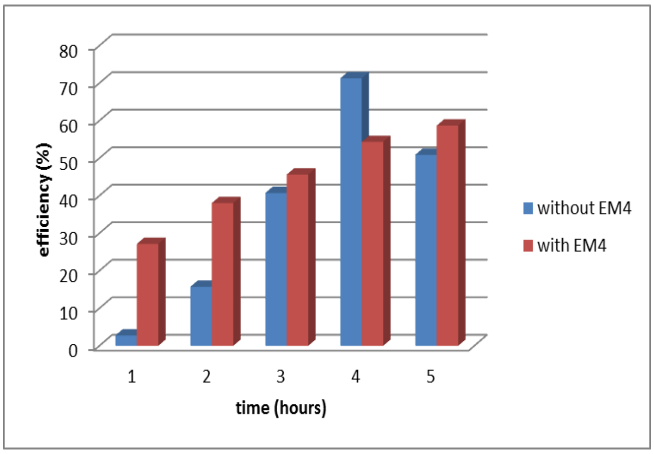

Figure 5. Decrease in TSS concentration at the aerobic reactor with and without EM4 addition.

In the condition of without EM4 addition, time necessary would be approximately seven hours. Such condition was caused by the addition of the EM4 in the form of liquids containing microorganisms and additional microorganisms from the wastewater. The biofilm layer that became the blanket for the honeycomb media surface would play a significant role in the wastewater degradation process. The biofilm layer consisted of consortium of microorganisms such as bacteria, sponges/fungi and protozoa. They actively degraded organic materials in the wastewater to decrease the concentration of the suspended solids in the wastewater.

4. CONCLUSION

A. In the anaerobic condition without or with EM4 addition, the pattern of the decrease in TSS concentration was irregular. In the aerobic reactor with EM4 addition the efficiency time tended to increase over time. In the anaerobic reactor without EM4 addition with the similar pattern, the efficiency rate tended to be higher than that of with EM4.

B. In the aerobic reactor with EM4 addition, the efficiency rate of the TSS tended to be stable over time and it did not need longer time (less than three hours) to reach the efficiency rate of higher than 20%. Whereas, in the condition without EM4 addition, it took seven hours to reach the efficiency of TSS decrease of 20% or higher.

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