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Determination of Oil and Fat Levels in Liquid Waste of Palm Oil Industry in Muaro Jambi District

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Abstract. Waste contains pollutants that can change the quality of the environment. Wastewater discharged into the environment must comply with standard quality standards. One of the parameters that are harmful to the environment are oils and fats. Oils and fats are on the surface of the water so they can block sunlight from entering the water and can interfere with the activities of aquatic biota. Determination of oil and fat content in palm oil industrial wastewater in Muaro Jambi District using the gravimetric method based on the Indonesian National Standard 6989.10:2011. The results obtained in the inlet waste pond of PT. A, PT. B and PT. C respectively 582.4 mg/L; 380.2 mg/L and 221.4 mg/L while for PT. A, PT. B and PT. C respectively 78.8 mg/L; 53.6 mg/L and 12.8 mg/L. According to the Regulation of the Minister of the Environment of the Republic of Indonesia No. 5 of 2014, the maximum permissible level for liquid waste oil and fat at the outlet liquid waste of the palm oil mill industry is 25 mg/L. Based on the test results, it can be concluded that the levels of oil and fat that meet the quality standards of palm oil liquid waste are outlet waste from PT. C.

Keywords : Oils and Fats, Gravimetry, Liquid Waste, Palm Oil

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Introduction

Based on data from the Jambi Province Plantation Service, oil palm is a plantation commodity that plays an important role in the economy of the people in Jambi Province. The Central Statistics Agency for Muaro Jambi Regency reports that Muaro Jambi District occupies the second position after Tanjung Jabung Timur Regency as the district with the most palm oil production in Jambi Province in 2015-2017. The development of oil palm area in Jambi Province depends on the development of oil palm plantation area in each district..

Muaro Jambi Regency is the largest palm oil production center in Jambi Province. Total production is 338,781 tons with an area of 130.9 thousand hectares [1]. The industry of Muaro Jambi Regency is growing rapidly along with the times. The development of the industry is also directly proportional to the increase in industrial waste produced. Industrial waste is the entire residue of the production process that cannot be reused and has no selling value. Waste containing pollutants can change the quality of the environment. Industrial waste can contain various types of organic materials, inorganic materials, inorganic salts, inorganic acids, organic compounds and heavy metals. Therefore, industrial waste must be treated first before being discharged into the environment so as not to harm and not pollute the environment. One of the problems faced by the palm oil industry is the disposal of oil effluent waste. The residual oil contained in the effluent is around 4,000-6,000 mg/l, while the threshold value for oils and fats is 50 mg/l [2].

Palm oil as vegetable oils resource contains three esters or fatty acid chains (acyl functional group) attached on glycerol functional group [3], so that one of the parameters that need to be considered is the presence of oil and fat. Oil and fat waste in large quantities if allowed to flow into the environment can pollute the environment because in the liquid waste there are pollutants that are quite dangerous and become a source of breeding of pathogenic bacteria that can reduce oxygen content. Oils and fats that are discharged to the soil surface will cover the soil pores and interfere with the absorption of groundwater in the waters. Meanwhile, oil and fat discharged into the water will cover the surface of the water because the difference in density of oil is smaller than the density of water. The real impact of the presence of oil and fat compounds on the surface of the water is the obstruction of sunlight penetration, which means it will reduce the rate of photosynthesis in the water, so that it will disrupt and kill the life of organisms in the water [4]. Oil and at waste is included in the category of organic waste. Athough there are organic materials that are biodegradable, the presence of biodegradable materials in large quantities in water can endanger the life of organism in the water. According to the Regulation of the Minister of the Environment the Republic of Indonesia No.5 of 2014 concerning the quality standards of wastewater for buisinesses or activities, domestic waste must have criteria for maximum oil and fat content of 10 mg/L [5].

Determination of oil and fat content in palm oil effluent in Muaro Jambi Regency using the gravimetric method in accordance with SNI 6989.10:2011 on Test Methods for Vegetable Oils and Mineral Oils. This test was conducted at the Regional Technical Implementation Unit (UPTD) Laboratory of the Environmental Service of Muaro Jambi Regency using 6 different samples from 3 palm oil mills located in Muaro Jambi namely PT. A, PT. B and PT. C, where the tested waste comes from 3 inlet ponds and 3 outlet ponds.

Experimental

Equipment and Materials

This research uses equipment such as glass bottles, ovens, scales, distillation flasks, volumetric pipettes, separating funnels. While the materials used were concentrated hydrochloric acid, n-Hexane with a purity of 98%, sodium sulfate, acetone, hexadecane and stearic acid were purchased from Merck (Darmstadt, Germany).

Standard Solution Preparation

Standard solutions of hexadecane: stearic acid was prepared at a ratio of 1:1 with a concentration of 2 mg/mL each in acetone. The stearic acid and hexadecane were weighed 200 mg each, then put into a 100 mL volumetric flask and added some acetone and then heated in a water bath at 40°C until the stearic acid dissolved completely. After that, it was cooled to room temperature and added acetone up to the mark.

Determination of Oil and Fat Content

The distillation flask was weighed as the initial weight (W0). Waste samples totaling 1000 mL were put into a separatory funnel. Concentrated hydrochloric acid was added until the sample pH was < 2. After that, 30 mL of n-Hexane with 98% purity was added and shaken for 2 minutes. Wait a few moments until there is a separation between the oil phase and the water phase. After the oil and water phases were formed, the filtrate was filtered using filter paper which had been previously washed with Na_2SO_4.

The extraction process was repeated 2 times by adding concentrated hydrochloric acid and n-Hexane to the residue in order to obtain a good extract. The extract obtained was distilled at 70°C for 30 minutes. After that, the extract was dried at 70°C for 30-45 minutes to remove the remaining water. The next stage is the cooling process by inserting the flask containing the extract into a desiccator for 30 minutes. After that, the weight of the distillation flask was re-weighed as the final weight (W1). The mass yield of oil and fat extract was obtained from the difference between the final weight of the glass gourd (W1) and the initial weight of the glass gourd (W0) [6].

Data Analysis

Standard Solution Preparation Results

The cotton The Standard Solution serves as a reference for the retrieval test before analyzing the test sample (on going recovery). If the result of % recovery meets the acceptability limit, then the analysis of the test sample can be carried out. If it does not meet the acceptability limit, then a retest is carried out on the % recovery until it meets the acceptability limit. The Gravimetric Test Method for Vegetable Oils and Mineral Oils is in accordance with the Indonesian National Standard 6989.10:2011 regarding the % recovery limit listed in table 2 [6].

Percent Recovery can be calculated by the following formula:

$$\%R = \frac{A \times 100\%}{B}$$

Where A is the level of the standard solution measured, B is the level of the standard solution added or the target value. Based on the results of the percent recovery measurement from the retrieval test, the number is 97.5%. This shows that the results of the percent recovery meet the acceptable limits, so the test analysis on the determination of oil and fat content can be carried out.

Test Results for Determination of Oil and Fat Content

In this study, as presented in table 3, the samples (A0, B0, C0) were samples from the inlet waste pond while the samples (A1, B1, C1) were samples from the outlet pond. Determination of oil and fat content is obtained from the difference between the weight of the final flask W1 and the weight of the initial flask W0, which can be calculated by the following formula:

$$\frac{(W_1 - W_0) \times 1000}{V}$$

Where W0 is the mass of the empty distillation flask expressed in milligrams (mg), W1 is the mass of the distillation flask containing oil and fat extracts expressed in milligrams (mg), V is the sample volume expressed in milliliters (mL).

Table 1. Results of Making Standard Solutions

Standard Solution	W_0^I(mg)	W_0^{II}(mg)	W_1^I(mg)	W_1^{II}(mg)	Result(mg/L)
Standard 1	130,3763	130,3760	130,4145	130,4142	38.2
Standard 2	132,3842	132,3841	132,4246	132,4243	40,2

Table 2. Acceptance Limits on Going Recovery

On Going Recovery	Acceptance Limit (%)
% *Recovery* Oil and Fat	78-114
% *Recovery* Hydrocarbon	64-132

Table 3 Test Results for Determination of Oil and Fat Content

PT	W_0^I(mg)	W_0^{II}(mg)	W_1^I(mg)	W_1^{II}(mg)	Results (mg/L)
A_0	174,4777	174,4774	175,0601	175,0598	582,4
A_1	133,8549	133,8547	133,9337	133,9335	78,8
B_0	114,3268	114,3265	114,7070	114,7067	380,2
B_1	150,4272	150,4269	150,4808	150,4805	53,6
C_0	122,7541	122,7540	122,9757	122,9754	221,4
C_1	163,5587	163,5585	163,5715	163,5713	12,8

Results and Discussion

In testing the oil and fat content, the first step is the extraction process. Extraction is a process to separate one or more immiscible components using a suitable solvent phase. Samples with a total amount of 1000 mL were put into a separating funnel and then acidified with HCl so that the pH of the sample was <2. Then added n-hexane solvent with a purity of 98% which serves to bind the fatty oil contained in the sample because n-hexane is a solvent that has a large distribution coefficient with high selectivity and has non-polar properties. Extraction uses the principle of solubility "like dissolves like", i.e. polar solvents will dissolve polar compounds, and vice versa nonpolar solvents will dissolved nonpolar compounds, besides organic solvents will dissolve organic compounds [7].

The extraction process is carried out by shaking using a separating funnel to speed up the extraction process so that a perfect separation occurs. After shaking for 2 minutes, then allowed to stand again until the water and n-hexane layers separate. The extraction results were filtered using filter paper which had been added with anhydrous sodium sulfate (Na_2SO_4) to remove the remaining water contained in the separated oil and fat compounds, so that better extraction results were obtained. The extraction process was carried out twice in order to provide a higher level of efficiency than the one-time extraction. After obtaining the filtering results from the extraction process, the distillation process was continued at a temperature of 70°C to separate the n-hexane solvent contained in the extraction results.

Distillation is a method used to physically separate compounds from a particular mixture. This separation is based on differences in boiling points or based on differences in the speed and ease of vaporization of the material. The distillation process uses a temperature of 70°C which is the boiling point of the n-hexane solvent so that in this process the solvent will evaporate well. Furthermore, the extracted oil and fat which had been separated from the n-hexane solvent were dried in an oven at 70°C for 30-45 minutes to obtain a perfect extract. After that, it was followed by a cooling process in a desiccator for 30 minutes to absorb the water vapor that was still present in the flask. The flask containing the extract was weighed as (W1) until a constant weight was obtained. The mass yield of oil and fat extract was obtained from the difference in the initial weight of the flask (W0) which was weighed before testing with the final weight of the flask containing

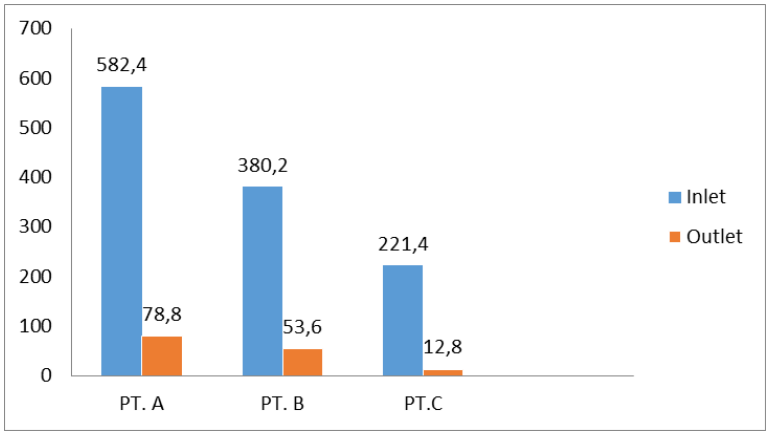

Figure 1. Graph of Oil and Fat Content

oil and fat extract (W1).

Figure 1 is the result of calculating the oil and fat content of each sample. These results indicate the oil and fat content obtained in the inlet sample at PT. A, PT. B and PT. C, respectively, were 582.4 mg/L, 380.2 mg/L and 221.4 mg/L and at the outlet sample PT. A, PT. B and PT. C are 78.8 mg/L, 53.6 mg/L and 12.8 mg/L, respectively. These results indicate that the sample from the inlet pond has very high oil and fat content when compared to the outlet pond. This is because the inlet pond is the first waste disposal pond from palm oil mill effluent which still contains many hazardous substances and has not gone through any waste treatment process. While the outlet waste has oil and fat levels that are not too high because the outlet waste pond is a waste disposal pond after the inlet pond. The outlet pond utilizes sunlight, algae (Algae), bacteria and oxygen in a natural cleaning process so that the levels of oil and fat contained in the waste are not too high.

Conclusion

Based on the results of the tests that have been carried out, it can be concluded that from the 6 test samples only 1 sample is in accordance with the Regulation of the Minister of the Environment of the Republic of Indonesia No.5 of 2014 [8] concerning waste water quality standards for palm oil industrial activities, namely a sample of C1 outlet waste with an oil and fat content of 12.8 mg/L. This waste is safe to be disposed of into the environment, while the other samples have passed the quality standard for waste water from the palm oil industry activities, so there needs to be a processing process before being discharged into the environment to reduce the levels of oil and fat contained in the waste.

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