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Analysis of Palm Oil Industry Liquid Waste Management at PT. Citra Putra Kebun Asri in South Kalimantan Province

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Abstract: Oil palm plantations are currently experiencing quite rapid growth; this has resulted in a large number of oil palm fruit processing industriespalm oil (crude palm oil) and palm kernel (palm kernel). The more oil palm fruit that is processed, the more liquid waste it produces. Liquid waste generated during the production process can harm the environment because of the high organic matter contained therein. The purpose of this study was to analyze the management of palm oil industrial wastewater at PT Citra Putra Kebun Asri.The method used in this study is an exploratory method and the collection and testing of data is done by graph sampling. The results of the analysis contained in the palm oil industrial wastewater, namely the pH content ranges from 4-8.5. The content of BOD and COD in the first pool had quite high levels, this was due to (human error) during testing, factory measuring instruments that had not been calibrated and inaccurate sampling by factory staff. While the BOD and COD in the application pond have values that are in accordance with the liquid waste quality standards with BOD values below 100 mh/L and COD values below 250 mg/L.

Keywords: Analysis; Liquid waste; Palm oil

Introduction

Palm oil (Elaeis guineensis Jacq) is a plantation plant that has an important role in agriculture in Indonesia (Ariyanti et al., 2023). Oil palm plants are one of the plantation commodities that have high economic value, this is what makes it one of the mainstays of the Indonesian state in the agricultural-based industrial development sector (agro-industry) (Daudi et al., 2021). In Indonesia, the oil palm plant has experienced very rapid and significant development and growth in recent years (Hastuti & Titiaryanti, 2022; Akli et al., 2022).

Oil palm plants also provide a fairly high income to farmers when compared to other plantation crops, this is what makes the area of oil palm plantations continue to increase (Hasibuan et al., 2023). The increase in oil palm plantation area was also offset by an increase in oil palm fruit production (Gultom et al., 2023). The rapid increase in palm fruit production has resulted in an increase in the establishment of palm oil mills (Wiharja et al., 2023).

Oil palm fruit produced from oil palm plantations which are commonly called Palm Fruit Bunches (FFB) are sent to palm oil mills for processing. Palm oil mills produce palm oil (crude palm oil) and palm kernel (palm kernel) (Fackrurrozi et al., 2019). In addition to producing palm oil and palm kernel, oil palm fruit also generates waste (Gusrawaldi et al., 2020). Waste is everything that is generated during the production process (Syamsuddin & Rivai, 2023). Palm oil waste is derived from the remaining results of the cultivation of oil palm plants, the palm processing industry and the processing of palm kernel oil. Of course, this process produces a lot of waste (Pravei & Widayar, 2022). In general, waste from palm oil mills consists of three types, namely liquid, solid and gas waste. Palm oil mill liquid waste comes from the steaming process unit, clarification process and exhaust from hydrocyclones. At the time of steaming large quantities of hot water, saturated steam and superheated steam are used, and most of it will turn into waste (Tan et al., 2019).

Liquid waste from the processing of palm oil factories is one of the wastes that has a considerable

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influence because it contains many contaminants that can harm the environmental ecosystem (Nabilah et al., 2022). In addition, liquid waste from palm oil mills also contains Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) (Antoni et al., 2021). While the palm oil mill solid waste is grouped into two, namely waste originating from the processing and those originating from the liquid waste treatment base. Solid waste originating from the processing process is in the form of Oil Palm Empty Bunches (EFB), shells, fiber, sludge, and oilcake (Arita et al., 2020).

Palm liquid waste that is not used will be disposed of into the environment, but must be processed first so as not to endanger the environment (Nuryanti et al., 2019). Because it is dangerous, palm oil mill effluent must be treated before being discharged into the environment. Wastewater management can be accommodated and processed in several stages (Syafrinal et al., 2023). Oil palm liquid waste is processed and stored in holding ponds consisting of Fat pit pond, Deoiling pond, Acidification pond, Primary anaerobic pond, and Land application (Sitorus & Mardina, 2020). The process of liquid waste management is very important to do and must comply with existing regulations (Sofiyanti et al., 2023).

Liquid waste management must be in accordance with the AMDAL (Environmental Impact Analysis) document contained in the approved (Environmental Management Plan) and (Environmental Monitoring Plan). AMDAL is an instrument that must be obtained and must be in accordance with waste quality standards in order to anticipate environmental damage (Sukananda & Nugraha, 2020).

Quality standards are limits or levels of living things, substances or energy or other components that exist or must exist and pollution elements that are tolerated in accordance with their designation (Sholihah et al., 2019). The quality standard for PKS liquid waste for business and palm oil industry activities refers to the AMDAL and Regulation of the Minister of Environment of the Republic of Indonesia No. 5 of 2014 concerning PKS waste quality standards is shown in Table 1.

Table 1. Liquid Waste Quality Standards

Parameter	Units	Standard Quality
BOD	mg/L	100
COD	mg/L	350
TSS	mg/L	250
Oil and fat	mg/L	25
Nitrogen (N)	mg/L	50
pH	-	6 - 9

Source: Regulation of the Minister of Environment of the Republic of Indonesia Number 5 of 2014

Based on the background above, the authors are interested in analyzing the management of liquid waste in the palm oil industry. Dwhere TSS, BOD, COD and pH are the parameters to be tested. This research is locatedat PT Citra Putra Kebun Asri (PT. CPKA) located in Tanah Laut Regency, South Kalimantan Province.

Method

Preliminary Observation

The survey is the first step before conducting research with the aim of the researcher being able to get an overview of the location that will be used as the research location and collecting secondary data.

Implementation Method

Observation of liquid waste is carried out by the exploratory method. Namely making observations along the path of the Waste Pool to be analysed (Tang *et al*., 2020). Collection and testing in this study were carried out from January to December 2022. Data collection was carried out by means of grap sampling. The samples taken in this study were POM waste from the last pool or application pool.

Identification

Identification of substances contained in liquid waste using research results and standard laboratory data results of PT. Citra Putra Kebun Asri, to find out and explain the level of Quality Standards for palm oil liquid waste that meet the requirements.

Result and Discussion

Research Sites

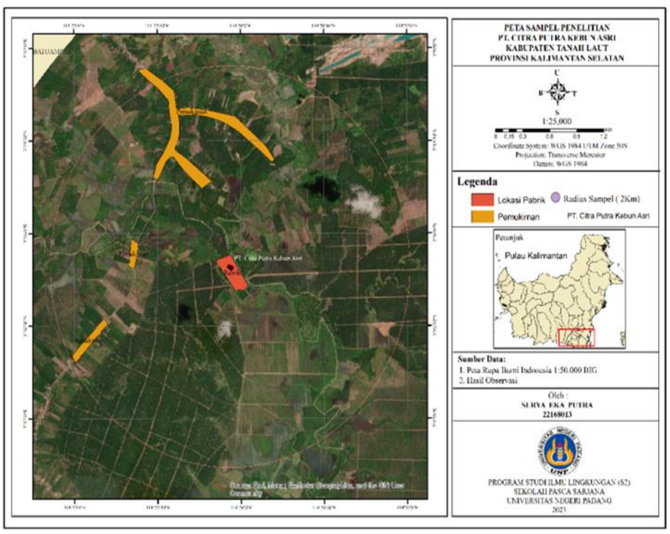

Figure 1. Research location map

Tanah Laut Regency is one of the regencies in South Kalimantan Province, the area of oil palm plantations per 2021 in Tanah Laut Regency based on data from the Plantation and Livestock Service Office of South Kalimantan Province in 2022 is 73,665 Ha with 7 palm oil mills, one of which is Factory PT Citra Putra Kebun Asri (Diskominfo Tala, 2023).

Factory PT. Citra Putra Kebun Asri began operating in 2013 with a FFB processing capacity of 60 tonnes/hour. This factory uses horizontal boiling using a 5 ton capacity truck. The factory can process 1,200 tons of FFB per day and produce 600 – 720 tons of liquid waste per day. Waste treatment is carried out in 7 units of waste ponds near the factory.

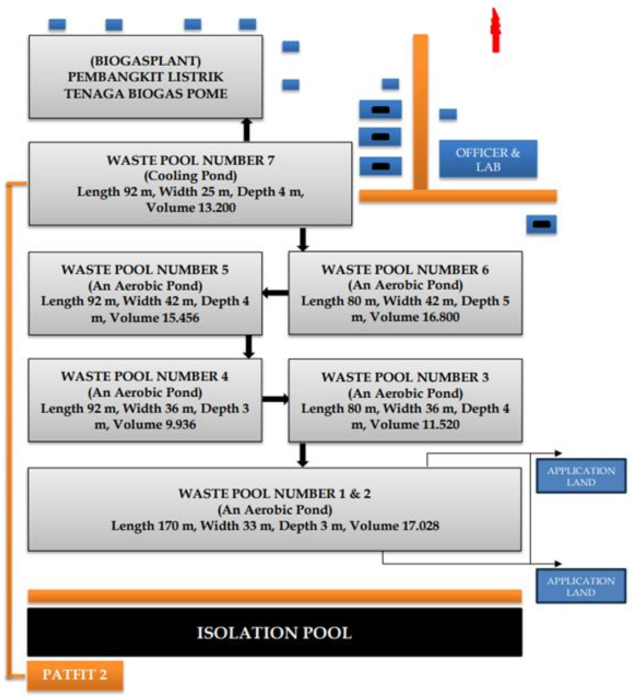

Figure 2. Waste Pool Layout PT. Citra Putra Kebun Asri

Pool pH 1 and Application Pool

As a water quality parameter, pH plays a very important role because pH is an indicator of the type and reaction rate of several parameters in water (Zulfahmi et al., 2022). From the results of analysis of pH data obtained from July 2022 to July 2023 in the first pool and application ponds it ranges from 4-8.5. In July and October, the pH value decreased, hal this can happen because the waste treatment process is less consistent and less stable. It could also be caused by weather factors. Putri et al., (2020) said that, the increase and decrease in pH is caused by carbon dioxide dissolved in water will experience an equilibrium reaction that produces OH ions that cause an increase in the pH value. However, the average pH value is already at the environmental quality standard threshold, namely pH 6 – 9. In Figure 3, it can be seen that the pH value in the gardening pond and application pond has been relatively constant for 12 months.

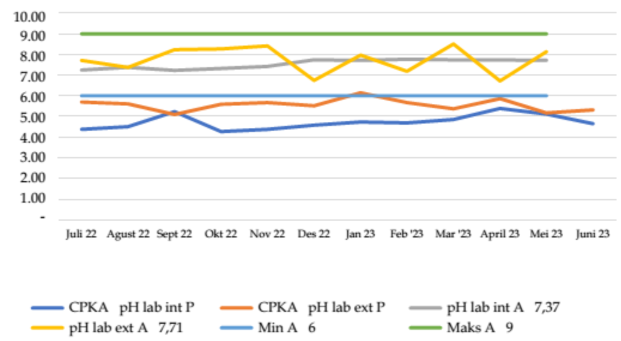

Figure 3. pH test results in pond 1 and application

Biological Oxygen Demands (BOD) Pool 1 and Application Pool

Based on Figure 4, the BOD level in the first pool has a very high value every month. October experienced the highest increase in BOD levels, this can happendue to factory staff (human error) when carrying out tests, factory measuring instruments that have not been calibrated and sampling by factory staff who are not quite right. Whereas in the application pool the BOD level is below the maximum threshold and has decreased,a decrease in the concentration of BOD indicates that the organic matter contained in wastewater is mostly biodegradable (biologically degradable) (Mandasari et al., 2021).

Figure 4. BOD test results in pool 1 and application

Chemical OxygenDemand (COD) Pool 1 and Apication Pool

The COD parameter is the amount of oxygen required to oxidize materials that can be oxidized in wastewater by oxidizing compounds as a determinant of organic matter (Zulfahmi et al., 2022). The COD value in the first pool was above the minimum threshold of 350 mg/L, this could happen becausethe waste treatment process is less consistent and less stable. It can also be caused by weather factors and factory staff (human error) when carrying out tests, factory measuring instruments that have not been calibrated and sampling by factory staff who are not quite right. The COD level in the application pool is below the maximum limit, this could have happened because the organic compounds in the application pool had decreased, so that the COD level was below the applicable regulatory threshold, namely 350 (Masthura et al., 2022).

Figure 5. COD test results in pond 1 and application

Total Suspended Solids (TSS) Pool 1 and Application Pool

TSS are suspended substances in the water (Zulfahmi et al., 2023). From the results of the analysis, the TSS substance contained in the first pool was very high, this happened because when the factory staff took the sample it was not quite right and when the test was carried out independently, the tools used were not calibrated first, so that the TSS levels were obtained. exceeds the threshold for the quality of liquid waste (Viena et al., 2023). Meanwhile, the application pool has a total suspended solid (TSS) value that is in accordance with the threshold. However, in May there was an increase, this could happen becausethe waste treatment process is less consistent and less stable and can also be caused by weather factors. High TSS has an adverse effect on water quality and the environment, because it causes turbidity, so sunlight cannot enter the water and makes organisms unable to photosynthesize (Sisnayati et al., 2021).

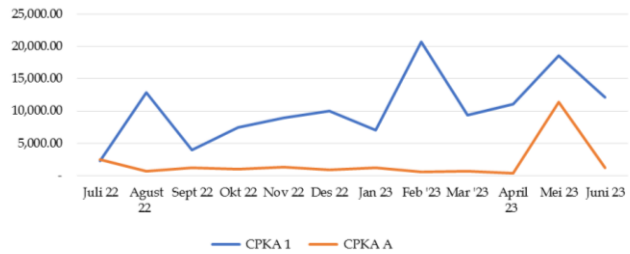

Figure 6. TSS test results in pond 1 and application

Frequency Distribution and Normality Test of First Pond and Application Pool PT Citra Putra Kebun Asri

In the frequency distribution and numerical distribution test (normality), parameter data for the first pond wastewater and the application pond PT Citra Putra Kebun Asri done with the SPSS application. Because the data is less than 50 ($n < 50$), the analytical method uses Shapiro-Wilk, where $p > 0.05$ is considered normally distributed data (Dahlan, 2015).

Table 2. Frequency Distribution and First Pond Normality Test

Parameter	Min	Max	Means	Normality test	Data Distribution
phint	4.270	5.390	4.733	p=0.428	Normal
phext	5.100	6.150	5.560	p=0.876	Normal
BOD	11.95	48.696	25.131	p=0.307	Normal
COD	25.92	10.660	70.430	p=0.069	Normal
TSS	2,337	20.700	10.386	p=0.666	Normal

Source: Processed data results

Based on table 2, it was found that all parameters of internal pH (pHint), external pH (pHext), BOD, COD and TSS data were normally distributed with a significance value of $p > 0.05$. This shows that the liquid waste that enters the processing site has consistent parameters. This means that the production process is running well.

Table 3. Frequency Distribution and Application Pool Normality Test

Parameters	Min	Max	Means	Test Normality	Data Distribution
phint	7.23	7.77	7.531	p=0.014	Abnormal
phext	6.72	8.50	7.746	p=0.244	Normal
BOD	28.200	3.440	10.450	p=0.044	Abnormal
COD	14.552	15.524	4.879	p=0.000	Abnormal
TSS	43.33	11.350	19.390	p=0.000	Abnormal

Source: Processed data results

Based on table 3, it can be seen that only the pHext parameter is normally distributed with a significance $p = 0.244$ ($p > 0.05$). For the parameters pHint, BOD, COD and TSS the data were not normally distributed with a significance $p < 0.05$. This can happen because the waste treatment process is less consistent and less stable. It could also be caused by weather factors.

For pHint and pHext, the Wilcoxon Ranks Test was carried out because one of the data was not normally distributed. The results of the Wilcoxon Ranks Test showed that there was no significant difference in the average pH between pHint and pHext in the PT. Image of Putra Kebun Asri with significance p = 0.450 (p > 0.05). This shows that the process of sampling and analysis of the two samples is close, even though government laboratories already have accreditation and checks using SNI standards.

Analysis of Liquid Waste Treatment PT. Image of Putra Kebun Asri

To see the processing of liquid waste PT Citra Putra Kebun Asri has been done well, then a statistical analysis of the parameters of the first pool with the application pool is carried out. For pairs of normally distributed data, an unpaired T-test was performed. For pairs of data that are not normally distributed, a transformation test is performed first. If the data is still not normally distributed, then proceed with the numerical mean test of 2 independent groups, with one group of data not normally distributed (Mann-Whitney Test).

Table 4. First Pool and Application Pool Different Test Data

	Parameter	Mann-Whitney Test	T-Test
phint	First Pool	p = 0.000	
	Application Pool		
phext	First Pool		p = 0.000
	Application Pool		
BOD	First Pool	p = 0.000	
	Application Pool		
COD	First Pool	p = 0.000	
	Application Pool		
TSS	First Pool	p = 0.000	
	Application Pool		

Source: Processed data results

From the table above, the pHint and pHext values were obtained using a pairwise different test (T-Test) because the samples were taken from the same place but the checks were carried out at the factory laboratory (pHint) and at the government laboratory (pHext). Significancy results obtained p = 0.000 (p <0.05). This value indicates that there is a significant difference in average between pHint and pHext. The government laboratory has been accredited so that it can be said that the results are more accurate than internal checks. This discrepancy can occur due to several things, such as: The carelessness of factory staff (human error) when carrying out tests, factory measuring instruments that have not been calibrated and sampling by factory staff who are not quite right.

Analysis of the values of pH, BOD and COD of Application Ponds compared with standard values for PT Citra Putra Kebun Asri

Data from table 5 shows that all pHint and pHext parameters are in accordance with the standard, which is between 6-9. The BOD parameter according to the standard is only 16.7%, while 83.3% of the parameters are below the AMDAL standard (standard 2000 – 5000 mg/l). The more BOD is below standard, the nutrient content of the waste that is applied to the garden becomes less.

Table 5. Application Pool Parameters based on Standard Parameters of PT Citra Putra Kebun Asri

Parameter	Amount of data	As per standards (%)	Subpar (%)	Top standards
phint	12	100	-	-
phext	12	100	-	-
BOD	12	16.7	83.3	-

Source: Processed data results

To anticipate this in the future, circulation between waste ponds must be carried out properly so that all parameters can be in accordance with predetermined standards. Supervision must be carried out strictly. It is also planned to purchase tools for checking BOD so that the frequency of checking can be carried out more frequently. Don't just rely on checking once a month from a government laboratory.

Conclusion

The conclusion of this study is the analysis results found in the palm oil industry wastewater, namely the pH content ranges from 4-8.5. While the BOD and COD in the application pond have values that are in accordance with the liquid waste quality standards with BOD values below 100 mg/L and COD values below 250 mg/L.

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Auhor Contribution

S.E.P: original draft preparation, results, discussion, methodology, conclusions; I.D, E.B, N.S, I.U: analysis, review, proofreading and editing.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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