The effect of time and velocity variation in sequencing batches reactor on TSS and nitrogen removal in tofu waste

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Abstract. The tofu industry is one of the home industries which in the processing process, produces liquid waste. Tofu liquid waste is known to contain very high organic matter such as Nitrogen and TSS so that if it is directly discharged into water bodies, if discharged directly into the environment will cause water. The purpose of this study was to determine and analyse the effect of variations in times and velocity of sequence batch reactor on the optimization of Nitrogen and TSS removal in tofu industrial wastewater by anaerobic bacteria originating from natural sediments. This study uses a Sequencing Batch Reactor, and the waste used is artificial by the characteristics in the preliminary test. In this study, time and speed variations were used in the mixing process. The artificial waste has a TSS value of 2,910 mg/l and Nitrogen of 18.82 mg/l. The results show that using a sequence batch reactor can reduce the TSS value to 66 mg/l and reduce the nitrogen value to 1.214 mg/l.

1. Introduction
Tofu is a traditional Indonesian food that is easy to find and highly nutritious, plus the price is very affordable and cheap. Making this tofu is pretty easy, so there are many tofu industries on a household scale. This household-scale factory still uses simple equipment and does not have its liquid waste treatment system.

The liquid tofu waste is produced from the washing, boiling, pressing and printing process of tofu. Therefore, the liquid waste produced is very high. Tofu liquid waste has the characteristics of containing high organic matter, high levels of TSS and Nitrogen so that if it is discharged into the environment directly, it will reduce the carrying capacity of the environment.

Biological processes can carry out tofu waste treatment technology with anaerobic, aerobic systems or a combination of aerobic-anaerobic systems. Accordingly, tofu liquid wastes should be disposed of after processing treatment. The most affordable and the simpler processing alternative of liquid tofu wastes is by biological process[1]. With an anaerobic biological process, the processing efficiency is only around 70%-80%, so that the water still contains a relatively high level of organic pollutants, and the odour is still generated so that this causes problems[2].

Batch Reactor is a wastewater treatment technology using the principle of suspended growth[3]. The embedded biomass system has better microbial activity than the suspended biomass system. The microorganisms that form the biofilm layer have a low substrate concentration and provide a higher possibility of reaction with nutrients outside the substrate[4]. SBR is an activated sludge process designed to operate in unsteady-state flow conditions. Wastewater treatment using SBR can also
produce better effluent quality than other biological treatment methods[5]. The working principle of this SBR system is an activated sludge system with fill and pour operations[6].

This study used bacteria from a septic tank, and the processing was carried out using a batch reactor using variations in speed; 100 ppm and 140 ppm. The speed used is trial and error and allowed to form sedimentation so that it can be seen how effective this batch reactor is in reducing TSS and Nitrogen levels in tofu waste, its relation to developing waste treatment technology that is cheap, fast and easy to operate and has no environmental impact after processing it.

2. Methodology

This research was conducted with an experimental method. The experimental method used in this study is a laboratory scale. Observations in experimental research were carried out under artificial conditions regulated by the researcher. This research will be carried out for 35 days by operating the reactor in batches. Parameters tested are TSS and Nitrogen. The source of the microorganisms tested came from a septic tank in one of the settlements in the Tembalang area. The independent variable is the concentration of the mixing process in the batch reactor, 100 ppm and 140 ppm, and the sedimentation time is 4 hours. The dependent variable in this study is the levels of TSS and Nitrogen. The control variables are the initial TSS concentration and the initial Nitrogen concentration, with the pH and temperature being kept constant.

The study begins with conducting a preliminary test. The preliminary test is intended to determine the characteristics used as a reference for making artificial waste. The characteristics tested are TSS and Nitrogen. The TSS test was carried out by gravimetry, and the Nitrogen test was carried out by the destruction and indophenol method. The characteristics of tofu waste that have been identified will be a reference for making artificial waste. Then the artificial waste will be put into a sequence batch reactor. Artificial waste will undergo a mixing process for 3 hours by applying velocity variations; 100 rpm and 140 rpm. After the mixing process, the artificial waste will go through a sedimentation process for 4 hours. Then the TSS and Nitrogen values will be tested as the final result of SBR processing. Here is the framework of this research:

Figure 1. The framework of the research.
3. Results and discussion

This study has three stages: identifying the characteristics of tofu waste, making artificial liquid waste, and then the running stage.

Table 1. Test results of tofu waste characteristics.

| Parameter | Unit | Concentration | Maximum Rate* | Explanation                        |
|-----------|------|---------------|---------------|------------------------------------|
| COD       | mg/l | 7.000         | 100           | It does not meet the quality standard |
| BOD       | mg/l | 2.000         | 10            | It does not meet the quality standard |
| pH        |      | 5.37          | 6-9           | It does not meet the quality standard |
| Suhu      | °C   | 58.4          | -             | -                                   |
| DO        | mg/l | 1.03          | -             | -                                   |
| TSS       | mg/l | 2.910         | 200           | It does not meet the quality standard |
| N         | mg/l | 18.82         |               |                                     |

*) Decree of the State Minister of the Environment No KEP-51/MENLH/10/1995

The materials used to make artificial waste are aquaest, kaolin, and glucose. In this study, it was carried out with the same time and 2 variations of speed. Meanwhile, for the acclimatization process, two artificial concentrations of the same were made. Concentration is made with a ratio of 100% of the concentration of the original waste. Then in the final stage, which can be called the running stage, it uses a concentration variation of 100% of the original waste.

Table 2. Variation of 100% BOD and COD parameter concentrations.

| Reactor | Speed (rpm) | Time (Hour) | Concentration |
|---------|-------------|-------------|---------------|
|         |             |             | BOD (mg/L)    | COD (mg/L)    |
| Reactor 1 | 100         | 4           | 86            | 0.775         |
| Reactor 2 | 140         | 4           | 66            | 1.214         |

Figure 2. Graph of TSS and N removal at the 4th hour.

The graph above shows the removal of TSS and N concentrations at the 4th Hour at the running stage with different speed variations. In Reactor 1, the speed used was 100 rpm for 4 hours, which resulted in a TSS concentration of 86 mg/L and an N concentration of 0.775 mg/L. Meanwhile, in
Reactor 2, using a speed variation of 140 rpm, the TSS concentration is 66 mg/L, and the COD concentration is 1.214 mg/L.

3.1. Effect of speed variation
The results showed that the TSS removal efficiency at a concentration of 2,910 mg/L of 97.73% was 66 mg/L. These numbers show that the results of this study using Sequencing Batch Reactor can reduce TSS by 97.73% with a speed of 140 rpm.

The calculation of the removal efficiency for the COD concentration can be seen as follows:
Initial TSS concentration: 2,910 mg/L
Final TSS concentration: 66 mg/L
Removal efficiency %: \((2,910-66)/2,910 \times 100\% = 97.73\%\)

Meanwhile, the initial N concentration was 18.82 mg/L to 1.214 mg/L, so the removal efficiency was 93.55%. So, from this figure, it is stated that the use of Sequencing Batch Reactor can significantly reduce TSS and N.
Initial N concentration: 18.82 mg/L
Final N concentration: 1.214 mg/L
Removal efficiency %: \((18.82-1.214)/18.82 \times 100\% = 93.55\%\)

4. Conclusion
TSS and N contained in the tofu waste process must be treated before being discharged to the water's surface. The allowance for TSS and N values can be made using a biological process. The technology that can be used is the Sequence Batch Reactor. The results showed that the Sequence Batch Reactor could reduce the TSS value by 97.73% from the initial TSS value of 2,910 mg/l to 66 mg/l. It also occurs in the N parameter. The sequence batch reactor can set aside the initial N value of 18.82 mg/l to 1.214 mg/l with a removal efficiency of 93.55%. From the research results, it is known that the final values of TSS and Nitrogen are below the established quality standards. The final TSS value is 66 mg/l, which is below the quality standard of 200 mg/l.

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