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Analysis of Air Pollution Distribution in West Pasaman Regency Effects of Palm Oil Mills

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ABSTRACT

The purpose of this research was to identify sources of pollution and analyze the level of pollution for the parameters of TSP (Dust), particulates, NO_2, and SO_2 and to map their distribution. The research was conducted at 9 (nine) palm oil mills spread throughout West Pasaman Regency. The data used are primary and secondary data. The primary data includes particulates, TSP, SO_2, and NO_2 gases. Secondary data consists of test results data at the Environmental Service in 2017, morphological data, and factory location maps. Data processing methods include statistical analysis of Shapiro Wilk. Then proceed with descriptive analysis to determine the characteristics of the range of minimum and maximum values of air pollution distribution. Spatial analysis of the overlay type was carried out using a GIS application. Particulate, TSP, NO_2 and SO_2 test results at each location have met the required air quality standards. mapping the distribution of air pollutants for the parameters TSP (Dust), NO_2 and SO_2 with the direction of their spread according to the wind direction. Comparison with the latest regulations, namely PP Number 22 of 2021 Appendix VII, shows that the test results are still below the set quality standards. With the test values obtained and the meteorological factors in each company, it shows that there is no significant effect of pollutant content from sources of pollution on the environment around the palm oil mills.

Keyword: *TSP; Particulate; NO_2; SO_2; Spread.*

INTRODUCTION

Indonesia is the first-ranked palm oil-producing country in the world, with an estimated palm oil production of 31.10 million tonnes (Didik, 2017). West Sumatra Province, one of the region as largest palm oil-producing area, is located in West Pasaman Regency (Noven, 2015). In 2019, the area of oil palm plantations in this district reached 121,800 hectares with total production in 1 year from this plantation reaching 1,865,431 tons (Putri & Fitrisia, 2021). The environmental impact that occurs as a result of palm oil production activities is a decrease in air quality (Badrun, 2010).

Research on the level of air pollution due to palm oil factories has been carried out in the Provinces of Riau and Jambi Provinces because these two provinces have more palm oil factories than other regions. In Riau Province there are 178 palm oil mills spread across 7 districts (Utari, Zubir, & Lindayanti, 2021), and based on the Palm Oil Information Center portal, in 2015 there were 78 palm oil mills in Jambi Province. In Kab. Muaro Jambi Jambi Province, research on 2 industrial palm oil factories that use different boiler fuels, namely palm shells and coal.

The observed parameters of particulates, SO_2 and NO_2, show that the palm oil manufacturing industry that uses coal as boiler fuel has a higher content of particulates, SO_2 and NO_2 compared to shell-fired boilers (Sugiarto, Herawati, & Riyanti, 2019).

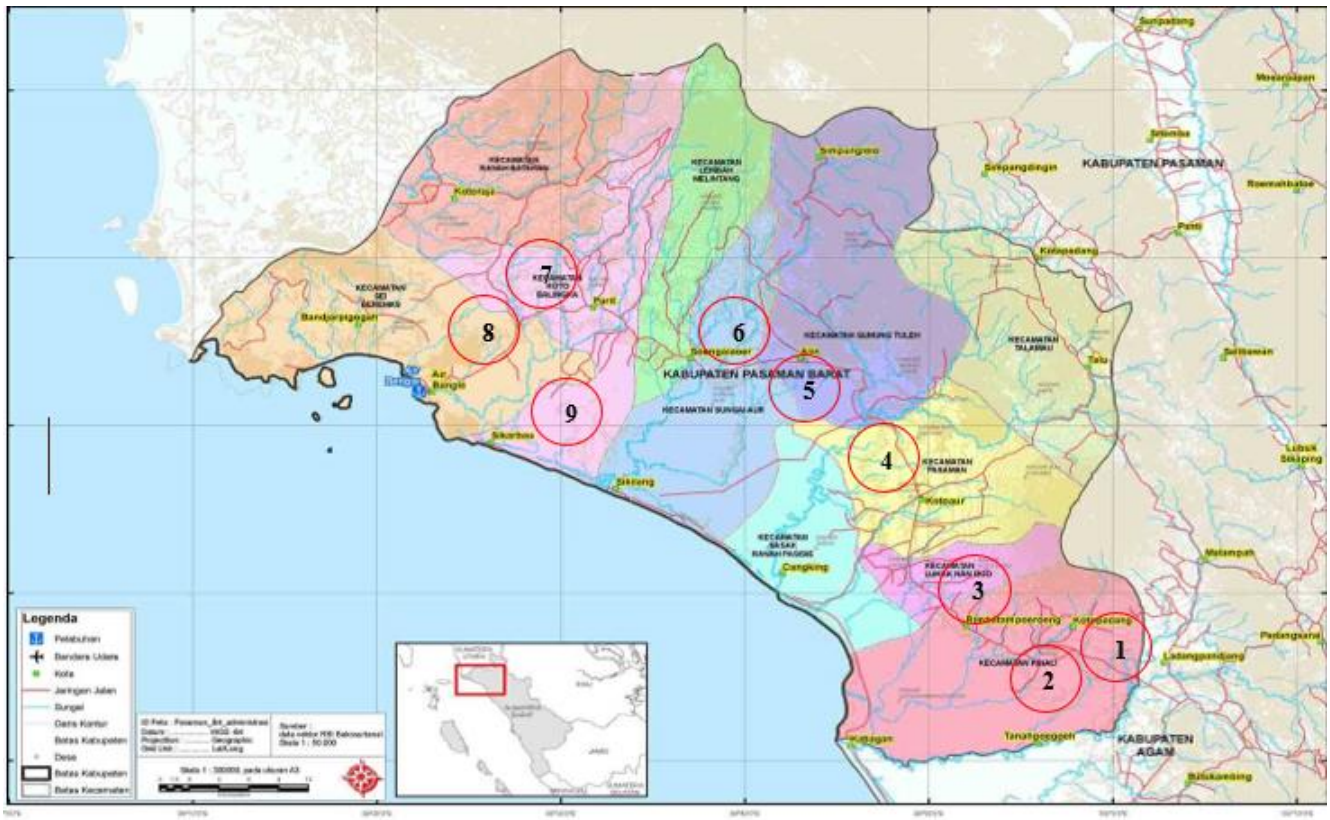
To see the area of distribution of air pollution caused by industrial activities, a mapping application is usually used. In 2014, the dispersion of air pollutants was analyzed using Surfer 10 in the area around the district Mijen, Semarang City due to transportation and industry (Permatasari, Sasongko, & Buchori, 2014).

ArcGIS is a mapping application that provides spatial information and relates it to actual conditions on the earth's surface which are commonly used in analyzing the distribution of pollutants from air pollution. Using ArcGIS requires geographic, meteorological, and pollutant data to be mapped. Analysis of air pollutant distribution based on ArcGIS will obtain accurate information regarding the spatial extent of pollutant distribution and its intensity at the affected location (Yerramillli, Dodla, & Yerramilli, 2011).

This study aims to analyze the level of air pollution emissions produced by palm oil mills to determine the steps that need to be taken in terms of management and control of air pollution in West Pasaman Regency.

METHOD

The location of the palm oil mill where the analysis will be carried out is in West Pasaman Regency, West Sumatra Province. Based on data from the West Pasaman Regency Plantation Office in 2014, there were 12 (twelve) palm oil mills spread across several sub-districts. Of these, 9 (nine) palm oil mills were selected as samples for air pollution analysis.



Caprion:

1.	PT. A	6.	PT. F
2.	PT. B	7.	PT. G
3.	PT. C	8.	PT. H
4.	PT. D	9.	PT. I
5.	PT. E		

Figure 1. Map of the distribution of West Pasaman palm oil mills

Primary Data

Primary data were obtained from the results of direct testing at the source of pollution in the palm oil factory and the environment around the industry which was used as the research object.

1. Particulates
   A sampling of the particulate test at the pollution source was carried out isokinetically (SNI 7117.17:2009).
2. TSP (Dust)
   TSP data collection in ambient air is carried out in the housing closest to the factory location to determine the level of air pollution. The data collection procedure uses high-volume auto-sampler equipment (SNI 7119-3:2017).
3. SO_2 and NO_2 gases
   - SO_2 and NO_2 air emissions
     For SO_2 and NO_2 gas parameters originating from pollutant sources, it is carried out using gas analyzer equipment. The data collection method is by placing the gas analyzer probe into the test sampling hole.
   - ambient air SO_2 and NO_2
     While the parameters of SO_2 and NO_2 gases in the ambient air were carried out using an impinger.

Secondary Data

1. Test results data
   The data taken is SO_2, NO_2, TSP (dust), and particulate measurement results which are sourced from the UKL-UPL monitoring report document for palm oil factories located at the West Pasaman Regency Environmental Service.
2. Meteorological Data
   Data information about wind speed and dominant wind direction was used to see an overview of wind speed and direction at the study site. Meteorological data were obtained from daily data during tests carried out by the Baristand Industri Padang sampling team.
3. Map of palm oil mill locations
   To find out the location plan of each factory and the coordinates of the test using a map that comes from the Google Earth application.

Statistic Analysis

The first step in statistical analysis is determining whether the data used is normally distributed or not. In this study, because the data used was 5 pieces of data, the normal distribution test used was Shapiro Wilk's analysis. The basis for decision-making from Shapiro Wilk's analysis is;

- If the significance value is > 0.05, the research data is normally distributed
- If the significance value is <0.05, the research data is not normally distributed

The next step is to test the validity of the data using paired t-test analysis. Paired t-test is a hypothesis test conducted to find out whether the mean of the same sample group has a significant difference or not.

Descriptive Analysis

Descriptive analysis was carried out to determine the characteristics of the range of minimum and maximum values for the distribution of air pollution in Kab. Pasaman Barat somewhere which is presented in the form of tables and graphs.

Overlays analysis

While the spatial analysis of the overlay type is carried out using a GIS application to combine different layers so that they can display the attributes of the two maps, namely the map of the Kab. West Pasaman and GIS application program map results.

RESULT

Particulate Parameters and TSP (Dust)

Particulate matter and TSP (dust) at each location have met the required air quality standards. This means that there have been efforts made by PT. A to improve test results in its incinerator so that it can meet air quality standards.

Table 1. Comparison of the results of particulate and TSP (Dust) testing

No.	Company	Test Result				
		Boilers (mg/Nm^3)	Generator (mg/Nm^3)	Incinerator (mg/Nm^3)	Solid Dryer (mg/Nm^3)	Residential (mg/Nm^3)
1	PT. A	142.1	35.61	221.05	0	43.46
2	PT. B	54.96	30.5	185	0	62.64
3	PT. C	31.45	13.6	0	0	92.25
4	PT. D	136.11	57.69	0	0	49.75
5	PT. E	173.17	0	0	183.8	50.61
6	PT. F	152.63	68.46	0	0	50.89
7	PT. G	89.45	32.44	103	0	47.06
8	PT. H	173.69	56.05	0	0	42.51
9	PT. I	130.06	30.28	0	0	22.66

NO_2 Parameters

Table 2 shows a comparison of the NO_2 test results between sources of pollution and residential areas around the palm oil mill. It can be seen that the results of NO_2 in housing have not had a significant effect due to air pollution from the combustion process at all pollutant sources.

Table 2. Comparison of NO_2 test results

No.	Company	Test Result				
		Boilers (mg/Nm^3)	Generator (mg/Nm^3)	Incinerator (mg/Nm^3)	Solid Dryer (mg/Nm^3)	Residential (mg/Nm^3)
1	PT. A	191.19	392.26	97.84	0	14.73
2	PT. B	112.46	136.49	210.97	0	0.02
3	PT. C	48	66.75	0	0	4.87
4	PT. D	91.83	231.16	0	0	2.02
5	PT. E	214.72	148.47	0	109.57	10.79
6	PT. F	221.07	422.91	0	0	0.95
7	PT. G	93.71	247.98	62.09	0	10.09
8	PT. H	212.42	262.4	0	0	1.37
9	PT. I	177.81	220.11	0	0	0.93

SO_2 Parameters

Table 3 shows the defense strategy and air quality improvement that was caused by the incinerator at PT. A so that the SO_2 test results at that location decreased compared to previous years. In general, all test results at each test location were below the specified air quality standards.

Table 3. Comparison of SO_2 test results

No.	Company	Test Result				
		Boilers (mg/Nm^3)	Generator (mg/Nm^3)	Incinerator (mg/Nm^3)	Solid Dryer (mg/Nm^3)	Residential (mg/Nm^3)
1	PT. A	116.42	123.83	155.57	0	21.37
2	PT. B	3.93	2.62	17.67	0	0.01
3	PT. C	12.75	16.28	0	0	8.58
4	PT. D	49.52	37.06	0	0	3.6
5	PT. E	260.84	47.3	0	255.79	14.06
6	PT. F	171.46	40.58	0	0	2.87

7	PT. G	45.16	3.93	415.55	0	1.12
8	PT. H	138.08	32.14	0	0	2.91
9	PT. I	181.93	33.38	0	0	4.44

Statistic Test

The results of Shapiro Wilk's analysis to see whether the data used are normally distributed can be seen in table 4.

The hypothesis used in this Shapiro-Wilk test is:

• If the significance value is > 0.05, the data is normally distributed

• If the significance value is <0.05, the data is not normally distributed

Table 4. Results of the Shapiro Wilk statistical test

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PT. A	,168	5	,200*	,968	5	,865
PT. B	,190	5	,200*	,955	5	,776
PT. C	,203	5	,200*	,962	5	,824
PT. D	,200	5	,200*	,951	5	,747
PT. E	,302	5	,155	,791	5	,068
PT. F	,224	5	,200*	,916	5	,507
PT. G	,234	5	,200*	,909	5	,461
PT. H	,217	5	,200*	,972	5	,890
PT. I	,313	5	,122	,817	5	,111

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

From table 4 it can be seen that all data in each palm oil mill has a significant value greater than 0.05. In accordance with the hypothesis used, it can be concluded that the test data used is normally distributed.

After the data is normally distributed, it is followed by a paired t-test to validate it with the latest test results. Not all primary data can be analyzed by paired t-test because there are several locations that only have single data, while the requirement for paired t-test is to have more than one data so that the mean data is obtained.

Table 5. Paired T test correlation results PT. incinerator particulate parameters. A

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PARTIKULAT INSINERATOR PT. A LAMA	341,0050	2	410,29871	290,12500
	PARTIKULAT INSINERATOR PT. A BARU	547,2200	2	97,35446	68,84000

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PARTIKULAT INSINERATOR PT. A LAMA & PARTIKULAT INSINERATOR PT. A BARU	2	-1,000	,000

From table 5 the correlation section obtained a significance value of 0.000. Based on the hypothesis in decision making that if the significance value is less than 0.05 then there is a relationship between the two data.

Table 6. Paired T test results for PT. A

Paired Samples Test

		Paired Differences			
		Mean	Std. Deviation	Std. Error Mean	95% Confidence ... Lower
Pair 1	PARTIKULAT INSINERATOR PT. A LAMA - PARTIKULAT INSINERATOR PT. A BARU	-206,21500	507,65317	358,96500	-4767,29778

Paired Samples Test

		Paired ... 95% Confidence ... Upper	t	df	Sig. (2-tailed)
Pair 1	PARTIKULAT INSINERATOR PT. A LAMA - PARTIKULAT INSINERATOR PT. A BARU	4354,86778	-,574	1	,668

Table 6 is the main part of the paired t test where this table is the basis for decisions in validating test data. From the table above it can be seen that the significance value of the paired t test is 0.668. In accordance with the basis for decision making where if the significance results obtained are greater than 0.05, it means that there is no significant difference between the two data.

Analysis of Emissions and Ambient Air Data

The results of particulate and SO_2 tests in the incinerator, which had previously shown a downward trend, obtained results far below the quality standard. This illustrates that the company has been consistent in implementing the pollution control program.

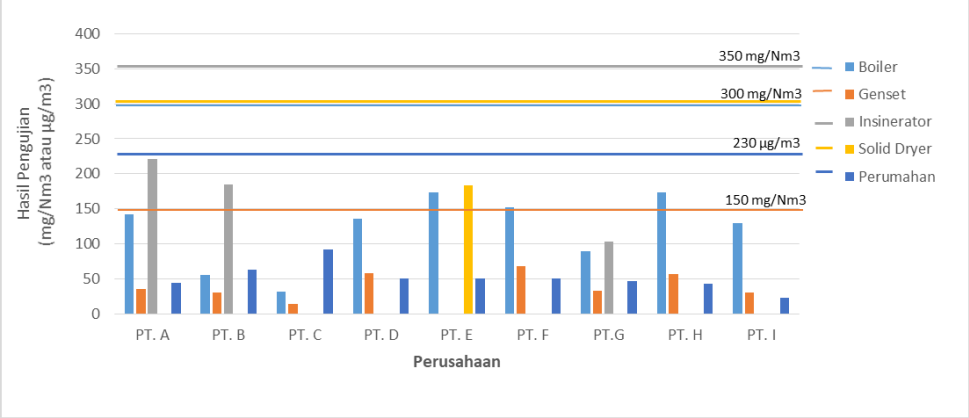


Figure 2. Comparison of the results of particulate testing with TSP (Dust)

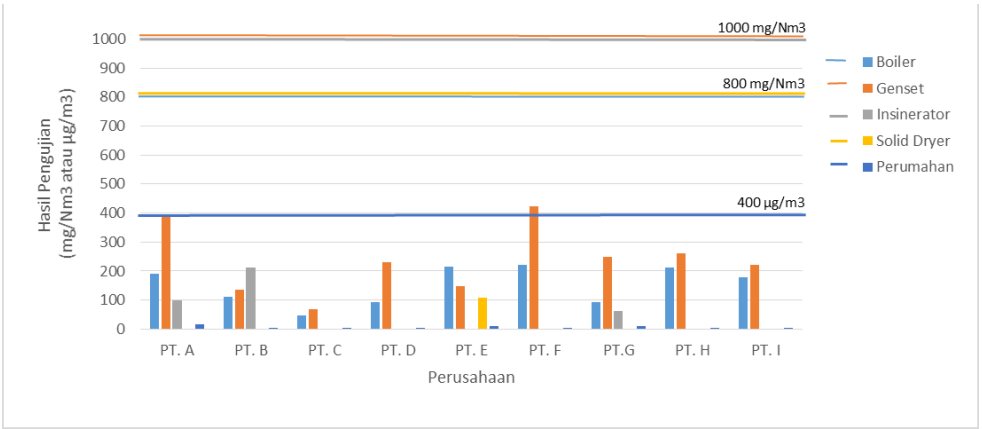


Figure 3. Comparison of NO_2 test results

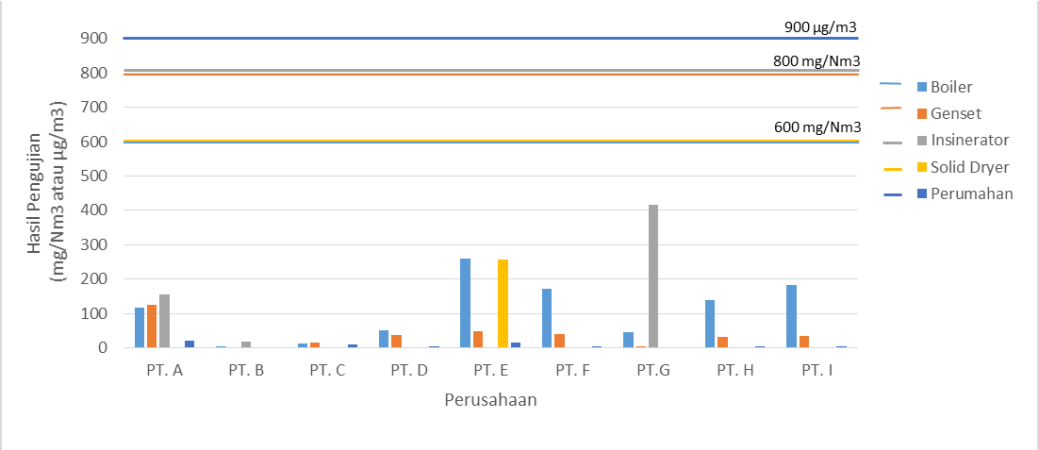


Figure 4. Comparison of SO_2 test results

DISCUSSION

Distribution of Pollutants in Incinerators

Of the 9 (nine) palm oil mills that were used as research objects, only 3 (three) palm oil mills had incinerators, namely PT. A, PT. B and PT. G. Figure 5 below shows the results of particulate testing at PT. A has the highest value compared to other palm oil mills, namely 343.17 mg/Nm^3 or is in the orange scoring. The overall results of particulate testing in the incinerator have not exceeded the established air quality standard of 350 mg/Nm^3.

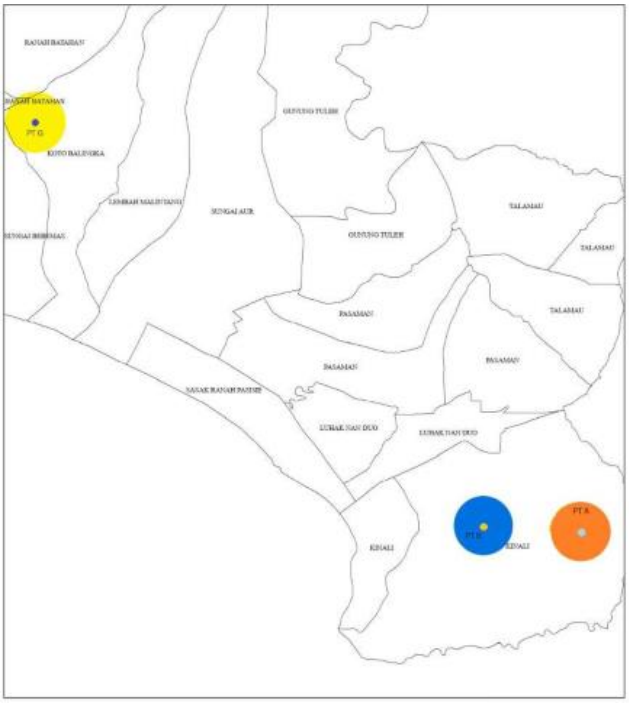


Figure 5. Map of the distribution of particulate pollutants in the incinerator

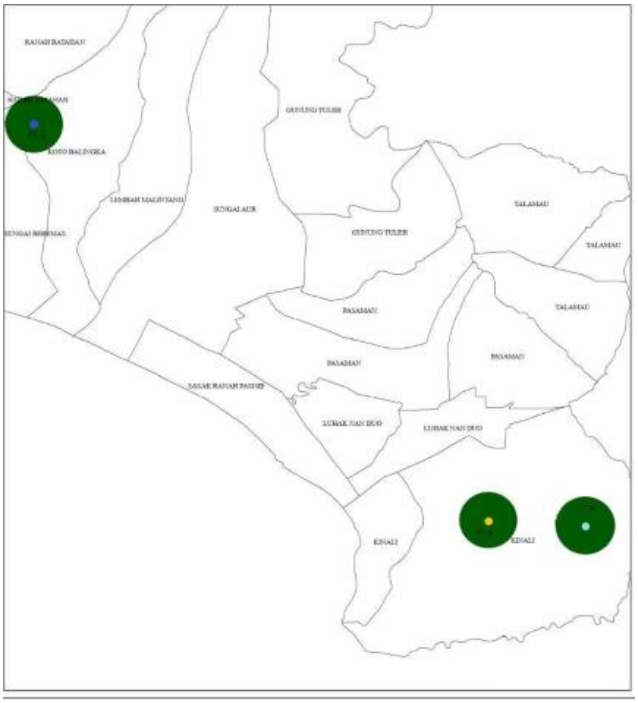


Figure 6. Map of distribution of NO_2 pollutant in the incinerator

The NO_2 pollutant distribution map, as shown in Figure 6, shows that the three palm oil mills are still far below the air quality standard, where the test results are still on a green score. However, in the SO2 test, there are variations in the scoring color with the highest results found in PT. A of 618.49 mg/Nm3, but this result is still below the air quality standard.

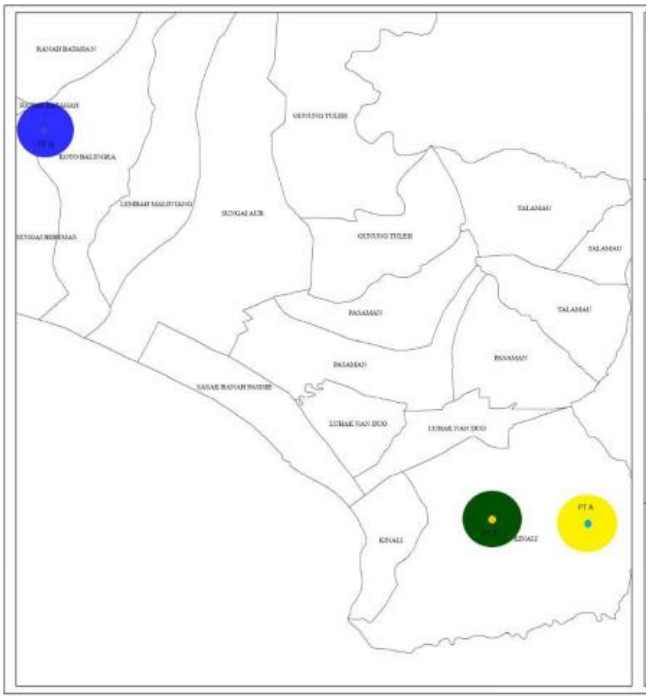


Figure 7. SO_2 pollutant distribution map in the incinerator

Emission Air Quality Management

The test results for research objects for pollutant sources tend to exceed the quality standard in the incinerator unit with particulate and SO_2 parameters. Only NO_2 whose test results are still below the specified quality standards. This is because the combustion process in the incinerator takes place at low temperatures and the fuel is in the form of empty marks which are still wet and contain palm oil.

To overcome the problems that often arise in this incinerator related to test results on certain parameters that exceed quality standards, it can be reviewed in 2 parts, namely internal and external. The internal solution includes improvements to the pollutant source and the external solution covers areas that will be affected by the pollutant source.

One of them is by applying cyclone technology to the incinerator chimney. The working principle of this cyclone technology is to spray water on the exhaust gas in the hope that the particulates produced by the combustion process will settle and fall back into the incinerator. The efficiency of using this cyclone is 95% for particles with a diameter of 5 – 20 µm (Ratnani, 2008)..

CONCLUSION

The main sources of air pollution in palm oil factories come from boilers, generators, incinerators and solid dryers. There is a trend of decreasing test results which exceed the quality standards from the previous year, namely in the PT. A and PT. G which shows the company has succeeded in taking action to control air pollution. Comparison with the latest regulations shows that the test results are still below the established quality standards. With the test values obtained and the meteorological factors in each company, it shows that there is no significant effect of pollutant content from sources of pollution on the environment around the palm oil mills.

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