



Pollutant Levels Comparison in Tofu Industrial and Domestic Wastewater in Ternate City

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Abstract

Tofu industry is one of the fast-growing industries in Indonesia and causes an increase in wastewater, especially in Ternate. The research purpose was determining a Comparison of pollutant levels in tofu industrial and Domestic Wastewater. The sample was 1 liter of tofu industrial and 1-liter domestic wastewater. The research type is analytic descriptive. The research was conducted at Chemistry laboratory, health polytechnic of ternate and university of Khairun. Test results of tofu wastewater showed that TSS parameters were 416 mg/L, TDS 1,389 mg/L, DO 4 ppm, pH 7 and BOD 62.8 mg/L. Meanwhile, Tests result of domestic wastewater shows that TDS 839 mg/L, TSS 379 mg/L DO 5.4 ppm, pH 10 and BOD 49.6 mg/L. In conclusion, tofu wastewater has worse quality compared to domestic wastewater. It is recommended that Tofu industry can take the initiative in treating the wastewater produced before disposing into the environment.

Introduction

Domestic and tofu industry wastewater have become important issues that arise in line with the increasing human population and the development progress. Tofu industry is one of the fast-growing industries in Indonesia, this causes an increase in the amount of waste of the tofu industry in Indonesia, especially in Ternate. Indonesian Ministry of Environment in 2014 released study results that 60-70% of rivers in Indonesia have been polluted by domestic or household waste. Domestic or household wastewater that is not treated properly can cause various kinds of problems for humans and the environment (Asadiyah & Karnaningroem, 2018). Tofu production is a domestic industry, that most of it has no appropriate wastewater treatment facilities. Wastewater of tofu contains high organic matter which can decrease the water quality (Seroja et al, 2018).

Municipal or household wastes are often

generated from several sources where variable human activities are encountered. Several studies indicate that much of the municipal solid waste from developing countries are generated from households (55–80%), followed by commercial or market areas (10–30%) with varying quantities from streets, industries, institutions among others (Miezah et al., 2015). The presence of a sufficient concentration of dissolved oxygen is critical to maintaining the aquatic life and aesthetic quality of streams and lakes. Determining how organic matter affects the concentration of dissolved oxygen (DO) in a stream or lake is integral to water-quality management (Delze dan McKenzie, 2003).

Total Suspended Solid (TSS) can be used as the indicator of sediment in the reservoir, which usually consists of silt, fine sand, and microorganisms. The high concentration of TSS in the water column can be used as the indication that the process of sedimentation in

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the reservoir is also high (Fauzi dan Wicaksono, 2016). Total dissolved solids (TDS) are naturally present in water or are the result of mining or some industrial treatment of water. TDS contain minerals and organic molecules that provide benefits such as nutrients or contaminants such as toxic metals and organic pollutants (Weber-scannell dan Duffy, 2007).

Biochemical oxygen demand (BOD) is one of the most important and widely used parameters for characterizing the organic pollution of water and wastewater, which is estimated by determining the amount of oxygen required by aerobic microorganisms for degrading organic matters in wastewater. Conventional BOD method is the well-known BOD₅ which needs 5-day incubation at 20°C in the dark (Verma dan Singh, 2018).

Oxygen is essential for the process of respiration and is, therefore, a limiting substance to most aquatic organisms. Consequently, the dissolved oxygen concentration of water is a key control of habitat quality and a critical measure of stream health (Franklin, 2014). pH is a measure of how acidic/basic water is. The range goes from 0-14, with 7 being neutral. a pH of less than 7 indicates acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically (Islam et al., 2017). Wastewater from the process of making tofu consists of 99.9% water and 0.1% solid objects consisting of organic and inorganic substances. The liquid waste of the tofu industry comes from the process of washing, soaking, and boiling soybeans that contain large amounts of essential nutrients, especially nitrogen, which are needed by plants. In soybean soaking waste, from 50 kg of soybean marinade will contain nitrogen which is quite high about 1.5% dissolved protein (Faisal et al., 2016).

The dangerous of polluted water stated in a book written by (Welch dan Lindell., 1980) stated that Some substances or their degradation products, present in water used for livestock may occasionally be transmitted to humans

such as nitrates, sulfates, total dissolved solids (salinity), a number of metals and organic micropollutants such as pesticides. The purpose of this study was to determine the Comparison of pollutant levels in tofu industrial wastewater and Domestic Wastewater in Ternate City.

Method

PH measurements were carried out using a PH meter, BOD test using the Winkler method (titration in the laboratory) while for DO test was carried out using a DO meter. The tofu wastewater sampling method follows the rules set out in SNI 6989.59: 2008. The method in measuring TDS and TSS uses gravimetric method in which a Gravimetry is one of the quantitative analysis methods of a substance or component that has been known by measuring the weight of components in a pure state after going through a separation process, in other words, the gravimetric method emphasizes the principle of purification and weighing. In addition, the gravimetric analysis can be defined as a process of isolation and measurement of the weight of a particular element or compound. The biggest part of gravimetric analysis involves the transformation of elements or radicals into pure stable compounds that can be immediately converted into meticulously weighed forms. As for the performance of this method which requires a long time in the process, besides that it requires fairly simple equipment such as a balance sheet and oven, it does not require calibration because the results are based on molecular weight, work on soluble or insoluble solids (Badan Standardisasi Nasional, 2009).

$$TDS = 1000/V \times (F - B) \times 1000 = \dots \text{ mg/L}$$

Information:

B = weight of the Vaporizer Cup (g)

F = weight of the Vaporizer Cup + dissolved residue (g)

$$TSS = 1000/V \times \{G \times (C + D)\} \times 1000 = \dots \text{ mg/L}$$

Information:

C = weight of the Vaporizer Cup (g)

D = Filter Paper weight (g)

G = weight of the Vaporizer Cup + filter paper filter (g)

Samples to be analyzed first are added MnCl_2 solution with NaOH-KI so that MnO_2 deposition will occur. By adding H_2SO_4 or HCl , the precipitate that occurs will dissolve again and also free the iodine molecule which is equivalent to dissolved oxygen. The released iodine is then titrated with a standard solution of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) and using an indicator of starch solution (starch). The principle of checking BOD parameters is based on the oxidation reaction of organic substances with oxygen in the water and the process takes place due to the presence of aerobic bacteria. To decompose organic matter takes ± 2 days for 50% of reactions, 5 days for 75% of reactions achieved and 20 days for 100% of reactions achieved. In other words, the BOD test acts as natural biological process simulation, initially measured DO zero and after incubation, for 5 days at 20°C or 3 days at 25°C – 27°C again measured DO water. The difference in DO water which is considered as oxygen consumption for biochemical processes will be completed within 5 days is used assuming all biochemical processes will be completed within 5 days, even though it is not yet finished. BOD testing using the Winkler-Alkali iodide azide method is the determination of BOD carried out by measuring the reduced levels of dissolved oxygen in samples stored in tightly closed bottles, incubated for 5 days at room temperature, in the Winkler method used MgSO_4 , FeCl_3 , CaCl_2 diluents, and phosphate buffer. Then proceed with the method of Alkali iodide azide that is by titration, in the determination of dissolved oxygen levels MnSO_4 , H_2SO_4 , and alkali iodide

azide reagents are used. Samples titrated with sodium thiosulfate using a starch indicator (U.S. Environmental Protection Agency, 2017). TDS, TSS, PH and DO test is carried out at the Ternate health polytechnic laboratory while the BOD test is carried out at the university of Khairun chemical laboratory.

Results and Discussions

Based on the results of research conducted in the Chemistry Laboratory, Environmental Health department, Health Polytechnic of Ternate and university of Khairun can be seen in the table 1.

Based on Table 1, it can be seen that the quality of industrial wastewater was the TSS 416 mg / L, TDS 1,389 mg / L, DO 4 ppm, pH 7 and BOD 62.8 mg / L. This value has exceeded the standards set by the Ministry of Environment. The quality of domestic wastewater was TSS 379 mg / L, TDS 839 mg / L, DO 5 ppm, pH 10 and BOD 49.6 mg / L. This value has exceeded the standards set by the Ministry of Environment. The Pollutants of tofu are greater than the Pollutants of domestic wastewater.

This result according to Permenlh No. 1 of 2010 both in tofu wastewater and domestic wastewater can be categorized as not eligible to be discharged into the environment. The factors causing water pollution are industrial waste (33.33%), domestic waste (47.62%), and urban waste (19.04%). (Widiyanto, AF et al, 2015).

High TSS can cause other impacts such as reducing the photosynthetic activity of marine plants both micro and macro so that the oxygen released by plants is reduced and causes the fish to die. So if the TSS concentration in

Table 1. The Comparison of Domestic Wastewater and Tofu Industrial Wastewater Quality

Parameter	Unit	Domestic Wastewater		Tofu Industry Wastewater	
		Standards	Results	Standards	Results
TDS	Mg/L	250-850 mg/l	839 mg/L	250-850 mg/l	1.389 mg/L
TSS	Mg/L	100-350 mg/l	379 mg/L	100-350 mg/l	416 mg/L
DO	Mg/L	>5-0	5 ppm	>5-0	4 ppm
pH	-	9.0-6.0	10	9.0-6.0	7
BOD	Mg/L	10-25	49.6 mg/L	10-25	62.8 mg/L

Source: Primary Data. 2019

the river body continues to increase and flow into the high seas for a long time it can reduce the quality of coastal waters (Helfinalis, et al 2012). Total Suspended Solid (TSS) can be used as the indicator of sediment in the reservoir, which usually consists of silt, fine sand, and microorganisms. The high concentration of TSS in the water column can be used as the indication that the process of sedimentation in the reservoir is also high. (Fauzi dan Wicaksono, 2016). According to (Puspawati, 2017), based on the results of his research, it is stated that high TSS can obstruct sunlight entering the waters. This will cause photosynthesis in water to be inhibited so that oxygen levels are reduced in water (Puspawati, 2017). Discharge of effluents with high levels of suspended solids into aquatic bodies lowers water quality and depletes dissolved oxygen available for aquatic life (Rono, 2017). In addition, what causes high TSS according to Ningsih. Is a large number of soiling or turbidity levels in wastewater which causes the emergence of solids that are suspended in the wastewater. (Ningsih, 2011)

Suspended Solid (TSS) solid material is a place where heterogeneous reactions take place, which functions as the earliest precipitating material and can inhibit the ability to produce organic matter in the waters. High TSS can also cause other effects such as the high total suspended solid concentration value can reduce the photosynthetic activity of both micro and macro marine plants so that the oxygen released by plants decreases and causes fish to die. So if the TSS concentration in the river body continues to increase and flow into the high seas for a long time it can reduce the quality of the waters (Jiyah, et al, 2017)

The highest TDS number based on the result is really dangerous for life being, it is in line of (Islam et al., 2017) stating that Total Dissolve Solids (TDS) are a measure of the combined content of all inorganic and organic matters or salts that are found in water. The main ingredients are usually the cations such as calcium, magnesium and potassium and the anions such as carbonate bicarbonate, nitrate, chloride sulfate, etc. Among the contents of TDS, dissolved calcium and magnesium in the water are called "Hardness". Some ions of the above mentioned are essential whereas some ions

are toxic to human health. (Islam et al., 2017). TDS can be dangerous for aquatic organisms in which Total dissolved solids cause toxicity through increases in salinity, changes in the ionic composition of the water and toxicity of individual ions. Increases in salinity have been shown to cause shifts in biotic communities, limit biodiversity, exclude less-tolerant species and cause acute or chronic effects at specific life stages. (Weber-scannell dan Duffy, 2007). The polluted water is dangerous for communities, it is stated on (Nizel dan Islam, 2015)'s research in 2015 saying Local communities are suffering from a variety of health problems including skin, diarrhea, dysentery, respiratory illnesses, anemia and complications in childbirth because of polluted water. Total Dissolved Solids (TDS) correlates positively with conductivity and affects pH. The higher the TDS, the higher the conductivity and the lower the pH, towards acidity (Islam et al., 2017).

The highest number of BOD will determine the quality of water, it is in line with (Syakur, 2017) research stating that To find out the quality of water in water can be done by observing some chemical parameters, like Dissolved Oxygen (DO) and biological oxygen demand (Biological Oxygen Demand = BOD). A high BOD value and exceeding the quality standard is very dangerous for the environment, this is supported by research by (Syakur, 2017) which states that Disposal of waste with high levels of BOD or organic substances that are high enough to be causing problems to water due to the amount of oxygen dissolved in water decreases. It can harm the ecosystem living things in the water. The greater the BOD number indicates that the degree of impurities of wastewater the greater it is. The BOD trial is one of the important trials for knowing the strength or the pollution power of wastewater, industrial waste, sewage, and polluted water. (Larasati, et al, 2018)

A low DO value indicates that the waters are not in a healthy condition, this is supported by research conducted by (Ajayi et al., 2016) which states that The Dissolved oxygen values of the water samples obtained from the Covenant University oxidation pond decreased in value from the first point of collection from 10.1mg/l to 7.9mg/l respectively for four random

collection points. This shows that the water is in a healthy condition and is fit for aquatic life. It also reveals that the Covenant University treatment plant is effective.

Based on the results of the study, it is known that pH in domestic wastewater is not eligible, this can cause problems where the degree of acidity (pH) of water smaller than 6.5 or acidic pH increases the corrosivity of metal objects, causes discomfort and can cause several chemicals to become poisons that interfere health. Variation in the pH value of waters greatly affects the biota in water. In addition, the high pH value determines the predominance of phytoplankton that affects the primary productivity level of water where the presence of phytoplankton is supported by the availability of nutrients in marine waters (Megawati, et al, 2014). Water conditions that are very basic or very acidic will endanger the survival of the organism because it will interfere with the metabolic process and respiration. water itself can cause skin irritation as demonstrated by occlusion experiments. Functional damage of the skin is shown by increased transepidermal water loss (TEWL). Factors that might account for the irritancy of water include pH, hardness, osmolarity, temperature, and extraction of natural moisturizing factors in the stratum corneum (Kulthanan, et al, 2013)

Conclusions

The test results of tofu wastewater showed that the TSS parameters were 416 mg/L, TDS 1,389 mg/L, DO 4 ppm, pH 7 and BOD 62.8 mg/L. Tests result of domestic wastewater shows that TDS 839 mg/L, TSS 379 mg/L DO 5.4 ppm, pH 10 and BOD 49.6 mg/L. The Pollutants of tofu are greater than the Pollutants of domestic wastewater.

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