Quality test of liquid tofu waste in one of the industries in Bantaeng district

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The tofu industry is growing rapidly, along with the increasing number of people in Indonesia. On the other hand, industrial liquid waste contains very high organic compound that potentially pollutes the environment. Without a good handling process, tofu liquid waste can cause a variety of negative impacts such as water pollution, unpleasant odor, and lower aesthetic to the environment. Most tofu industries are run by small and medium industries so that the disposal of its waste is less attention. Liquid waste from the tofu industry can be used to produce biogas through an anaerobic process if it is well processed. The aim of this research is to measure the physical and chemical parameters of liquid waste in one of the tofu industries in Bantaeng by taking samples at three different points. Based on the physical parameters obtained temperature, TDS, TSS, smell and color from three points for Point I are 29.6°C, 1932 mg/L, 7690 mg/L, smelly and white-colored, point II are 27.8°C, 540 mg/L, 1646 mg/L, smelled, murky-colored, point III temperature of 29°C, 510 mg/L, 288 mg/L. Based on chemical parameters, the tofu liquid waste pH, BOD (Biochemical Oxygen Demand), and COD (Chemical Oxygen Demand) for the point I, II, and III in a row are pH (7-7.8); BOD 7.5 mg/L, 3.3 mg/L, 9.6 mg/L; COD 1405 mg/L, 930 mg/L, 370 mg/L. From the parameters that have been measured. It be can be concluded that some parameters for industrial tofu liquid waste is still unqualified to the requirements of the quality standards set by KEPMENLH No. 5 in 2014. The unqualified standards are the TSS parameter and COD so that further research is required in order for the industrial liquid waste can be disposed of to the environment.

1. Introduction
Wastewater is water that comes from solids, both soluble and insoluble, which comes from human activities that contain hazardous substances and can damage the health of the environment and humans [1]. Wastewater from industries, especially household industries, has not been well managed before being discharged into water flow. Around 50 m³/ha/day of domestic waste produced that does not undertake a wet process.

One of the home industries that produce a lot of liquid waste is the tofu industry [2]. According to Darsono's report in 2007, the number of tofu industry in Indonesia reached 84,000 business units, with a production capacity of more than 2.56 million tons per year. Wastewater discharged into the environment is around 20 million cubic meters per year. Wastewater consists of water (99.9%), and the remainder consists of dissolved solids and suspended solid particles of 0.1%. Solid particles of inorganic substances (± 30%) and organic substances (± 70%) of this 70% are protein (± 65%), carbohydrates (± 25%), fat (± 25%) [3].
Tofu waste contains high organic matter [4], because the raw material for making tofu (soybean) contains protein up to 40 - 60%. Tofu waste has 8640 mg/L COD, 297.5 mg/L total Nitrogen, COD: N ratio is 203: 7 [5].

The presence of organic compounds causes the liquid waste of tofu industry to contain high Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solid (TSS). High TSS causes several disadvantages, including blocked drainage due to sludge formation. Sedimented mud will cause odors because the sun is blocked from entering the water. This directly reduces the amount of dissolved oxygen due to the disrupted photosynthesis process [6].

The amount of dissolved oxygen is also related to the BOD and COD parameters. Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen needed by microorganisms (usually bacteria) to decompose organic matter under aerobic conditions [7,8]. Whereas COD or Chemical Oxygen Demand is the amount of oxygen needed to decompose all organic matter in water [9].

According to the Regulation of the Minister of Environment of the Republic of Indonesia Number 5 of 2014 concerning Wastewater Quality Standards, the TSS of wastewater from soybean process is 200 mg/L. Most households, industrial wastes such as liquid waste from tofu factories, do not become aware of wastewater treatment technology (IPAL) due to expensive operational costs and the complexity of the operating system.

One of the liquid waste’s utilization is as fertilizer and pesticide and even organic fungicide with additional other materials, including using empon-empon or herbal plants through fermentation. Tofu liquid waste contains a lot of residual protein and vinegar so that it can boost the effectiveness of fermentation [10].

2. Materials and Methods

2.1. Research Place

This research was conducted at the Laboratory of Basic Testing Laboratory of AK-Manufacturing Bantaeng, Chemical Analysis Study Program, and the sampling of tofu waste in the Talatala, Bontoala Village, Kec. Bissapu, Kab. Bantaeng at the three points, the first point (T1) taking directly at the disposal source, the second point (T2) is about 20 meters from the tofu waste disposal stream and the third point (T3) at the flow to paddy fields

2.2. Tools and Materials

Materials: tofu wastewater in the Talatala tofu factory, Kelurahan Bontoala, Kec. Bissapu, Kab. Bantaeng, washing solution and BOD, COD analysis reagent with grade pro analysis, Whatman filter paper and reagents according to SNI procedures.

Tools: buckets, dipper, plastic jerry cans, sample bottles, furnaces, grab samplers, pH meters, thermometers, cool boxes, and laboratory equipment for BOD-COD analysis.

Methods: After the samples are taken, then measured the temperature and pH. After that proceed with a physical observation of wastewater. The samples were then analyzed with the BOD5, COD and TSS parameters and compared with the wastewater quality standard according to the Regulation of the Minister of Environment of the Republic of Indonesia Number 5 of 2014 [11].

2.3. Testing Methods for Physical and Chemical Parameters

2.3.1. Physical Parameters

2.3.1.1. Observation of color, odor, and temperature. Odor color observations are carried out using the organoleptic test. While the temperature is done with thermometers.
2.3.1.2. Chemical Parameters

a. Determination of pH Value
The pH value is determined by using Germany-Original pH paper

b. Determination of TDS / TSS
TDS and TSS testing is carried out in accordance with the procedures in SNI 06-6989.3-2004

Formula: $\text{mg/L TSS} = \frac{(A - B) \times 1000}{\text{mL sample}}$ (1)

Annotation:
A = Weight of filter paper containing suspended substances (mg)
B = Weight of empty filter paper (mg)

c. Determination of BOD
A number of test samples were added to an oxygen-saturated diluent solution that had been added with a nutrient solution and microbial seedlings, then incubated in a dark room at 20°C ± 1°C for 5 days. The BOD is calculated based on the difference in dissolved oxygen concentration in 0 (zero) days until 5 five days. This analysis method is in accordance with SNI 6989.72: 2009 [12].

d. Determination of COD
Pipette the volume of the test sample, add a digestion solution, and add an adequate sulfuric acid reagent solution to the tube or ampoule. Cover the tube and shake gently until it is homogeneous. Put the tube on the heater that has been heated at 150 °C, reflux for 2 hours, and this analysis method is in accordance with SNI 6989.73: 2009 [13].

3. Discussions
Sampling was taken at three locations in the village of Tala-tala. The following are the pictures of the location of the tofu wastewater sampling place in the Tala-tala area, Kelurahan Bontoala, Kec. Bissapu, Kab. Bantaeng. Locations 1, 2 and 3 written as T1, T2, and T3

![Figure 1. Location of the sampling points at T1, T2, T3](image-url)
Figure 2. Samples from different location point

From figure 2 above, the samples are murky. The further the point sampling, the less murky of the sample is. Besides the color, the odor of the samples is also tested. The sampling point I (T1) has a unique odor, which more like smelly soya. At the T2 and T3 sampling point the odor of the waste tofu liquid is foul. These are because samples from points II and III mixed with domestic waste. Analysis of tofu wastewater in the Tala-tala area, Kelurahan of Bontoala, Kec. Bissapu, Kab. Bantaeng tested both physical and chemical properties, including temperature, pH, BOD5, COD, and TSS. The results of the analysis are shown in Table 1 below.

Table 1. Physical parameters of tofu liquid waste

| Parameters | Units | Location | Max conc. |
|------------|-------|----------|-----------|
| Temperature | °C    | I        | II        | III       |
|            |       | 29.6     | 27.8      | 29        | 38        |
| TDS        | mg/L  | 1932     | 540       | 510       | 2000      |
| TSS        | mg/L  | 7690     | 1646      | 288       | 200       |

* Max levels taken from KEPMENLH No. 5 of 2014 concerning Wastewater Quality Standards

The results of the analysis showed that the condition of tofu wastewater in the Tala-tala area, Kelurahan of Bontoala, Kec. Bissapu, Kab. Bantaeng at locations 1, 2 and 3 for temperature and TDS parameters have met the quality standards for wastewater. Temperature of water is influenced by the temperature of the air ambient and the intensity of exposure of sunlight entering the body of water, the intensity of sunlight is influenced by cloud, season [14].

In the TSS parameters, the results obtained are very far beyond the quality requirements of wastewater. According to Tarigan and Edward (2003), TSS (Total Suspended Solids) are all solid substances (sand, mud, and clay) or particles suspended in water and living components (biotic) such as microorganisms or dead components (abiotic) [15]. The high TSS level at T1 presumably due to a large amount of waste from the remaining waste given that the tofu water waste discharged into the environment was not treated beforehand. As for the next pick up point, tofu water waste has been mixed with the flow of domestic discharges around the plant so that the concentration of solids is reduced. As a whole, from T1 to T3 the parameter values have almost decreased. This is, as mentioned in Hendrasari and Cahyarini 2010, that in each body of water has a self-purification, so the farther the distance from the source of pollutants, the lower waste content [16].

High TDS levels generally indicate hard water, which can cause crust in the pipe, and filter, reduce performance and increase system maintenance costs. This effect can be seen in aquariums, swimming pools, and "reverse osmosis" water treatment systems. From the hydroponics and aquaculture sectors, TDS parameters are useful for creating an environment that can increase crop productivity. For hydroponic use, total dissolved solids are considered to be one of the best indicators of nutrient availability for developed aquatic plants. TDS is a solute in the form of inorganic anions or cations, the low value of TDS indicates the inorganic content in wastes is fairly low. Tofu waste, as previously reported more dominantly, contains organic substances because tofu is made from soy, which is an
organic material. From the results of TDS measurements, it is found that at three points palace, the TDS value of tofu waste is still relatively lower than the standard requirement except at point I, which is concentrated waste due to it does not mix with domestic waste around the tofu factory.

Besides physical parameters, the chemical parameters of tofu waste also need to be monitored. The value of these chemical parameters can be seen in Table 2. Fluctuations in pH values are influenced by the presence of organic and inorganic waste discharges into the river [17]. The difference in pH values can be influenced by the addition of organic and inorganic that enters along with the domestic waste flow. Overall at all points (T1, T2, T3), the pH parameters are fulfill the requirement standard of wastewater specified by class I i.e. pH ranges between 6-9.

| Table 2. Chemical parameters of tofu liquid waste |
|---------------------------------------------|
| Parameters | Units | Results | Max Conc. |
|-------------|-------|---------|-----------|
| pH          | -     | 7       | 7         | 6-9       |
|             |       | II      | III       |           |
| BOD         | mg/L  | 7.5     | 3.3       | 9.6       | 50        |
| COD         | mg/L  | 1405    | 930       | 730       | 100       |

* Max levels taken from KEPMENLH No. 5 of 2014 concerning Wastewater Quality Standards

Decomposition of organic substances is natural. If a body of water is polluted by organic substances, aerobic bacteria will use the oxygen to decompose organic matter presents in the waste. Lack of oxygen supply impacts on the death of fish and other biota in the waters, and the condition being anaerobic then can cause a foul odor to the water. The amount of organic matter pollution that can be decomposed by bacteria is measured by the BOD parameter.

The principle of measuring BOD is basically quite simple, the initial dissolved oxygen content (DOI) of the sample measured immediately after sampling, then measuring the dissolved oxygen content of the sample that has been incubated for 5 days under dark conditions at a constant temperature (20°C) which is often referred to as DO5. The difference between DOI and DO5 (DOI - DO5) is the BOD value expressed in milligrams of oxygen per liter (mg / L). Biochemical oxidation is a slow process. Within 20 days, the oxidation of carbon organic matter reached 95-99%, and within 5 days, around 60-70% of the organic material had been decomposed [8]. Five days of incubation are general agreements in determining BOD. Based on this, the calculation of BOD levels starts from DOI to DO5.

Oxygen measurements are carried out using a device called a DO meter which is equipped with a special probe. During incubation, the waste contained in the Winkler bottle needs to be incubated in a dark room to prevent photosynthesis. The process of photosynthesis obscures DO values because photosynthesis produces oxygen. The measured DO value is expected to be oxygen, which only comes from waste then is decomposed by microorganisms. DO5 should not be zero so that BOD can be determined.

The temperature of 20°C in incubation is also a standard temperature. The temperature of 20°C is the average temperature of slow-flowing rivers in temperate regions (Metcalf & Eddy, 1991), where this BOD theory originated [8]. Tropical waters temperatures generally range between 25 - 30 °C with a lower incubation temperature, the activity of decomposing bacteria may also be lower and not optimal as expected. BOD gives a description of the amount of oxygen used by bacteria to decompose the material in the waste during the next five days. In other words BOD can determine the burden of pollution due to wastewater from residents and industries. If the BOD value is obtained, then biological treatment systems for the polluted water can be designed. Furthermore, by comparing the value of BOD to COD, it will also show how much the amount of organic material that persistent in the waters.
Based on the observation of the physical condition of wastewater from the point I to point II, which is approximately 20 meters away, there is a muddy puddle of water accompanied by a bad odor, so this condition needs to get serious treatment. This is possible because of the high value of BOD, as said by Fajri et al. 2017 that the Biological Oxygen Demand (BOD) or the amount of oxygen needed by bacteria to decompose or oxidize almost all dissolved organic substances and some organic substances that are suspended in water [18]. Based on the results obtained BOD values from three sample points are still relatively below the threshold required.

While another parameter, COD, still has a higher value than the maximum allowable standard. As explained by Puspayana and Damayanti 2013, that tofu wastewater has characteristics such as COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), which still exceeds the wastewater quality standard [19]. The high BOD and COD values indicate the high organic content contained in the waste. Waste with high COD value is very dangerous for the environment because it can reduce the content of dissolved oxygen in water [20]. While a high TSS value will inhibit the entry of light from the surface into the water and will cause disruption of photosynthesis [21].

4. Conclusion
Based on the TSS and COD values obtained, the researchers suggest that further waste treatment be done to reduce the levels of both of them so that they can be safely disposed of in water bodies.

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