The Exposure of Emission Gas Pollutant to Residential Area around the Industrial Area: Case Study - Medan Star Industrial Area Tanjung Morawa Subdistrict, Deli Serdang District

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Abstract: The objective of the research was to find out to what extent the exposure of emission gas pollutant SO_2, NO_2, and CO from immovable and movable sources in the Operational KIM (Medan Industrial Area), Tanjung Morawa Star and to find out the people's attitude and perception in the vicinity on the activity of KIM Star, Tanjung Morawa. Based on the result of measurement and calculation, the value of air emission is still in accordance with the quality standard required in the Government Regulation No. 41/1999. The result of interview showed that people's attitude and perception in the vicinity on the operational of KIM Star Tanjung Morawa is relatively good. The result of the calculation showed that emission exposure from KIM Star Tanjung Morawa is smaller than the activity of transportation (mobile source). The cumulative calculation of air emission from immovable source showed that the value produced would decrease 50%-70% in each additional distance of 400 m - 500 m.

1 INTRODUCTION

Tanjung Morawa is one of the sub-districts in Deli Serdang District, North Sumatera which is one of the biggest contributors to the locally – generated revenue of Deli Serdang District especially from the industrial sector. The strategic location of Tanjung Morawa Sub-district is close to downtown Medan and the Balmera toll road (Belawan, Medan, Tanjung Morawa) has made this area one of the important industrial centers in North Sumatra. Medan Industrial Area (MIA) Star Tanjung Morawa is an industrial area located in Tanjung Morawa Sub-district has provided substantial benefits to the improvement of the economy and development progress around it (Kompassiana, 2015). But on the other hand the existence of this industrial area has resulted in a decrease in environmental quality, especially air quality. Industries operating in this region use fossil fuels that produce exhaust gases that can cause air pollution.

According to Sugiarti (2006), the most dominant air pollutant gas affecting human health is Carbon Monoxide (CO), Nitrogen Oxide (NO2), and Sulfur Oxide (SO2). The components of air pollutants mentioned above can pollute the air individually - or can pollute together. The effect of air pollutant gas on human health can have direct or indirect effects such as; damaging the composition of blood hemoglobin, ARI disease, throat irritation, pneumokinosis, cardiovascular and cancer. The influence of air pollutant gas on human health has resulted in anxiety in the community living around MIA Star Tanjung Morawa that can cause the impact of derivatives in the form of negative attitudes and perceptions on the existing industrial activities in the region. Public perception of pollutant substances depends on the knowledge / education and experience. Residents who are around the MIA Star a variety of habits of society is also different from the issue of this pollutant substance.

Emissions from factory and motorized chimneys arising from the operation of MIA Star Tanjung Morawa enter the air and can move from the source point in the other direction to form the pattern of ambient air distribution according to the dominant wind direction (Wardani, 2003). This situation caused a decline in ambient air quality at MIA Star

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Tanjung Morawa, which was inhaled every second by the surrounding community. For this reason, it is necessary to identify the pattern of ambient air distribution around MIA Star Tanjung Morawa to find out how far the ambient emission movement has exceeded the threshold. This is very important for efforts to anticipate, prevent and regulate the effects of air pollution

An estimate of the extent to which the emission exposure is stopped can be obtained by using the Gauss dispersion model. According to Bakar (2006) the Gauss dispersion model was used to determine the distance of emission exposure produced by industrial activities and its supporting activities at MIA Star Tanjung Morawa. The exposure distance produced by the Gauss dispersion model will show the location and area affected by the most contamination, the furthest distance from the pollution range in certain wind conditions shifting the position of the largest contamination with the occurrence of weather changes, as well as reduced or increased levels of pollutants in the most contaminated locations in accordance with effective height differences emission.

2 REVIEW OF REFERENCES

Air is a mixture of several gases whose ratio is not fixed, depending on the state of air temperature, air pressure and the state of the surrounding environment. Air contains a certain amount of oxygen, is an essential component of life, both humans and other living things. Normal air is a mixture of gases including 78% N2; 20% O2; 0.93% Ar; 0.03% CO2 and the rest consists of neon (Ne), helium (He), methane (CH4) and hydrogen (H2). Conversely, if there is an addition of other gases that cause interference and changes in the composition, it is said that the air is polluted / polluted. The entry of foreign substances or substances into the air always causes changes in air quality. The entry of foreign materials or substances does not always cause air pollution. Referring to the definition, new air pollution occurs if the entry of foreign substances or substances causes air quality to drop to the level where human life and animals are disturbed or the environment does not function as it should (Wardana, 2001).

According to PP RI No. 41 of 1999 concerning Control of Air Pollution, the source of the causes of air pollution (by human activities), can be grouped into:

1. Movable sources, which is derived from transportation / motorized vehicle activities;
2. Specific movable sources, those originating from trains, aircraft, ships and other heavy vehicles;
3. Stationary sources, which originates from a fixed emission source somewhere. Then these sources are grouped back into sections, ie point source, source source, area source, and line source.
4. Specific immovable sources, which come from forest / land fires and waste burning.

Air quality standards are the threshold of pollutant concentrations that are considered harmless to living things. This air quality standard is presented in weight per unit volume per unit time. Relating to the maximum value of emission concentrations in ambient air, this has been regulated in Government Regulation No. 41 of 1999.

Nitrogen oxide is often referred to as NOx because nitrogen oxide has two different forms of nature, namely NO2 gas and NO gas. The nature of NO2 gas is colorless and smelly, while NO gas is colorless and odorless. NO2 gas color is brownish red and smells sharp nose sting. NOx air pollution in the air comes primarily from the combustion gases resulting from combustion generators from stationary power station generators or engines using natural gas fuel. Toxicity of NO2 gas is four times stronger than NO gas toxicity. The body organs that are most sensitive to NO2 gas pollution are the lungs. Lungs contaminated by NO2 gas will swell so that people who have difficulty breathing can lead to his death (Wardhana, 2001).

Sulfur oxide gases or often written with SOx consist of SO2 and SO3 gas which both have different properties. SO2 gas smells strong and not flammable. Air that has been contaminated SOx, causing humans to experience respiratory problems. This is because the easy SOx gas becomes the smoke that attacks the mucous membranes of the nose, throat and other respiratory tract to the lungs. The SOx gas attack causes irritation to the affected part of the body (Wardhana, 2001).

In this study Gauss dispersion model was used to calculate the estimated large gas pollutants. The concentration of pollutants from gases and aerosols (particles less than 20 microns in diameter) at x, y, z from continuous sources with high effective H emissions, formulated in equations:

$$C_{(x,y,z,H)} = \frac{Q}{2\mu\sigma_y\sigma_z U_H} exp\left[\left(\frac{-y^2}{2\sigma_y^2}\right)\right]\left\{exp\left[\left(\frac{(z-H)^2}{2\sigma_z^2}\right)\right] + exp\left[\left(\frac{(z+H)^2}{2\sigma_z^2}\right)\right]\right\} \quad (1)$$

3 RESEARCH METHODOLOGY

3.1 Materials and Tools

Equipment used in this research is divided into two groups, namely hardware and software. The hardware used in this research is Global Positioning System (GPS) used to provide geographical reference of observation location, computer used to process, analyze data and present result of data analysis in the form of map, digital camera used for documentation of actual condition in field, tape recorder / used to record interviews conducted with resource persons, stationery is used to record data and interviews, and printers are used to print data and maps. The software used in this study is Microsoft Excel 2007 used to perform tabular data calculations, Microsoft Office 2007 is used to present the report of research results, GIS is used to describe the spread of emissions in the form of maps.

Materials used in this study include climatological data including: air temperature, wind direction and speed, rainfall, sub-district data in numbers, demographic data, health data and nutritional status and ambient air measurement data

4 METHOD OF PROCESSING AND DATA ANALYSIS

4.1 Climatology

Climatological data processing will produce wind speed and dominant wind direction.

4.2 Gauss Dispersion Model

The Gauss disperssiom model is used to calculate the amount of exposure to emissions produced by immovable and operational moving sources of MIA Star Tanjung Morawa. The amount of exposure is calculated based on the distance in the direction of the dominant wind direction.

4.3 Interview with the Community

Data processing from interviews with the community will be carried out in a tabulative manner, while data analysis will be carried out with quantitative and qualitative descriptive methods.

5 RESULTS AND DISCUSSION

5.1 Analysis of Calculation of Immovable Resources

The calculation of point sources originating from the operation of a stationary source machine such as a boiler and generator at MIA Star Tanjung Morawa has resulted in a pattern where the magnitude of the emission concentration in terms of distance will be affected by the value of x (the downwind distance along the centerline flume of the emission source) and the value y (crosswind distance from centerline flume). The large concentration of emissions generated by MIA Star Tanjung Morawa activity is the cumulative emission generated by the companies in the region. In detail the amount of emissions produced at points STU-1, STU-2, and STU-3 are listed in Table 1.

Table 1: Calculation of total emissions generated point sources at MIA Star Tanjung Morawa.

Observation location	Units	Emission concentration (µgr/Nm^3)		
		NO_2	CO	SO_2
STU-1	µg/Nm^3	3,5758	28,1175	1,9829
STU -2	µg/Nm^3	1,3600	9,4941	0,9067
STU -3	µg/Nm^3	0,4862	3,6715	0,2928

Remarks : QS according to PP No. 41 Year 1999
NO_2 = 400 µgr/Nm^3, CO = 30.000 µgr/Nm^3, dan SO_2 = 900 µgr/Nm^3

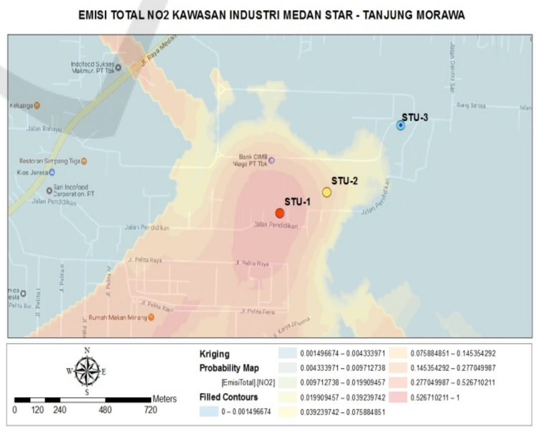

Figure 1: Figure of Concentration Emission Pattern of NO from Industrial Area at STU-1, STU-2, and STU-3.

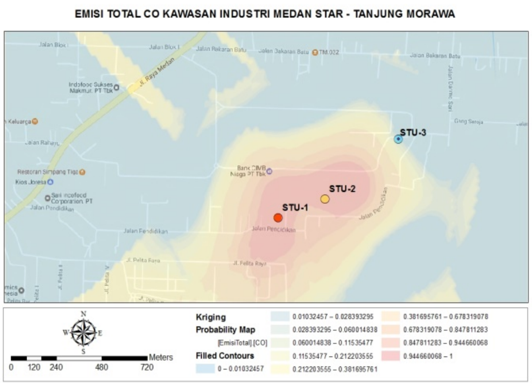

Figure 2: Figure of Concentration Emission Pattern of CO From Industrial Area at STU-1, STU-2, dan STU-3.

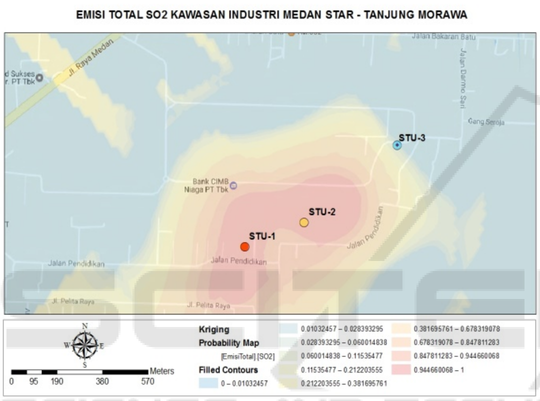

Figure 3: Figure of Concentration Emission Pattern of SO_2 from Industrial Area at STU-1, STU-2, dan STU-3.

Based on Table 1. it is known, to concentration emission of NO2 on STU-1 (distance of 100 m from the outer wall of MIA Star Tanjung Morawa to the Northeast) at 3,575830737 µg / m3, at STU-2 (distance of 500 m from the outer wall of the Area Medan (Star) Industry Tanjung Morawa towards the Northeast) is 1.360011811 µg / m3, and in STU-3 (1000 m distance from the outer wall of MIA Star Tanjung Morawa towards the Northeast) is 0.48621631µg / m3. In STU-2 it decreased from STU-1 by 2.215819 µg / m3 or by 61.91%. In STU-3, it decreased from STU-2 by 0.873796 µg / m3 or by 64.24%.

Concentration Emission of CO in STU-1 (distance of 100 m from the outer wall of MIA Star Tanjung Morawa to the Northeast) of 28.11748208 µg / m3, at STU-2 (distance of 500 m from the outer wall of MIA Star Tanjung Morawa towards Northeast) amounting to 9,494124521 µg / m3, and in STU-3 (1000 m distance from the outer wall of MIA Star) Tanjung Morawa towards the Northeast) of 3,671518995µg / m3. In STU-2, it decreased from SKU-1 to 18,62336 µg / m3 or 66.23%. In STU-3 it decreased from STU-2 by 5,822606 µg / m3 or by 61,23%.

The concentration emission of SO2 at STU-1 (100 m distance from the outer wall of MIA Star Tanjung Morawa to the Northeast) is 1.982875317 µg / m3, at STU-2 (200 m distance from the outer wall of MIA Star Tanjung Morawa to the Northeast) of 0.906727076 µg / m3, and at STU-3 (500 m distance from the outer wall of MIA Star Tanjung Morawa to the northeast) of 0.292768841 µg / m3. In STU-2, it decreased from STU-1 by 1,076148 µg / m3 or by 54.72%. The STU-3 experienced a decline from SKU-2 of 0.613958 µg / m3 or 67.77%.

5.2 Analysis of Calculation of Movable Resources

The reference point for determining the distance of emission source source to STU-1, STU-2 and STU-3 was taken at the center point of MIA Star Tanjung Morawa location. The value of σ_y and σz is based on distance (x) refers from PT F to STU-1, STU-2 and STU-3. The calculation results of the SO2, NO2 and CO emission exposure from immovable sources in KIM Star Tanjung Morawa are listed in Table 2

Table 2: Calculation Results of exposure to SO2, NO2 and CO emissions from mobile sources at MIA Star Tanjung Morawa to STU-1, STU-2 and STU-3.

Parameter	Unit	QS*	STU-1	STU-2	STU-3
NO_2	µg/Nm^3	400	16.4576	6.8520	4.9810
CO	µg/Nm^3	30,000	161.4469	67.2170	48.8640
SO_2	µg/Nm^3	900	0.0145	0.0060	0.0040

*) Government Regulations No. 41 Tahun 1999

5.3 Comparison of Exposure Emissions from Immovable Sources, Moving Sources and Measurement Results of the STU-1 (100 m)

Table 3: Comparison of Exposure Emissions from immovable sources, moving sources and measurement results of the STU-1 (100 m).

Emission Sources	Units	Parameters		
		NO_2	CO	SO_2
Immovable sources	µgr/Nm^3	3.5758	28.1175	1.9829
Movable sources	µgr/Nm^3	16.4576	161.4469	0.0145
Measurement results	µgr/Nm^3	33.4500	903.0000	16.7000
Quality Standard*	µgr/Nm^3	400	30,000	900

*) Government Regulations No. 41 Year 1999

5.4 Comparison of Emission Exposure from Immovable Sources, Moving Sources and Measurement Results in STU-2 (500 m)

Table 4: Comparison of Emission Exposure from immovable sources, moving sources and measurement results in STU-2 (500 m)

Emission Sources	Units	Parameters		
		NO_2	CO	SO_2
Immovable sources	µgr/Nm^3	1.3600	9.4941	0.9067
Movable sources	µgr/Nm^3	6.8500	67.2170	0.0060
Measurement results	µgr/Nm^3	12.0300	300.0000	7.4300
Quality Standard*	µgr/Nm^3	400	30,000	900

*) Government Regulations No. 41 Year 1999

5.5 Comparison of Emission Exposure from Immovable Sources, Moving Sources and Measurement Results in STU-3 (1000 m)

Table 5: Comparison of Emission Exposure from immovable sources, moving sources and measurement results in STU-3 (1000 m)

Emission sources	Units	Parameter		
		NO_2	CO	SO_2
Immovable sources	µgr/Nm^3	0.4862	3.6715	0.2928
Movable sources	µgr/Nm^3	4.9810	48.8640	0.0040
Measurement results	µgr/Nm^3	5.4500	124.0000	3.4900
Quality Standard*	µgr/Nm^3	400	30,000	900

*) Government Regulations No. 41 Year 1999

The calculations of emission exposure from mobile sources in STU-1 for the parameters of NO2, CO and SO2 were obtained by 16.4576 µgr / Nm3, 161,4469 µgr / Nm3, and 0.0145 µgr / Nm3, respectively. The calculations of emission exposures from mobile sources in STU-2 for the parameters of NO2, CO and SO2 were obtained by 6.85 µgr / Nm3, 67,217 µgr / Nm3, and 0.006 µgr / Nm3, respectively. The calculations of emission exposure from mobile sources in STU-3 for the parameters of NO2, CO and SO2 were obtained by 4.981 µgr / Nm3, 48.864 µgr / Nm3, and 0.004 µgr / Nm3, respectively. The results of the calculation of the amount of ambient emission exposure from the moving source is greater than the immovable source. There is a difference between the results of the calculation and the results of direct measurement, where the large emissions based on the calculation is smaller than the measurement results made. The difference is caused by the existence of other industrial activities outside the area and the activity of vehicle transportation around the point of measurement, especially from Medan-Tanjung Morawa road.

6 CONCLUSIONS

Based on the results of the discussion in the previous section the conclusions that can be drawn from this study are as follows:

1. The cumulative calculation of the emission exposure from MIA Star Tanjung Morawa operational inactive sources at a distance of 100 m, 500 m, and 1000 m shows that the resulting

value will be reduced by 50 -70% at each distance of 400-500 m.

2. The results of calculating the amount of ambient emission exposure at a distance of 100 m, 500 m, and 1000 m from transportation activities (moving sources) are greater than the plant's operational activities (non-moving sources).
3. Emission exposure at STU-1, STU-2 and STU-3 locations is not only sourced from KIM Star Tanjung Morawa's operations, but also influenced by industrial activities and transportation around the activities.
4. The attitude and perception of the surrounding community towards pollution caused by the operation of MIA Star Tanjung Morawa is still relatively good.

7 SUGGESTIONS

1 Considering the community's perception of pollutant substances depends on their knowledge / education and experience, it is necessary to conduct socialization to the community around the Medan Industrial Area (MIA) Star by the authorized agency.

2 Determination of the location of the industrial area needs to pay attention to the distance to the location of the residents.

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