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Model of Liquid Waste Treatment Unit of Tofu by Using Water Plants (*Pistia Strafiates*) and Biofilter

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Abstract: ***Liquid waste in tofu industry has high content of organic compound, thus, it is needed to be treated firstly before it was disposed to the environment. Level of pollutants of liquid waste pollutant from tofu production can be decreased through biological system treatment by using water plants which are modified by biofiltration through using sand, gravel, and coral so that the quality of waste that was disposed to the water outside was in accordance with the applicable regulation. Moreover, this research aimed at analyzing the ability of water plants (Pistia strafiates) for reducing the parameter of BOD, COD, and TSS in tofu waste. The research that was used was experimental research. Sample collection was conducted once in 2 hours in outlet of waste treatment until obtaining effluent result that qualified the effluent quality standard that was expected. Data analysis was conducted by using comparative test for examining the difference of data for more than two groups. The obtained result from this research was it was occurred a significant decrease for either parameter of BOD, COD, or TSS by using reactor that was planted water plants.***

Keywords: BOD, COD, TSS, Biofilter, Water Plants *(Pistia strafiates*)

1. Introduction

Tofu is one of traditional food that is usually consumed everyday by Indonesian people. The production process of tofu produces 2 kinds of waste, which are solid waste and liquid waste. Generally, solid waste is used as cattle's feed, meanwhile, the liquid waste is disposed directly to the environment. Liquid waste of this tofu industry has high content of organic compound. Without any good process, this tofu waste causes negative impact, such as water pollution, disease, bad smell, increasing mosquito's growth, and decreasing the aesthetics of the around environment [1].
Many tofu industries which are home industry scale in East Java do not have any instalation of liquid waste treatment. Unwilling of the owner of the tofu industry to treat the liquid waste is caused by complex problem and inefficiency of the process of waste treatment. Whereas, the liquid waste of tofu industry has high content of organic compound that has potency to produce biogas through anaerobic process. Generally, biogas contains 50-80% of metana, CO2, H2S, and little water that can be made as alternative energy source of kerosene or LPG replacement. Through converting liquid waste from tofu industry to be biogas, the owner of the tofu industry does not only contribute in keeping the environment, but also increases her/ his income by reducing the consumption of fuel in the process of making tofu.

Most of liquid waste that is produced by tofu industry is viscous liquid that is separated from tofu lump or it is known as whey. This liquid contains high protein and can be biodegradable as soon as possible. This liquid waste is often disposed directly without any treatment first. Thus, it causes bad smell and pollutes river. Other liquid waste sources are from soybean washing, washing of process tools, mopping, cooking, and soybean immersion emulsion. Total of liquid waste that is produced by tofu industry is about 15-20 l/kg of soybean as the material. Meanwhile, the pollutants are TSS in 30 g/L per-kg of soybean material, BOD in 65 mg/L per-kg of soybean material, and COD in 130 mg/L per-kg of soybean material.

According to the result of preliminary survey on 13rd January 2016, there were 20 small home industries that produced tofu in river side of Kalianyar, Kalianyar Village, Kunir Subdistrict, Bondowoso District and disposed the waste directly to the river. The result of beginning measurement against the content of pH, BOD, COD, and TSS which were measured on the upstream (before getting pollution of tofu waste) showed the pollutant content on tofu waste was 6, 68 ppm, 123 ppm, and 30 ppm. Meanwhile, in the location of Kalianyar River after getting pollution of tofu waste were in pH= 6, BOD = 127 ppm, COD = 239 ppm, and TSS = 80 ppm. The result showed that the pollution level that was caused by tofu waste from the houses around the river was quite high, surpassed the quality standard threshold of East Java Governor's Regulation Number 72 in 2013 regarding Quality Standard of Liquid Waste for Industry or Other Business Activities.

By considering the result of preliminary observation, we were interested to conduct experiment research in order to reduce pollutant level of liquid waste pollutan from tofu production through biological system treatment by using water plants which were modified by biofiltration through using sand, gravel, and coral. Moreover, this research aimed at analyzing the ability of water plants (Pistia strafiates) for reducing the parameter of BOD, COD, and TSS in tofu waste.

2. Research Methods

This research was experimental research by cross-sectional approach, and the sample was conducted an examination in laboratory. The model of this treatment unit was mostly consisted of tank for collecting liquid waste in home industry of tofu, treatment tank which biologically used water plants (((Pistia strafiates) and without any water plants), and biofilter treatment unit that was consisted of bioball media. Tank for collecting waste, tank for biological treatment, tank for biofilter treatment were made from clear glass material with certain specification (thickness in 1 cm).

The sample collection was conducted once in 2 hours in the outlet of waste treatment until obtaining effluent result that qualified effluent quality standard that was expected.

Data analysis was conducted by using comparative test in order to examine the difference of data for more than two groups. This research only noticed one change, which was decrease of waste water level from tofu industry that qualified the parameter of effluent quality standard after getting treatment.

3. Result and Discussion

Figure 1: Design of Waste Treatment Unit

Effective volume of reactor was 495,8 liter. This waste treatment unit was made from 2 reactors that would be used as research variation, which Reactor I was operated without using any water plants and Reactor II was filled by water plants (Pistia strafiates). Drain system in this research used continuous system, which the liquid waste was in and out from the reactor with balanced debit. Total of reactor that was made for this research was 2 (two) models/ shapes with same size. The material for making this reactor was clear glass with the thickness in 1 cm that was designed to look like reactor of liquid waste treatment that would be implemented in the field.

In order to operationalize reactor that was made, each reactor was completed with water pump and aerator pump. Detention time in reactor was organized by settling either influent or effluent debit in the reactor.

Acclimatization process was needed in order to condition the reactor of the liquid waste treatment so that it would be ready to be used as instrument in this research activities. As the design of this research was biological treatment, the acclimatization process was needed in order to create microorganism that could breed in the reactor based on the types of microorganism [2]. Besides, because variation in this research used water plants (Pistia strafiates) as the media of the growth of microorganism in the water, acclimatization process was also needed to condition the water plants for being able to grow and breed in the reactor that was filled by waste water as the media of its growth.

The water plant that was used in this research was Pistia strafiates. Acclimatization process of the water plant into reactor of waste water underwent several times of adaptation, regarding the habitat of this plant was moved from the natural environment (pond) into new environment (water media that had different quality). Adaptation of water plants into reactor was seen from first day until third day, which the leaves from this water plants withered and their color changed from green to be yellowish green. However, the plants did not die and they were exposed continuously in the outside by expecting that they would still get the sunlight. This condition was occurred until sixth day that later, the plants started adapting with the environment in the reactor. Then, the leaves of the plants started being green again and could endure until the final activity of this research.

The water plants in this research were exposed continuously in the reactor by expecting that it could help decomposition process of liquid waste in the Reactor I room I through the growth of life microorganism that sticked on the root of the water plants. The growth of these water plants was always controlled so that their density was not excessive until surpassing the capacity of the reactor.

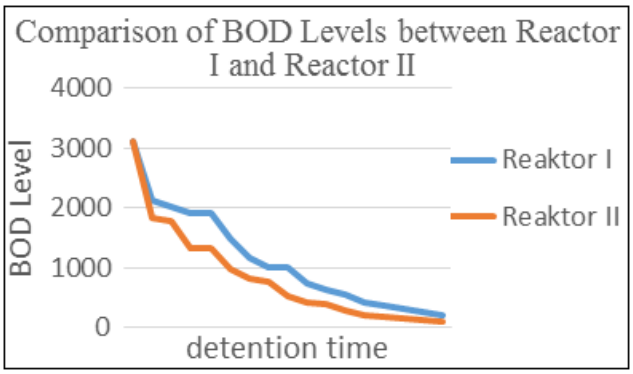

Figure 2: Comparison of BOD level between Reactor I and Reactor II

Figure 2 above showed that in Reactor I and Reactor II were occurred a decrease of BOD parameter in effluent in every additional detention time for the liquid waste treatment. This showed that the role of water plants (Pistia strafiates) in this research gave efficiency of the decrease of BOD in higher reactor. The existence of life microorganism that thicked on the root of the water plants hastened decomposition process of organic substance in liquid waste that was treated.

In reactor I, liquid waste treatment without using any water plants in detention time of 32 hours with the efficiency of decrease of BOD parameter in 93,92 % still had not been able to reach quality standard as what it was stated in East Java Governor's Regulation Number 72 in 2017. The additional detention time with similar debit data would impact on the change of dimension of liquid waste treatment that was bigger and bigger. In this case, if the treatment system would be applied in the field, it was suggested that after through biological reactor, it needed to be added further treatment. The further treatment could be biological treatment for either aerob or anaerob for improving the quality of BOD after through main treatment.

Furthermore, it was different with reactor II in treatment unit that was conducted in this research. The existence of water plants (Pistia strafiates) in room 1 would show BOD value in the effluent that had qualified the quality standard of liquid waste as what it was required in East Java Governor's

Regulation Number 72 in 2013. By detention time for 30 hours in reactor, it could decrease BOD level until in 130,68 mg/L (quality standard was in 150 mg/L). Decrease of BOD that was 95,81 % was the result of decomposition of organic substance in reactor by life microorganism in suspended growth in room 1, which the life microorganism sticked on the root of the water plants; in room 2, the life anaerob microorganism sticked on bioball (attacth growth); and in room 3, the life aerob microorganism sticked on bioball (attacth growth) [3]. Each process in reactor had specification in efficiency of organic substance treatment. However, in this research, the efficiency was counted and measured totally for the process that was the union from the biological processes which were occurred in every room.

In order to know the ability of each process of liquid waste treatment for either biological anaerob or biological aerob, it could be conducted further research by analyzing treatment result of liquid waste in the room (the sample was taken). Therefore, it could be known the specification of each process in the reactor.

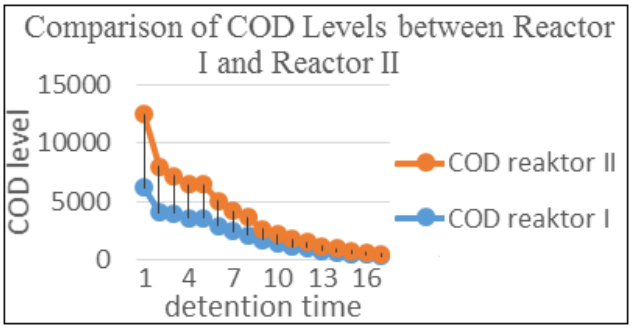

Figure 3: Comparison of COD level in reactor I and II

Figure 3 above showed that either in Reactor I or Reactor II were occurred the decrease of COD parameter in effluent in every additional detention time for liquid waste treatment. The role of the water plants (Pistia strafiates) in this research was to give efficiency of the decrease of COD in higher reactor. The existence of life microorganism that sticked on the root of the water plants also hastened decomposition process of organic substance in the liquid waste that was treated.

In reactor I, liquid waste treatment without any water plants in detention time of 32 hours with the efficiency of the decrease of BOD parameter in 94,72 % still had not been able to reach the quality standard as what it was stated in East Java Governor's Regulation Number 72 in 2017, which was 300 mg/L. The additional detention time with similar debit data would impact on dimension change of liquid waste that was bigger and bigger. In this case, if the treatment system would be applied in the field, it would be suggested that after through biological reactor, it needed to be added further treatment. The further treatment could be biological treatment for either aerob or anaerob in order to improve the quality of COD after through main treatment.

Nevertheless, it was different with reactor II in the treatment unit that was conducted in this research. The existence of water plants (Pistia strafiates) in room I would show COD value in the effluent that had qualified the quality standard as what it was required in East Java Governor's Regulation Number 72 in 2013. By detention time for 28 hours in reactor, it could decrease COD level until 287,22 mg/L (the quality standard was in 300 mg/L). Decrease of COD that was in 95,40 % was decomposition result of organic substance in reactor by life microorganism in suspended growth in room 1 and the life microorganism sticked on the root of the water plants, in room 2 the life anaerob microorganism sticked on bioball media (attacth growth), and in room 3 the life aerob microorganism sticked on bioball media (attacth growth). Each process in the reactor had specification in the efficiency of the treatment of organic substance. However, in this research, the efficiency was counted and measured totally the process that was the union of biological processes which were occured in every room [4].

In order to know the ability of each treatment process of liquid waste for either biological anaerob process or biological aerob process, it could be conducted further research by analyzing the treatment result of liquid waste in the room (the sample was taken). Therefore, it could be known the specification of every process in the reactor.

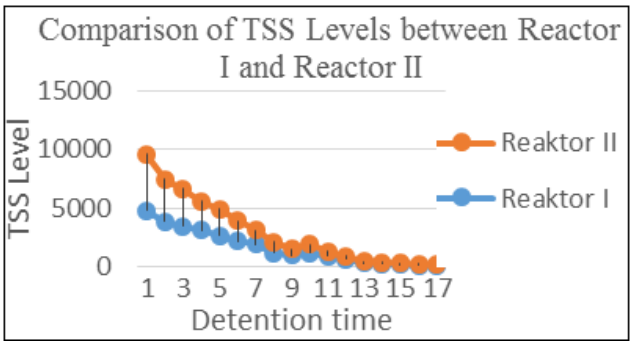

Figure 4: Comparison of TSS Level in Reactor I and Reactor II

Figure 4 above showed that either Reactor I or Reactor II were occured the decrease of TSS parameter in the effluent in every additional detention time in liquid waste treatment. The role of water plants (Pistia strafiates) in this research gave efficiency of the decrease of TSS in higher reactor. Decomposition process of organic substance by microorganism would impact against the increase of particle that was detained in the reactor. This would decrease the suspended particle in the reactor.

Decrease of suspended particle in the reactor was not only determined by the efficiency of biological treatment before, but also influenced by detention time factor in sufficient detention room. In research reactor, the detention room that was in room 4 was final process from liquid waste treatment for detaining the detained particle that could detain in certain time. In reactor I of liquid waste treatment without any water plants in detention time for 32 hours with the efficiency of the decrease of TSS parameter in 97,29 % still had not been able to reach quality standard as what it was stated in East Java Governor's Regulation Number 72 in 2017, which was in 100 mg/L. Furthermore, in order to increase the efficiency of the decrease of TSS in waste water, it needed to be conducted further treatment, such as biological treatment that was followed by detention process. In this case, if the

treatment system would be applied in the field, it was suggested that after through biological reactor, it needed to be added further treatment. The further treatment could be such as biological treatment in either aerob or anaerob for improving the quality of TSS after through main treatment.

However, it was different with reactor II in treatment unit that was conducted in this research. The existence of water plants (Pistia strafiates) in room 1 would show TSS value in the effluent that had qualified the quality standard of liquid waste as what it was stated in East Java Governor's Regulation Number 72 in 2013. By detention time for 28 hours in reactor, it could decrease TSS level until 100 mg/L (the quality standard was 100 mg/L). The decrease of TSS in 95,92 % was decomposition result of organic substance in reactor by life microorganism in either suspended growth or sticking on bioball media (attacth growth). Each process in the reactor had specification in the efficiency of the treatment of organic substance. However, in this research, the efficiency was counted and measured totally the process that was the union from biological processes which were occured in every room.

4. Conclusion

Reactor efficiency in treating liquid waste from tofu industry could be increased by adding water plants (Pistia strafiates) in room 1. Thus, it would qualify the quality standard on the effluent of liquid waste, particularly for the parameter of BOD, COD, and TSS

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