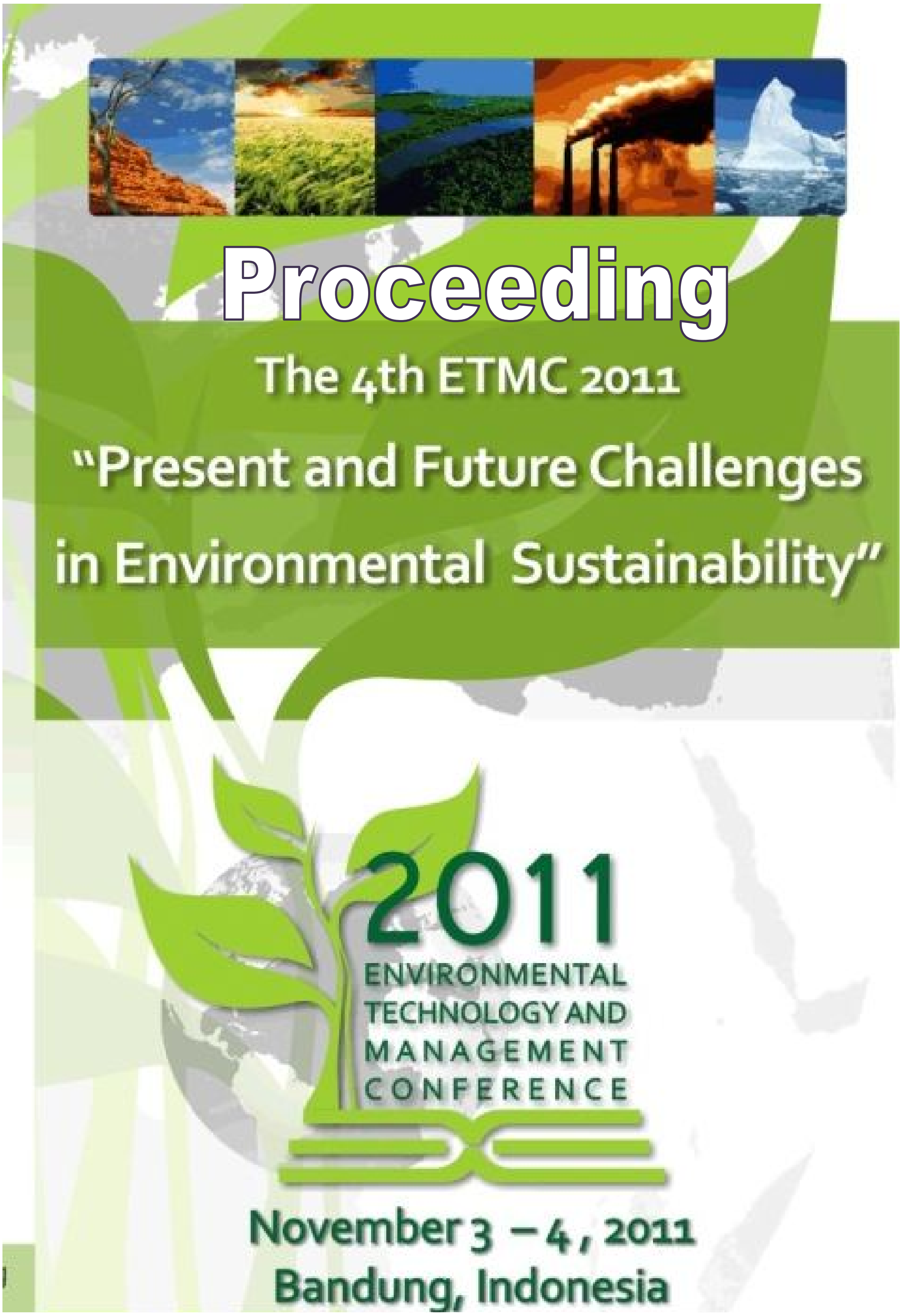

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Dispersion Simulation of Gaseous Pollutants Generated from a Drill Stem Test

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Abstract. A drill stem test on a potential oil well was carried out in offshore of East Kalimantan to obtain important information of the formation fluid and to establish the probability of commercial production. The objective of the study was to run dispersion simulation of the generated NO_2 and CO resulted from the burned fluid during the test. Dispersion simulation was based on Gaussian model and a burning scenario of 4000 barrels of fluid during two days test. Twelve years long climate data from Tarakan was explored to support pollutant dispersion direction prediction. It showed that prevailing wind blows from South to North at 3.3 m/s average speed. Gaseous pollutant would likely be dispersed to the northern area following the prevailing wind direction instead of moving to the densely populated coastal area of East Kalimantan located in the western side of the oil well. Analysis results indicated that during two days test the gaseous pollutant emission rate were 4.1E+7 and 4.4E+6 µg/s for NO_2 and CO, respectively. It can be concluded that CO concentration complies the standard at every point away from DST location. NO_2 complies with the national standard after 850 meter away from the DST location.

Keywords: *carbon monoxide, dispersion simulation, drill stem test, nitrogen dioxide, Gaussian dispersion.*

1 Introduction

A drill stem test on a potential oil well was carried out in offshore area of East Kalimantan, Indonesia in order to obtain important information of the formation fluid and to establish the probability of commercial production. During the test a huge of smoke and gaseous pollutant would be resulted as a consequence of the fluid burning during the test.

Here, the dispersion of two major gaseous pollutants, i.e. nitrogen dioxide (NO_2) and carbon monoxide (CO) were assessed to predict the gaseous concentration in the densely populated area surrounding the oil well. The general objective of the study was to run dispersion simulation of the generated nitrogen dioxide (NO_2) and carbon monoxide (CO) resulted from the burned fluid during the drill stem test (DST) and to predict the concentration of those gaseous pollutants in the ambient air surrounding the oil well. The predicted major gaseous pollutant concentrations were then justified by using associated national standard limit values.

Sulfur dioxide (SO_2) was normally included in the study of the gaseous dispersion simulation generated from a DST. In this case, however, since the analysis on the reservoir fluid sample, flash liquid sample as well as flash gas sample showed that the fluid contained no sulfur compound then the sulfur dioxide (SO_2) component was excluded from the simulation dispersion.

2 Methods

The drill stem test (DST) was carried out in an oil well located in offshore of East Kalimantan, Indonesia, at a distance of ±50 nautical miles from the seashore. The first DST was run for two (2) days whereas the subsequent DST was run a week after. Burner was assumed as a stack from the simulation point of view.

2.1 Technical Data, Constraints and the Emission Calculation

A number of technical data necessary for the dispersion simulation as well as some constrains (limitations) used in the dispersion simulation study are as follows:

a. The quantity of the burned fluid (hydrocarbon) was 4000 barrels per day (BPD).
b. The fluid (hydrocarbon) burning time span was 48 hours (2 days). The subsequent DST was carried out a week after.
c. The burner height was 40 m above sea level. This was then assumed as stack height in the dispersion simulation.
d. Supporting climate data was obtained from the nearest climate station, i.e. Tarakan Meteorological Station.
e. Number of oil well = 1 unit.

The amount of the emitted gaseous pollutant was calculated based on the amount of the burned fluid (hydrocarbon), i.e. 4000 barrels of fluid per day (BPD) during two days of the drill stem test. The emitted pollutant was obtained by multiplying the amount of the burned fluid by its emission factors which were compiled by US-EPA, i.e. US-EPA Standard AP-42 Chapter 1.3 pertaining on fuel oil combustion. The emission calculation sheet is presented in Table 1.

The calculated emission rates were then becomes inputs for gaseous pollutant dispersion simulation in the ambient air surrounding the oil well under drill stem test. Each of the pollutant would then be dispersed according to the prevailing wind direction, wind speed, burner efficiency and the stack emission rate.

Table 1 Gaseous pollutant calculation sheet.

Component	**Unit**	**Quantity**	
Burned fluid	BPD	4000	
	gal	1,7E+05	
Gaseous pollutant		CO	NO_2
Emission Factor *	$lb/10^3 gal$	5	47
Burner efficiency	%	99.97	99.97
Emission Quantity	lb/d	839	7889
Emission Rate	µg/s	4.4E+06	4.1E+07

*US-EPA Standard. AP-42. Chapter 1.3. Fuel Oil Combustion [2]

2.2 Gaseous Pollutant Simulation Dispersion

The gaseous pollutant dispersion simulation was run by implementing Gaussian dispersion model developed by Karl Friedrich Gauss (1777-1855). Concentration of any pollutant at the ground level where most of the cases are concerned can be expressed as follows [4, 5, 6 and 7]:

$$C_{(x,y,z)} = \frac{Q}{\pi \sigma_y \sigma_z U} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]\right\} \qquad (1)$$

Where:
$C_{(x,y,z)}$ = gas concentration at any point (x,y,z) [$\mu g/m^3$]
Q = stack emission rate [g/s]
σ_y ; σ_z = dispersion coefficient according to Pasquill-Gifford curve [m]
U = wind speed [m/s]
y = distance (y) from the centerline [m]
z = vertical distance (z) from the centerline [m]
H = plume height from the ground [m].

3 Results and Discussion

Analysis on the series of the compiled climate data indicated that the prevailing wind blew from the South direction as indicated in Figure 1. This means that the emitted gaseous pollutant would be dispersed to the northern area of the source. Based on the compiled data, the average wind speed was about 3.3 m/s and the resultant vector of the whole wind originated from the South West direction.

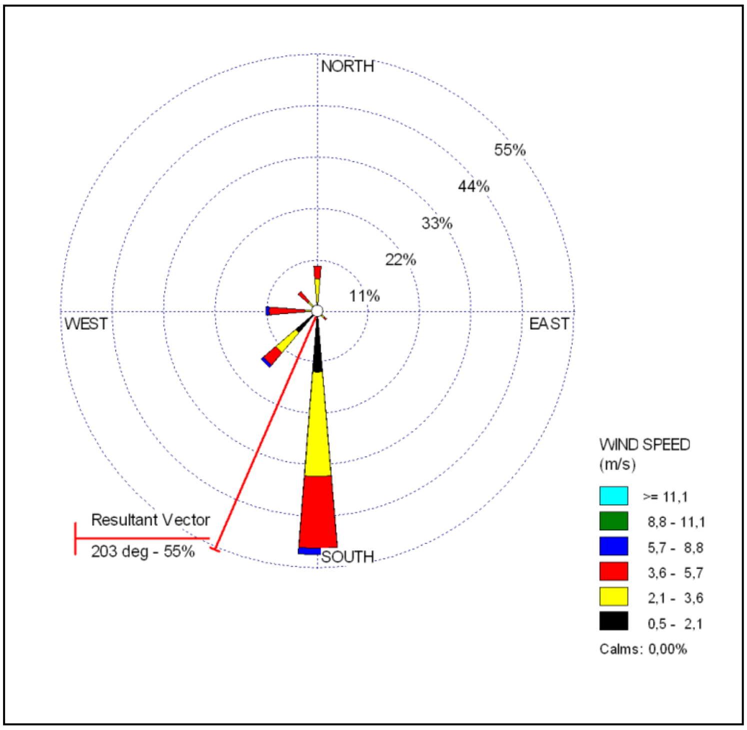
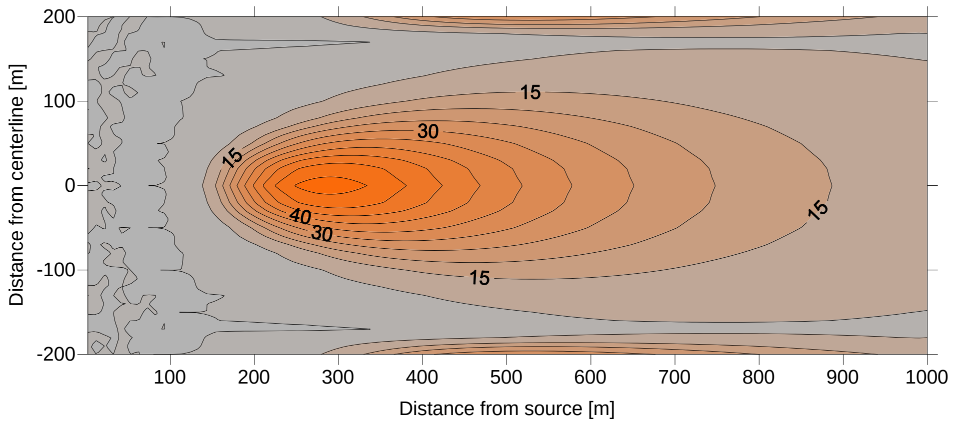


Figure 1 Windrose of the study area indicating wind speed and direction.

Result of dispersion simulation on carbon monoxide (CO) is presented in Figure 2. It shows that the national threshold limit of 10,000 µg/Nm^3 according to Government Regulation (PP. 41/1999 pertaining on Air Pollution Control) [3] was not exceeded even though at any point extremely closed to the source (burner). The highest concentration at a distance of some hundreds meter away from the source was merely ±80 µg/Nm^3. However, ambient air condition around the burner should always be noticed during the DST running period due to the risk of carbon monoxide (CO) since its characteristics as noxious gas for the human being. Larger exposures can lead to significant toxicity [1] of the central nervous system and heart, and even death.

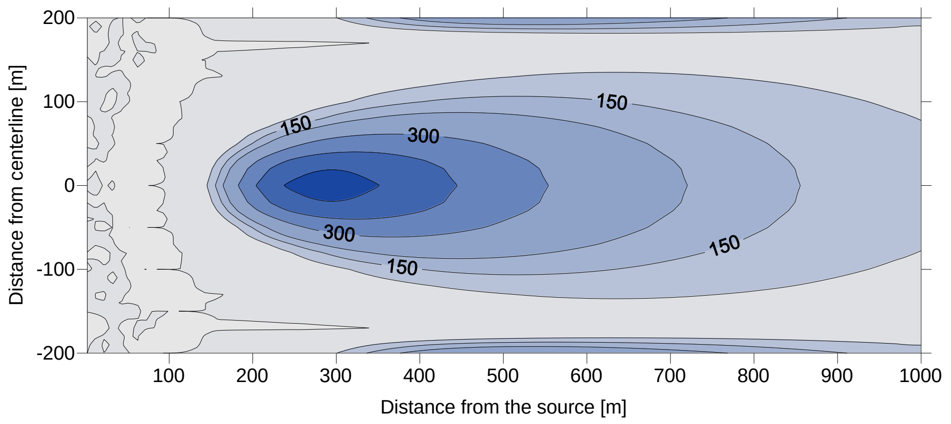


Remarks:

- Pollutant gas = CO
- Wind speed = 3.3 m/s
- Burned oil = 4000 BPD
- Stack emission rate = 4.4E+06 µg/s
- Stack height = 40 m
- Threshold limit = 10,000 µg/Nm^3

Figure 2 Dispersion simulation of carbon monoxide (CO) in ambient air.

Figure 3 reveals that after a distance of ± 850 meter from the source concentration of NO_2 reach its threshold limit (=150 µg/Nm^3). It indicates that all activities in the radius of 850 meters from the center of DST location contain risk of NO_2 exposure to human being. NO_2 is a toxic gas where its impact on human being has been recognized such as pneumonia although in this phase human healthy could be recovered after 6-8 weeks of medical treatment [8].



Remarks:

- Pollutant gas = NO_2
- Wind speed = 3.3 m/s
- Burned oil = 4000 BPD
- Stack emission rate = 4.1E+07µg/s
- Stack height = 40 m
- Threshold limit = 150 µg/Nm^3

Figure 3 Dispersion simulation of nitrogen oxide (NO_2) in ambient air.

Based on two results of dispersion simulation showed above, it can be summarized that according to national standard limit (i.e. PP. 41/1999 pertaining on Air Pollution Control) concentration carbon monoxide would comply with the national standard at every point away from the DST location. For Nitrogen dioxide (NO_2) parameter, it complies with the national standard limit after a distance of 850 meter away from the DST location.

Other important aspect of the gaseous pollutant dispersion is that due to the prevailing wind direction, the pollutant would likely be dispersed to the northern area following the prevailing wind direction instead of moving to the densely populated coastal area of East Kalimantan located in the western side of the oil well. As a consequence, the human settlement area would receive a minor negative impact of the dispersed pollutant.

4 Conclusion

Based on two results of dispersion simulation showed above, conclusions that can be drawn are as follows:

a. According to national standard limit (i.e. PP. 41/1999 pertaining on Air Pollution Control) concentration carbon monoxide (CO) would comply with the national standard at every point away from the DST location.
b. For Nitrogen dioxide (NO_2) parameter, it complies with the national standard limit after a distance of 850 meter away from the DST location

5 Nomenclature

BPD	=	Barrels per day
$C_{(x,y,z)}$	=	gas concentration at any point (x,y,z)
CO	=	Carbon monoxide
DST	=	drill stem test
NO_2	=	Nitrogen dioxide
Q	=	stack emission rate
y	=	Horizontal distance (y) from the centerline
z	=	Vertical distance (z) from the centerline
σ_y, σ_z	=	dispersion coefficient according to Pasquill-Gifford curve

6 References

[1] Anonymous. *Carbon monoxide poisoning*, Wikipedia, URL http://en.wikipedia.org/wiki/Carbon_monoxide_poisoning (14 September 2011).

[2] Anonymous. *Fuel Oil Combustion*. United States – Environmental Protection Agency (EPA). 1998.

[3] Anonymous. *Himpunan Peraturan Perundang-undangan di Bidang Pengelolaan Lingkungan Hidup dan Pengendalian Dampak Lingkungan Era Otonomi Daerah*. Kementerian Lingkungan Hidup. 2006.

[4] De Nevers, N. *Air Pollution Control Engineering*. McGraw-Hill, Co. New York. 1995.

[5] Kiely, G. *Environmental Engineering.* McGraw-Hill International Editions. 1998.

[6] La Grega, M.D, Buckingham, P.L., and Evans, J.C. *Hazardous Waste Management.* McGraw-Hill Book Co., Singapore. 2001.

[7] Peavy, H.S, Rowe, D.R., Tchobanoglous, G. *Environmental Engineering*. McGraw-Hill Book Co., Singapore. 1985.

[8] Slamet, J.S. *Kesehatan Lingkungan*. Gadjah Mada University Press. Yogyakarta. 2002.