Tempe Manufacturing Liquid Waste Treatment using Alum Coagulant with Variation of Coagulant Weight

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ABSTRACT

So far, liquid waste from the tempe industry has yet to be utilized and is only disposed of in sewers to the environment. The liquid waste from tempe consists of soluble proteins from soybeans, which can give rise to a sour smell, and there are tiny particles that settle, so it is necessary to treat the waste before it is discharged into the environment. Alum is one of the coagulants that can be used to treat liquid waste. This research contribution is to determine the effect of alum as a coagulant in tempe industrial wastewater to obtain optimal results. The optimum results in question are an increase in DO levels and a decrease in COD and TSS levels in the tempe industrial wastewater so that the resulting conditions are not dangerous if the waste is disposed of into the environment. The variables observed in this study were pH, DO, COD, and TSS comparing each variable. The variable used in this study was the weight of the alum coagulant with a stirring speed of 300 rpm for 90 minutes and standing for 24 hours. In this study, there is a correlation of variations in coagulant weight. The optimum results obtained were from 100 ml of waste. The optimum DO value produced was 8.4 mg/L at an interpretation of 10 g of coagulant weight. The optimum COD concentration obtained was 18612.5 mg/L at a variation of 20 g of coagulant weight. The optimum TSS concentration obtained was 102 mg/L with 25 g of coagulant weight variation.

1. Introduction

Indonesia is the largest country that processes soybeans into tempeh. Tempe is one of the food needs at an affordable price, and processing soybeans into tempe can increase the economic value of soybeans [1]. Banana peel also can be processed into flour to improve its economic importance [2]. In processing, all industries will produce waste. There are two kinds of waste produced by the tempe industry, namely solid waste, which is usually used as animal feed, and liquid waste, which is thrown into the environment and can damage soil structure if done continuously [3]. Solid waste can be converted into energy or gas using gasification technology [4]–[8]. Another technology that can be used to convert solid waste is pyrolysis [9].

Tempe is one of the fermented products of soybeans which is very well known by the people of Indonesia [10]. Tempe contains a lot of protein and vegetable oil. In the process of making tempeh, processing does not require special tools because the process of making tempe is mostly boiling and soaking. Soybeans also do not experience destruction in the manufacture of tempeh [11], [12], [13].

Alum is one of the coagulants commonly used in wastewater treatment because alum can bind colloidal particles floating in the water and bind them into large particles [14], [15]. Coagulation is a process in liquid waste treatment to remove a solid from the waste [16]. The mechanism binds small impurity particles in water into large particles or flocs so that waste can be purified and clarified quickly [17].

Liquid waste from industry is one of the trigger factors for environmental pollution. Tempe industry contains much organic matter and dissolved solids [18]. From the data obtained, the pH, DO, COD, and TSS contents in the liquid waste from soybean soaking were 4; 7.4 mg/L; 35398.87 mg/L; and 4551 mg/L. Meanwhile, based on the requirements for class IV liquid waste quality standards, the liquid waste quality standards are pH 5-9, DO 0-4 mg/L, COD 600 mg/L, and TSS 500 mg/L [18]. Therefore, this research contribution is to optimize the content of soybean soaking liquid waste so that it is safe to dispose of it directly into the environment.

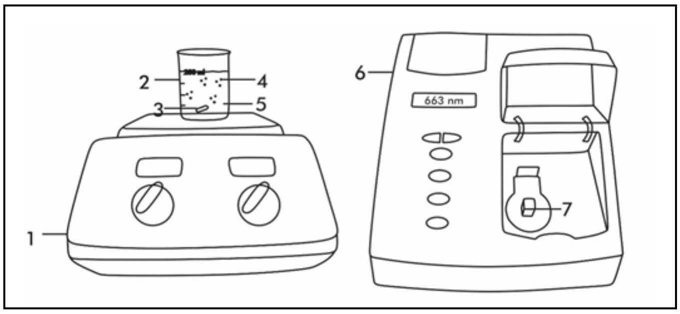
2. Research Methodology

2.1. Materials

The material used in this research is liquid waste used for soaking soybeans in the manufacture of tempeh. The liquid waste is water used to wash the soybeans for 12 hours taken from the homemade tempe industry in Karangtalun, Bantul. This study also used alum as a coagulant obtained from the market.

2.2. Procedures

Fig. 1. displays a series of equipment for research consisting of a magnetic stirrer, a stirrer, and a glass beaker. The research procedure was crushing the alum chunks and sifting using a 40-mesh screen. Then 100 ml of liquid waste used for soaking soybeans was measured for pH and DO. Once measured, add alum to the liquid waste with variations of 5, 10, 15, 20, and 25 g and stir it for 90 minutes at 300 rpm. After the stirring process, the waste is allowed to stand for 24 hours so that the particles settle, and the final process is filtering using filter paper carried out in triplicate. After the screening, the COD and TSS values were checked at the Yogyakarta Center for Environmental Health Engineering and Disease Control (BBTKLPP) based on SNI 6989.15:2019 for COD, SNI 6989.3:2019 for TSS.



Where:
1. Magnetic stirrer
2. Beaker glass
3. Stirrer
4. Coagulant
5. Solution
6. Spectrophotometer
7. Cuvet

Fig. 1. Research equipment

3. Results and Discussion

Research processing soybean soaking waste in the manufacture of tempe using coagulant alum with weight variations of 5, 10, 15, 20, and 25 g with a sample volume of 100 mL. The effect of variations in coagulant weight aims to determine the optimum amount of coagulant for processing soybean soaking waste by comparing the values of DO, COD, and TSS in a waste. The coagulation method can increase DO values and reduce COD and TSS values in wastewater. This is because most particulates in the wastewater have been bound and precipitated with the coagulant to reduce the number of particles in the wastewater. The increase in DO and decrease in COD and TSS were caused by flocs formed by organic compounds bonding with coagulant compounds. When the particles become flocs, which are then removed by the filtering method, the DO of water, COD, and TSS will decrease.

The coagulant used is alum coagulant because alum can bind impurity particles in waste. If it is carried out with a large capacity, alum is also easy to obtain at an affordable price. The coagulation results of the tempe industrial wastewater with variations in coagulant weight can be seen in Fig. 2.

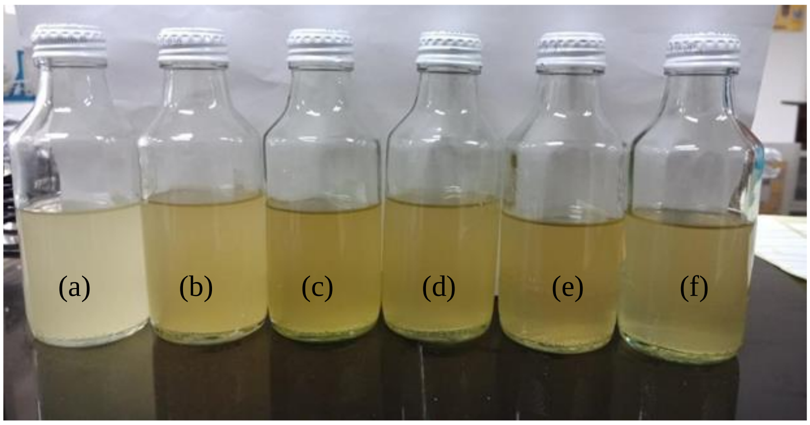


Fig. 2. Liquid waste coagulation results with variations in coagulant mass with a stirring time of 90 minutes (a) before coagulation (b) 5 g (c) 10 g (d) 15 g (e) 20 g (f) 25 g.

From the treatment results shown in Fig. 2, it can be seen that there are significant color differences from the screening and coagulation processes with variations in coagulant weight. The turbidity of the liquid waste produced is due to the large amount of particle content in the trash. Fig. 2 shows that the greater the coagulant variation to the right, so it can be seen that the more coagulant used, the more precise the waste will be. This is because the more coagulant used, the more impurity particles will be bound and wasted.

3.1. The Effect of Variation in Coagulant Weight on the Results of Increasing DO Concentration Values in Liquid Waste in Tempe Production

Water is declared good and not polluted if it has a high DO value of 7.4 mg/L, whereas if it has a low DO value, it can be indicated as dirty water. From the research results, the value of DO concentration in the liquid waste can be increased using alum coagulant. In this case, variations in the weight of the coagulant were carried out to find out the maximum value of the DO concentration that could be increased. The results of the increase in DO concentration values can be seen in Table 1.

Table 1. The Result of the DO Measurement

Mass of coagulant (gram)	DO (mg/L)
0	7.4
5	8.1
10	8.4
15	8.4
20	8.4
25	8.4

Table 1 shows that the more coagulant given, the DO measured will also increase. This is because the impurity particles are bound to the coagulant, and the processed waste water is more transparent [19], [20]. Where the initial DO value before treatment was 7.4 mg/L; in the amount of coagulant 5 g of 8.1 mg/L, and increased by 9.4595%; for a lot of coagulants 10 g, the DO value was 8.4 mg/L, an increase of 13.5135% for coagulants 15, 20 and 25 g the DO value was fixed. This happens because the maximum DO value that the coagulation process can increase is with a lot of 10 grams of coagulant. This study obtained the best DO increase at 10 grams of coagulant.

3.2. Effect of Coagulant Weight Variation on COD Reduction Results in Tempe Manufacturing Effluent

Chemical Oxygen Demand (COD) is a parameter that needs to be considered in waste treatment, especially in liquid waste, because the more significant the COD value contained in liquid waste, the greater the organic compounds contained therein. From the research results, the results of reducing the concentration of COD in wastewater using alum coagulant with variations in coagulant weight can be seen in Table 2.

Table 2. The Result of COD Measurement

Mass of coagulant (gram)	COD (mg/L)
0	21612.5
5	21612.5
10	20550
15	19862.5
20	18612.5
25	19612.5

Table 2 shows that the more coagulants are given, the COD value decreases. However, when the coagulant weight was 25 g, COD increased. The initial COD concentration before treatment was 21612.5 mg/L. For 5 g of coagulants, the COD is 21612.5 mg/L. For 10 g of coagulants, the COD decreased by 4.9161%. In the amount of coagulant 15 g, the COD decreased by 8.0972% for 20 g of coagulant; the COD decreased by 13.8809%. And for 25 g of coagulant, the COD decreased by 9.2539%. In the 25 g of coagulant, the COD concentration value increased. This was due to the influence of the previously measured DO value. With the DO value listed, the number of particles that affect the COD value can only decompose to a maximum of 18612.5 mg/L. This study showed that the maximum reduction in COD was at 20 grams of coagulant, with a decrease of 13.8809%. It is the same with previous research that adding a coagulant can reduce COD in wastewater [21].

3.3. The Effect of Variation in Coagulant Weight on the Result of TSS Reduction in Tempe Manufacturing Effluent

Total Suspended Solid (TSS) is the number of suspended solids. This is closely related to the water turbidity level caused by broken and dissolved organic and inorganic materials. The higher the suspended matter content, the more turbid the water. The results of decreasing TSS concentration values can be seen in Table 3.

Table 3. The Result of the TSS Measurement

Mass of Coagulant (gram)	TSS (mg/L)
0	4.551
5	425
10	292
15	198
20	106
25	102

Table 3 shows the number of coagulants used and decreased TSS concentration. This is because the more coagulant used, the more impurity particles are bound, so the treated wastewater will be more apparent where the concentration of TSS before treatment was 4551 mg/L. The amount of coagulant 5, 10, 15, 20, and 25 g can decrease the TSS by 90.6614%; 93.5838%; 95.6493%; 97.6708%; and 97.7587%. However, the more coagulants are used, the more COD concentration value increases.

Based on the research results described above, it can be seen that the expected results from the coagulant weight ratio have varied results where the maximum DO value occurs in coagulant variations with a weight of 10 g. This can happen because the maximum dissolved oxygen in the soybean soaking waste can be increased to 8.4 mg/L so that the DO results are stable when the coagulant weight is 10 to 25 g. The COD concentration value decreased significantly with the addition of coagulant weight variations, and the smallest value was found in the 20 g coagulant variation, which was 18212.5 mg/L. However, the 25 g variation experienced an increase because the optimum oxygen content that could dissolve organic compounds in the waste was found in the 20 g coagulant weight variation. In the TSS value, it can be seen that there is a decrease along with the addition of coagulant weight variations. This is because the more coagulant is added, the coagulant can bind the more suspended solids, so the water becomes more apparent, and the TSS value will be lower. The smallest TSS value produced was 25 g of coagulant, 106 mg/L.

4. Conclusion

The amount of coagulant used is one of the influential factors in the coagulation process. The more coagulant is also able to increase the DO value of waste. Another thing also, the more coagulant used, the TSS value will decrease because the more coagulant used, the more particles will be bound. For the COD value that has been measured, the more coagulant the COD value will decrease. The optimum DO value produced was 8.4 mg/L at a 10 grams coagulant weight variation. The optimum COD concentration obtained was 18612.5 mg/L at a variation of 20 g of coagulant weight. The optimum TSS concentration was 102 mg/L with a 25 g coagulant weight variation.

Notation

DO= Dissolved Oxygen, mg/L
COD= Chemical Oxygen Demand, mg/L
TSS= Total Suspended Solid, mg/L

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