The Effectiveness of Water Treatment in the Wastewater Treatment Plant (WWTP) of the Tempe Industry and Benefits to the Community

Ika Bayu Kartikasari[1*], Binsar Butar-Butar[2], Siti Rachmi Indahsari[2], Ahmad Adi Suhendra[2]

[1] Enviromental Engineering, Universitas Balikpapan, Indonesia
[2] PT Kilang Pertamina Internasional RU III

[*]Corresponding Author:
Email: ika.bayu.k@uniba-bpn.ac.id

Abstract.
The results of the tempe-making process will produce waste that is harmful to the environment from the washing, boiling, pressing and printing processes. The tempe industry in Plaju ulu village is a source of community income. Tempe industry activities produce waste that can pollute the environment, causing unpleasant odors. The wastewater treatment plant built by Pertamina RU 3 Plaju has a positive impact in reducing the impact of the tempe industry liquid waste. The formulation of the problem raised (1) The results of the effectiveness of the Plaju Tempe Industry WWTP. (2) Recommendations for WWTP technology that can be used in the Plaju Tempe Industry. The parameters used to measure the quality of the effluent are pH (degree of acidity), COD, BOD, TSS, and (Total Suspended Solid) during July and August 2022. To determine the quality of wastewater produced, data from laboratory test results must be compared with quality standards. waste water in accordance with the Regulation of the Minister of Environment of the Republic of Indonesia No. 5 of 2014. From the results of the processing effectiveness, the effectiveness of COD, BOD, and TSS was found to be 53.81%; 11.05%; and 22.65%. From the results of this processing, it is still considered not able to reduce the pollutants generated from the tempe industry activities. The pH and TSS parameters still do not meet the quality standards. The recommended waste treatment is anaerobic biofiltration, anaerobic digester, and phytoremediation in improving the parameters of pH, COD, BOD, and TSS in the tempe-making industry.

Keywords: *WWTP, Tempe Industry, effectiveness, village and anaerobic treatment.*

1. INTRODUCTION

Tempe is the main food of the Indonesian people in fulfilling community nutrition. The development of the tempe industry is growing rapidly along with the increase in demand. Until now, the processing process for making tempe is still produced traditionally and produces a high amount of waste. However, most of the tempe-making industries do not yet have a wastewater treatment plant before being discharged into water bodies [1]. Tempe industry in the processing process produces solid and liquid waste. Solid waste is generated from the filtering and coagulation process. Meanwhile, the liquid waste is generated from the washing, boiling, pressing and cutting. Liquid waste has the characteristics of containing high organic matter, temperatures reaching 40˚C-46˚C, levels of BOD_5 (6,000-8,000 mg/1), COD (7,500-14,000 mg/1), TSS and a fairly high pH as well. If it is directly discharged into water bodies, it will reduce the carrying capacity of the environment. So that the tempe industry requires a waste treatment that aims to reduce the risk of pollution loads [2].

The gases commonly found in tempe waste are nitrogen gas (N_2), oxygen (O_2), hydrogen sulfide (H_2S), ammonia (NH_3), carbon dioxide (CO_2) and methane (CH_4). So we need a processing technology that is able to reduce pollutants in tempe industrial waste and reduce odors caused by H_2S gas. Anaeronic processing by using microorganisms in anaerobic conditions can reduce BOD and CO by 90% and can produce biogas. Anaerobic processing has advantages such as producing gas as energy, producing less sludge and not requiring a large area of land [2], [3]. So that it can meet the processing results according to the waste water quality standards of the Soybean Processing Industry, at Permen LHK No. 5 of 2014.

The Innovative Food Village initiated by CSR Pertamina RU 3 Plaju is located in Plaju Ulu Village which has a village of tempe craftsmen which has been established since 1952. The results of the waste

looking for tempe reach 7 million liters / year, due to the low income of tempe craftsmen so that a communal WWTP is needed which is used to produce tempe. processing tempe industrial waste in an effort to reduce industrial waste pollution to water bodies. The Innovative Food Village Program in the development of communal WWTPs is able to increase the income of the tempe industry and develop innovative processing of tempe derivative products. This study aims to analyze the effectiveness of tempe wastewater treatment with existing IPAL treatment and the most effective use of tofu wastewater treatment technology.

II. METHODS

The data in this study were collected using (1) literature study, in existing studies based on journals related to tempe liquid waste management. (2) field survey to obtain wastewater samples and then laboratory tested in accordance with SNI 6989: 2011 concerning Water and Wastewater. Several parameters that are used to measure the quality of waste include discharge, pH (degree of acidity), COD, BOD, TSS, and (Total Suspended Solid) during July and August 2022. To determine the quality of wastewater produced, data from laboratory test results must be compared. with waste water quality standards in accordance with the Regulation of the Minister of the Environment of the Republic of Indonesia No. 5 of 2014. Testing the effectiveness of the WWTP performance in the tempe industry can be known by using the following equation:

$$Efektivitas = \frac{S1 - S0}{S0} \; x \; 100\%$$

From the data, it is known that the effectiveness value is expressed as a percentage (%), where So is the concentration of wastewater at the inlet and S1 is the concentration of wastewater at the outlet.

III. RESULT AND DISCUSSION

Characteristics of Tempe Wastewater

In making tempe, soybean is needed as a production material. In these production activities will produce waste that can damage the environment due to the content of carbohydrates, proteins, fats, mineral salts, and residues [1]. Characteristics Tempe liquid waste produces a lot of acri waste from soaking, washing, filtering, fermenting, and packaging activities. Liquid waste if not treated will cause unpleasant odors and cause pollution. To find out the results of the tempe wastewater treatment parameters originating from the WWTP, it is presented in table 1 below.

Tabel 1. Tempe Industrial WWTP water quality

No	Parameter	Maximum Grade Standard	Sample 1 (Juli)		Sample 2 (Agustus)		Average Processing Effectiveness
			Inlet	Outlet	Inlet	Outlet	
1	PH	6-9	4,09	4,98	4,01	4,49	-
2	BOD	150 mg/L	61,4	53,5	61,7	56	11,05 %
3	COD	300 mg/L	460	251	455	172	53,81%
4	TSS	100 mg/L	329	394	320	175	22,65 %

The BOD5/COD value in the treatment reaches <0.4, so the liquid waste is easily degraded biologically [4]. However, from the results of the WWTP processing, it is still not effective in treating wastewater. It can be seen from the TSS parameter that it still exceeds the quality standard set according to PERMEN LH No. 5 of 2014 which is 100 mg/L for the tempe processing industry. The main cause was identified due to the selection of WWTP which was less effective in handling tempe industrial waste so that it was less significant in reducing wastewater treatment. The results of the analysis of efficiency values (Table 1) show a decrease in BOD by 11.05% and COD by 53.81% and TSS by 22.65%. In the TSS parameter in the first test it is known that the inlet and outlet results have increased. Additional processing technology is required to reduce TSS, COD, and BOD.

The condition of the WWTP must also be adjusted to the flowed discharge to produce a high efficiency value. The amount of wastewater should be stable and suitable working conditions should always be maintained and excessive wastewater should be avoided. It can also maintain the sludge circulation system in the reactor as well as keep microorganisms and waste water away. The selection of the right tempe waste treatment can be used by using a biofilter or anaerobic digester which is effective in reducing COD and BOD values, while phytoremediation in reducing the content of organic substances and TSS in tempe processed waste before it is channeled into water bodies [4], [5],[6].

Tempe Water treatment Technology

Biofiltrasi Anaerobic

Biofilter (submerged filter) is a technology that utilizes microbes to grow and develop in a filter media and form a biofilm layer (attached growth). This treatment is carried out by making a sedimentation pond and flowing it through the biofilter process so that a biological process occurs in it for the breeding of microorganisms. The process of formation and colonization of biofilms begins with the production of slime formed by bacteria attached to the surface of the media. Attachment probably occurred initially due to chemical bonds and Van Der Walls forces [7][8][9].

By using anaerobic bacteria will form methane gas which can be used as an energy source. The cleaning process for anaerobic biofilters has an efficiency of 80-95% so that it can be an option in wastewater treatment plants. Some of the advantages of anaerobic biofilters are that they are easy to maintain, do not require a large area and low operating costs. This treatment can be used for liquid waste with high BOD because it is able to remove suspended solids well and produces less sludge [1][10].

Anaerobic Digester

Anaerobic reactor is a type of wastewater treatment to utilize gas. The biogas treatment system includes an inlet (inlet of liquid waste), an equalization tank, a sedimentation tank, an Anaerobic Filter tank, an overflow tank, a draining tank, and an outlet (out of treated liquid waste). The basic form of a fixed dome type biogas process equipment (fixed dome digester). The main content in biogas is methane and carbon dioxide. Methane gas can be used as a non-fuel energy source. In this degradation process, apart from methane, small amounts of hydrogen sulfide, carbon dioxide and ammonia are also formed [2]. The amount of biogas produced from the anaerobic degradation process of tofu industrial wastewater can be estimated from the data on the COD value and the level of degradation. Each kg of COD that is degraded under anaerobic conditions can produce as much as 0.39 m_3 CH_4 at a temperature of 35^{o}C. Other information mentions the conversion value of 0.35 m_3 CH_4/kg COD degraded. It should be noted that the actual amount of COD converted is proportional to the COD elimination rate whose value is strongly influenced by various factors. The influencing factors include the characteristics and amount of waste, the conditions of the degradation process, and the type and design of the reactor [4][11].

the biogas produced depends on the concentration of the material being fermented; ingredients that are too concentrated or runny contribute to decreased production. The ideal solid concentration in sewage sludge digestion varies between 8 and 10%. However, biogas digesters can be constructed to digest larger concentrations (up to 40%) of solids. In addition to concentration, different chemical and physical factors affect processing in the Anaerobic Digester including seeding, stirring, temperature, pH, C:N ratio, organic loading rate (OLR), hydraulic retention time (HRT), and volatile fatty acids (VFA). Each of these parameters that are not optimal can cause disturbances in the process because this changes the microbial environment and movement in the digester. So it is necessary to control to maximize biogas production. These parameters must be varied within the appropriate range so that the biogas plant can run effectively and efficiently [12][13].

Phytoremediation

Phytoremediation has many advantages compared to other techniques because it can be done with minimal environmental disruption. This technique is widely applied in Asia, America, and Europe in dealing

with environmental pollution, especially water pollution [14]. In a study conducted by Ruhmawati, et al. (2007), showed that vetiver grass was able to reduce TSS levels of tofu liquid waste. Phytoremediation is carried out by absorption by plants, decomposition of dissolved organic matter and deposition of decomposition products of organic matter. Tofu industrial waste treatment with vetiver plants can reduce TSS because it has fibrous roots that can be a place for attachment of colloids floating in water. TSS is closely related to water turbidity. Treatment of tofu processing waste is able to reduce TSS with the Constructed wetland system with the Subsurface method and is able to reduce TSS levels of tofu liquid waste by 90.2% [6][15].

The Benefits of Wastetreatment plant for the Plaju Village Community

Before the planned development of tempe wastewater treatment in Plaju Ulu Village, the condition of some areas reflected unhealthy environmental conditions. A lot of trash was found in the gutters. Slum areas will cause an unpleasant odor and a source of disease-causing bacteria. If not resolved immediately will have a negative impact on public health. This potential for pollution is caused by the location of waste disposal that has not been managed properly so that it contributes to environmental pollution. The presence of the Waste Bank in Plaju Ulu Village did not run as it should, this is because the manager of the Waste Bank has died and no one has replaced him. Then, the behavior of tempe and tofu craftsmen who dispose of production waste into the gutter certainly has a negative impact on the surrounding community. There are quite a lot of public complaints against this behavior, because the waste that is disposed of causes an unpleasant odor[16].

The disposal of unmanaged tempe processing waste can cause social conflict between communities and tempe and tofu craftsmen if not resolved immediately Waste from tempe and tofu production is dumped in the river, polluting the environment and causing unpleasant odors The liquid and solid waste produced is immediately disposed of and not utilized. The Wastewater Treatment Plant which was built under the CSR Cooperation of Pertamina RU 3 Plaju with the Tempe-making industrial area provides benefits to the surrounding community. The low level of sanitation handling and being in a slum and congested environment causes the environmental quality to worsen, resulting in a decrease in sales of tempe and yeast craftsmen. The WWTP development provides environmental quality improvement and makes Plaju Ulu Village an Innovative Food Village in terms of the environment and processing of tempe derivative products, so as to improve the quality of life of the community.

The increase in the utilization of liquid waste from tempe production is also carried out by conducting training on the utilization of liquid waste from tempe production to become Nata de Soya. Tempe liquid waste can be used as a product that has high economic value. Making Nata de Soya through a simple biotechnology process, namely the addition of Acetobacter xylinum. Nata de Soya is a cloudy white object, solid, thin and chewy like kolang kaling. Nata de Soya is made from tofu whey that has been fermented for ± 8 days. Making Nata de Soya can also use tofu liquid waste, because in tofu liquid waste contains good nutrients for the growth of nata by bacteria [8].

In the training, the community was invited to make preparations from tempeh waste and as an additional product from making tempeh. another program by conducting training on the utilization of solid waste from tempe and tofu production as animal feed so as to reduce solid waste from tempe production.

IV. CONCLUSION

From the results of the research that has been carried out, it can be concluded that 1) the wastewater treatment plant that has been built has met the quality standards of PERMEN LH No. 5 of 2014 on COD and BOD parameters, but they have not been able to meet the quality standards for pH and TSS. 2) the effectiveness of wastewater treatment that was built has an effectiveness of 11.05% BOD treatment and 53.81% COD and 22.65% TSS. So that improvements and further improvements are needed in order to improve the quality of processing. 3) The recommended selection is processing anaerobic biofilter, anaerobic digester, and phytoremediation to reduce polluted parameters such as TSS, COD, BOD, and pH.

REFERENCES

[1] S. H. Rahmawati and C. Puspitaningrum, "Analisis Pengolahan Air Limbah Industri Tahu dan Efektivitasnya Terhadap Masyarakat dan Lingkungan di Bandar Lampung Analysis of Tofu Industrial Wastewater Treatment and Its Effectiveness on Society and the Environment in Bandar Lampung," ***Open Sci. Technol.,*** vol. 02, no. 01, pp. 2776–169, 2022, [Online]. Available: https://opscitech.com/journal

[2] N. I. Handayani and I. R. J. Sari, "Teknologi pengolahan limbah cair industri tahu sebagai sumber energi dan mengurangi pencemaran air," ***Bisnis dan Eko-Industri Semarang***, pp. 1–9, 2015, [Online]. Available: http://prosiding.upgris.ac.id/index.php/pangan/pangan/paper/viewFile/672/626

[3] I. Indriyati, "Pengolahan Limbah Cair Organik Secara Biologi Menggunakan Reaktor Anaerobik Lekat Diam," ***J. Air Indones.,*** vol. 1, no. 3, pp. 340–343, 2018, doi: 10.29122/jai.v1i3.2361.

[4] M. Romli and Suprihatin, "Beban Pencemaran Limbah Cair Industri Tahu dan Analisis Alternatif Strategi Pengelolaannya," *J. Purifikasi*, vol. 10, no. 2, pp. 141–154, 2009.

[5] I. Nurhayati, P. AS, and Sugito, "Pengolahan Air Limbah Pabrik Tempe Dengan Biofilter," ***J. Tek. Waktu,*** vol. 09, no. 1412 – 1867, pp. 1–5, 2011.

[6] D. Armadi, A. Hidayat, and S. M. Simanjuntak, "Analisis Pengelolaan Air Bersih Berkelanjutan Di Kota Bogor (Studi Kasus: Pdam Tirta Pakuan)," ***J. Agric. Resour. Environ. Econ.,*** vol. 2, no. 1, pp. 1–12, 2019, doi: 10.29244/jaree.v2i1.25928.

[7] MetCalf and Eddy, *Wastewater Engineering : Treatment, Disposal and Reuse, 4th ed.* McGraw Hill Book Co., New York., 2003.

[8] M. R. Cahyani *et al.*, "Pengolahan Limbah Tahu dan Potensinya," ***Proceeding Chem. Conf.***, vol. 6, p. 27, 2021, doi: 10.20961/pcc.6.0.55086.27-33.

[9] S. K. Tomasoa and S. L. Jacobs, "Analisis Faktor Yang Mempengaruhi Tingkat Konsumsi Air Bersih Pdam Di Kota Ambon," *Eksekutif*, vol. 14, no. 1, pp. 160–182, 2017.

[10] D. S. Rahardiyan, "Perencanaan Instalasi Pengolahan Air Limbah (IPAL) Pada Pabrik Tahu Maju Jaya, Piyungan, Bantul, Daerah Istimewa Yogyakarta," ***Syria Stud., vol.*** 7, no. 1, pp. 37–72, 2015, [Online]. Available: https://www.researchgate.net/publication/269107473_What_is_governance/link/548173090cf22525dcb61443/download%0Ahttp://www.econ.upf.edu/~reynal/Civilwars_12December2010.pdf%0Ahttps://think-asia.org/handle/11540/8282%0Ahttps://www.jstor.org/stable/41857625

[11] Angraini, M. Sutisna, and Y. Pratama, "Pengolahan Limbah Cair Tahu secara Anaerob," ***J. Inst. Teknol. Nas.***, vol. 2, no. 1, pp. 1–10, 2014.

[12] M. N. Uddin, S. Yasir, A. Siddiki, M. Mo, F. Djavanroodi, and M. A. Hazrat, "***Prospects of Bioenergy Production From Organic Waste Using Anaerobic Digestion Technology : A Mini Review,***" vol. 9, no. February, 2021, doi: 10.3389/fenrg.2021.627093.

[13] E. Kwietniewska and J. Tys, "Process characteristics, inhibition factors and methane yields of anaerobic digestion process, with particular focus on microalgal biomass fermentation," ***Renew. Sustain. Energy Rev***., vol. 34, pp. 491–500, 2014, doi: 10.1016/j.rser.2014.03.041.

[14] I. Zahrina and E. Yenie, "Application Of Wastewater Treatment Technology In Tofu Industry , Pekanbaru City," pp. 223–229.

[15] T. Ruhmawati, D. Sukandar, M. Karmini, and T. Roni, "Penurunan Kadar Total Suspended Solid (TSS) Air Limbah Pabrik Tahu dengan Metode Fitoremediasi," ***J. Permukim.,*** **vol.** 12, no. 1, pp. 25–32, 2017.

[16] P. K. P. I. R. U. I. Plaju, ***Pembaharuan Pemetaan Sosial "Program Corporate Social Responsibility.****"*