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Performance of sequencing batch reactor (SBR) of treated tofu wastewater: variation of contact time and activated sludge sources

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Abstract. One of the wastewater treatment system that is able to reduce levels of contamination are industrial wastewater using Sequencing Batch Reactor (SBR). Important in the early stages of SBR is filling phase (filling) consisting of seeding and acclimatization period. In the seeding and acclimatization period, the reactor will be filled with activated sludge and wastewater aeration process during the next study period. This research was conducted to find out sources and the best contact time of the activated sludge in lowering the concentration of COD and TSS from wastewater of tofu industry. Activated sludge which will be used is sourced from slaughter house, gutters of tofu industry, and polluted rivers. The variation of contact time which will be used is day 0; 1; 3; 5; 9 and 13. The results showed that the activated sludge are sourced from a polluted river sludge with the best percent COD reduction of 81% and TSS by 94% at day 13.

1. Introduction

Now days, almost all tofu businesses in Indonesia still use simple technology, therefore the level of efficiency in the use of resources (water and raw materials) is still low and waste production is high. Tofu industrial wastewater has COD (Chemical Oxygen Demand) between 1940-4800 mg / L, BOD (Biological Oxygen Demand) between 1070-2600 mg / L, TSS (Total Suspended Solid) between 2100-3800 mg / L and a pH between 4.5 and 5.7.

Characteristics of the tofu wastewater contain high organic materials, if directly discharged into water bodies, will degrade environmental carrying capacity. One of the wastewater treatment systems that can treat industrial wastewater is Sequencing Batch Reactor [1]. Sequencing Batch Reactor uses activated sludge media. Active sludge is usually used for biological or biomass suspensions which are active in removing organic material. Under capable conditions, the activated sludge can decrease the BOD's value by 70-95% [1].

The purpose of this research is to find out sources and the best contact time of the activated sludge in lowering the concentration of COD and TSS from wastewater of tofu industry. Activated sludge which will be used is sourced from slaughter house, gutters of tofu industry, and polluted rivers.

2. Methods

This research is divided into two main stages, analyse the best sludge source then followed by analyse the best contact time. The reactor design criteria used are containers made of acrylic plastic, 20 cm long, 20 cm wide, and 30 cm in height.

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2.1. Sludge drawing process

Activated sludge which will be used is sourced from slaughter house, gutters of tofu industry, and polluted rivers. For the point of sludge taking is done by random method where the sludge is taken randomly so it is expected that the sludge contains many microbes.

2.2. Seeding process and acclimatization

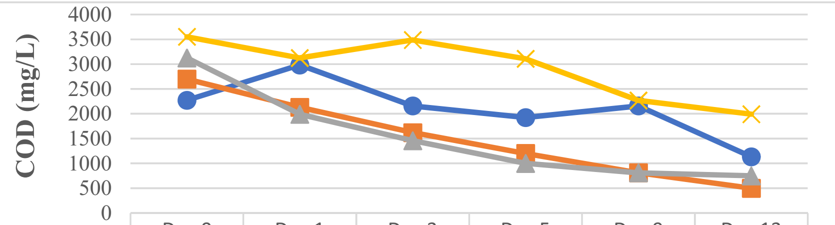
The three kinds of sludge that have been obtained are diluted by a ratio of 4: 100. The amount of media used is 40% of the volume of the reactor. Then each reactor is given an air intake using an aerator and placed on the base of the reactor. This aeration process to maintaining the value of DO remain more than 2 mg/L and also acts as a mixer between active sludge and wastewater.

The stages in the acclimatization period are carried out in the following manner, including 60% wastewater from the volume of the processing reactor into three reactor containers which have been gradually containing the sludge. Then enter the waste industry waste as much as 100% of the reactor volume into the empty reactor (without active sludge), as the control reactor. Analyze the magnitude of TSS and COD values and observing the magnitude of the decline of each parameter performed over a period of 2 weeks. And also to know the best contact time, wastewater samples taken with variation of contact time which will be used is day 0; 1; 3; 5; 9 and 13.

3. Results and Discussion

Analyse of COD and TSS value is done by sampling at 0 day, 1 day, 3 day, 5 day, 9 day, and 13 day, so the total time of research is within 2 weeks. The analysis was performed on the same day when the waste water sampling from the reactor. Reactor I with sludge from slaughterhouse, reactor II with polluted rivers sludge and reactor III with gutters of tofu industry sludge.

3.1. COD removal



	Day 0	Day 1	Day 3	Day 5	Day 9	Day 13
Reactor I (Slaughterhouse Sludge)	2272	2982	2158	1924	2158	1134
Reactor II (River Sludge)	2698	2130	1620	1200	810	500
Reactor III (Gutters of tofu industry Sludge)	3124	1988	1458	1000	810	750
Reactor Control	3550	3124	3486	3108	2268	1992

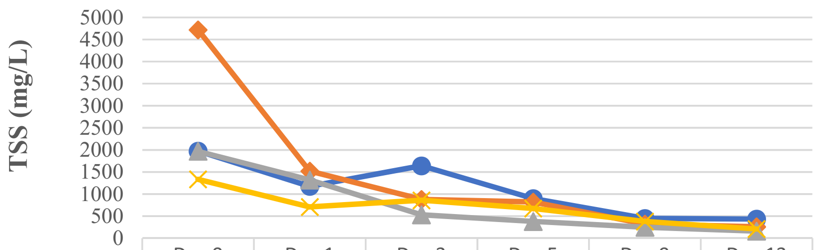
Figure 1. COD concentration during acclimatization

Figure 1 shows that all the measured samples decreased COD values. Both the processed reactor and the control reactor, have decreased the value of the COD content. For reactor I, during acclimatization was able to decrease COD concentration up to 1134 mg/L with efficiency is 50%. During the acclimatization period, there are fluctuations in COD levels decrease. This is due to the COD value owned by sludge slaughter house is high ranging from 5500-7000 mg/L. So at reactor I, microbes have to work harder to degrade COD content, either from waste or from the sludge slaughter house itself.

For reactor II during acclimatization period was able to reduce the initial COD level by 81 % from 2698 mg/L to 500 mg/L. In reactor II, the decline of COD content tends to be more stable than the reactor I. While for the reactor III, significant decrease in COD levels on day 1 that can reach the value of half of the initial value of 3124 mg/L to 1988 mg/L. However, for the next period until the acclimatization period ends, the ability of reactor III to degrade the waste is not as good as in the early days of acclimatization. The reactor III was able to reduce COD levels 76%.

The decrease of COD concentration caused by the activity of microorganism in degrading organic compounds for the purpose of life. Decreasing COD values by treatment (presence of active sludge in the reactor) gives better results than without treatment (control). This is caused by the activity of microorganisms to remodel organic materials that exist in the tofu industry wastewater. The decrease in the concentration of COD values indicates the process of decomposition of organic materials by microbial activity in the reactor where the organic matter contained in the tofu wastewater in the form of complex compounds has been degrade into simpler compounds. The decrease is due to the longer duration of waste residue in the reactor then the contact between the waste with active sludge will be longer so that the chance of microorganisms to degrade the organic material the greater and the more decomposing organic matter, so the best contact time to reduce the COD content is on day 13.

3.2. TSS removal



	Day 0	Day 1	Day 3	Day 5	Day 9	Day 13
Reactor I (Slaughterhouse Sludge)	1975	1175	1640	900	450	435
Reactor II (River Sludge)	4720	1520	880	820	320	260
Reactor III (Gutters of tofu industry Sludge)	1970	1320	530	380	250	160
Reactor Control	1335	710	860	675	380	210

Figure 2. TSS Concentration during acclimatization

Figure 2 shows a decrease in the value of TSS concentration during the acclimatization period at all reactor. For reactor I able to decrease of TSS concentration by 84% from 1975 mg/L to 435 mg/L. However, on the 3rd day had increased the value of TSS, which amounted to 1640 mg/L while on day 1 has decreased to reach 1175 mg/L. This can occur due to the lack of realization of the stirring area in the reactor causing some particles to become elevated, so that the TSS value obtained on the 3rd day sampling becomes higher.

For reactor II, can decrease TSS concentration by 94% from 4720 mg/L to 260 mg/L. For reactor II, the highest TSS removal was observed on day 1, where TSS concentration on day 1 had reached 1520 mg/L, and in subsequent days still decreased although not as much as day 1 decrease value. TSS concentrations in reactor II has a higher value than the other reactors, which is 4720 mg/L compared to other reactors are 1975 mg/L for reactor I and 1970 mg/L for reactor III. This can happen because of the value of the TSS contained in reactor II not only from wastewater, but also from the sludge of the river itself.

For reactor III, it can decrease TSS concentration from 1970 mg/L to 160 mg/L. The pattern of TSS degradation of reactor III tends to be more stable than other reactors. However, the capacity of the reactor III is no better than that of the other reactors, since the reactor III is only able to set aside the TSS value of 92% and the initial TSS value. As for the control reactor, it is capable of setting aside 86% of the initial TSS value. Although the value of the TSS decrease from the control reactor is higher than that of reactor I, but the reactor I has better performance than the control reactor. This is because in reactor I, it contains not only TSS value of wastewater but it contains TSS value of slaughter house sludge as well. So it can be concluded that active sludge has an important role in degrading efforts for both TSS and COD values from tofu wastewater.

Based on COD and TSS degradation data on contact time variation, it can be seen that the lowest value on day 13. This indicates that the best duration of contact is to decrease the COD and TSS content in tofu waste for 13 days. This is because, the longer the contact time the microbe will have a longer time to degrade the waste so that the value of COD and VSS lowest on observation day 13.

4. Conclusion

The result of this study COD and TSS removal using slaughterhouse COD removal of 50% and TSS removal of 84%, polluted rivers sludge COD removal of 81% and TSS removal of 94%, while gutters of tofu industry sludge COD removal of 76% with TSS removal of 86%. And also the best contact time for removal COD and TSS on day 13.

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