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ANALYSIS OF AMBIENT AIR QUALITY FOR PARAMETERS OF NITROGEN DIOXIDE (NO_2) TO CERAMIC TILES COMBUSTION PROCESS WITH GAUSS DISPERSION MODELS IN SIDOLUHUR, GODEAN, SLEMAN, D.I YOGYAKARTA

Supriyanto[1*], Yonatan Hafid[1]

[1] *Department of Enviromental Engineering,Universitas Islam Indonesia,Yogyakarta, 55584, Indonesia*

ABSTRACT

Nitrogen Dioxide (NO_2) was investigated in the surrounding area of roof tile industry. NO_2 was sampled and analyzed based on Indonesia National Standard for ambient air quality. This study measured in two locations in the morning and afternoon. The sampling used *Griess Saltzman* solution which was used to absorb NO_2-troposhere and the NO_2 analysis used spectrophotometer with 550 nm wave length. The First Location (7°45'49.76"LS 110°17'8.77"BT) showed that NO_2 concentration is was 0.450 μg/Nm^3 whereas The Second Location (7°45'44.23 "LS 110°17'17.90 "BT) showed that it is 0.522 μg/Nm^3 NO_2. The model confirmed that NO_2 sources come from 90% cooking and 10% stack (error <1%). In a more detail, the model also investigated the activity of fuel combustion as NO_2 sources. In addition, the ranks of NO2 sources from the largest sources are Stack, Wood, Liquid Petroleum Gas (LPG) and Kerosene. Finally this study indicated that NO_2 concentration is below the National Standard of Air Quality (400 μg/Nm^3)

Keywords: Air Quality Standard; Cooking; Nitrogen Dioxide; Roof Tile Industry; Sidoluhur

1. INTRODUCTION

The burning of fuel, such as in electric power plant and vehicles (Carslaw and Rhys-Tyler; 2013; Frins et.al 2014; Chan et.al, 2015) results in Nitrogen Oxide (NO_X) where Nitrogen Monoxide (NO) dominates (Podrez, 2015). In the troposphere, NO reacts with ozone and other oxidants (David et.al, 2013). Furthermore, NO_2 has influence on the production of soot photochemistry (Han et.al 2013). The Soot contains Nitro and Oxygen Substance, therefore NO_2 causes health problem due to respiratory issue and stroke (Ji, et.al, Li. 2015; Li.et al 2013). Some studies measured NO_2 concentration in the sea and land (Chan et.al 2015; Schreier et.al 2015).

2. METHODOLOGY/ EXPERIMENTAL

In this study, the determination of NO_2 in ambient air quality used *Griess Saltzman* Method whereas the model was calculated by Gauss Dispersion Modern

* Corresponding author: iamsupriyanto@gmail.com

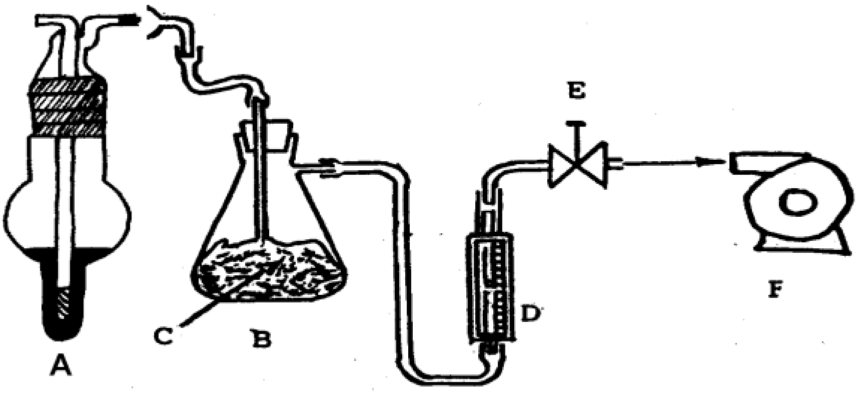

Figure 1 Equipment of NO_2 sampling

Figure 1 shows the sampling equipment to absorb NO_2 from the ambient air (SNI 19-7119.2-2005). A is fritted bubble; B is miss trap; C is soda lime; D is flow meter with 0.4 L/min; E is control valve; and F is pump.

2.1. Research Location

The sampling of ambient air quality took 5 (five) days from May 18, 2015 to May 22, 2015. It took place in Pandean, Sidoluhur, Godean, Sleman, Yogyakarta. The selection of the location (see Figure 2), was based on Indonesia National Standard (SNI 19-7119.6-2005).

Table 1 Coordinate Point for Sampling Location

Location	Adminisration Terittory	Coordinate Point
1.	Pandean, Sidoluhur Sub-district, Godean District	7°45'49.76"LS 110°17'8.77"BT
2.	Pandean, Sidoluhur Sub-district, Godean District	7°45'44.23 "LS 110°17'17.90 "BT

2.2. Sampling Method

The experiment was conducted for one hour with 2 (two) location points. It was based on Indonesia National Standard SNI 19.7119.2-2005 with *Griess Saltzman* Method by using spectrophotometer. The analysis concept was: NO_2 was absorbed by *Griess Saltzman* solution to produce *azo dye* solution. Solution of *azo dye* with pink color should be stable after 15 minutes. The solution concentration was determined with 550 nm wavelength in chemistry.

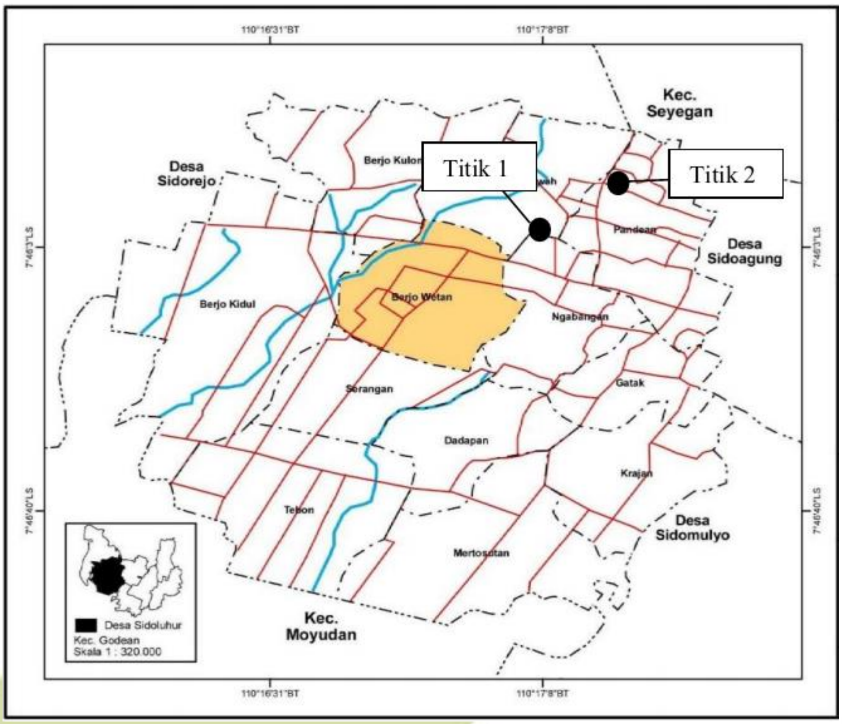

Figure 2 Location Sampling

For information, the volume of air was pumped to impinge used equation 1, whereas equation 2 calculated NO_2 concentration in ambient air.

$$V = \frac{F_1 + F_2}{2} x\, t\, x \frac{P}{T_a} x \frac{298}{760} \quad (1)$$

$$C = \frac{b}{V} \times \frac{10}{25} \times 1000 \quad (2)$$

2.3. Model Method

Equation 3 of Gauss Dispersion Model calculated NO_2 concentration from sources (De Nevers, 1995)

$$C = \frac{Q}{2\pi.u.\sigma z.\sigma z} xexp\left[-\left(\frac{1}{2}\frac{y^2}{\sigma y^2} + \frac{1}{2}\frac{(z-H)^2}{2\sigma z^2}\right)\right] \quad (3)$$

Where Plume Rise was calculated by equation 4 and Effective Stack was estimated by equation 5.

$$\Delta h = \frac{Us.d}{u} x\left[1,5 + (2,68x10^{-2}.(P).\left(\frac{Ts - Ta}{Ts}\right).d)\right] \quad (4)$$

$$H = h + \Delta h \quad (5)$$

Meanwhile, Disperssion Coefficient (σx, σy, and σz) was calculated by Pasquill-Giford (Vallero, 2008). The above all equations calculated the potential of NO_2 sources.

Nomenclature

B	NO_2 concentration from calibration curve (μg)
C	Concentration (μg/Nm^3)
D	Diameter of stack (m)
F_i	Atmospheric Pressure (L/min)
H	Effective Stack Height (m)
H	Stack Height (m)
P_a	Atmospheric Pressure (mmHg)
Q	Flow rate of pollutant (g/s)
T	Sampling Time
Ta	Atmospheric Temperature (K)
Ts	NO_2 Temperature (K)
U	Wind velocity (m/s)
U_s	Flow rate of pollutant (m/s)
V	Pumped air volume (m^3)
X	Downwind (m)
Y	Crosswind (m)
Z	Vertical direction (m)
Δh	Plume rise (m)
Π	Mathematic coefficient (3.14)
Σx	Dispersion coefficient toward downwind (m)
Σy	Dispersion coefficient toward crosswind (m)
Σz	Dispersion coefficient toward vertical direction (m)

2.3. Variable research

Table 1 shows the ratio between cooking from domestic area and stack from roof tile industry. Cooking used Liquid Petroleum Gas (LPG), wood and kerosene. Meanwhile stack of roof tile industry used wood. The ratio was used to compare the pollutant from the two sources (cooking and stack). The smallest difference between the experiment and model was chosen to represent the pollutant sources in the atmosphere.

Table 1 Variable Ratio

Cooking (%)	Stack (%)
10	90
30	70
40	60
50	50
90	10

3. RESULTS AND DISCUSSION

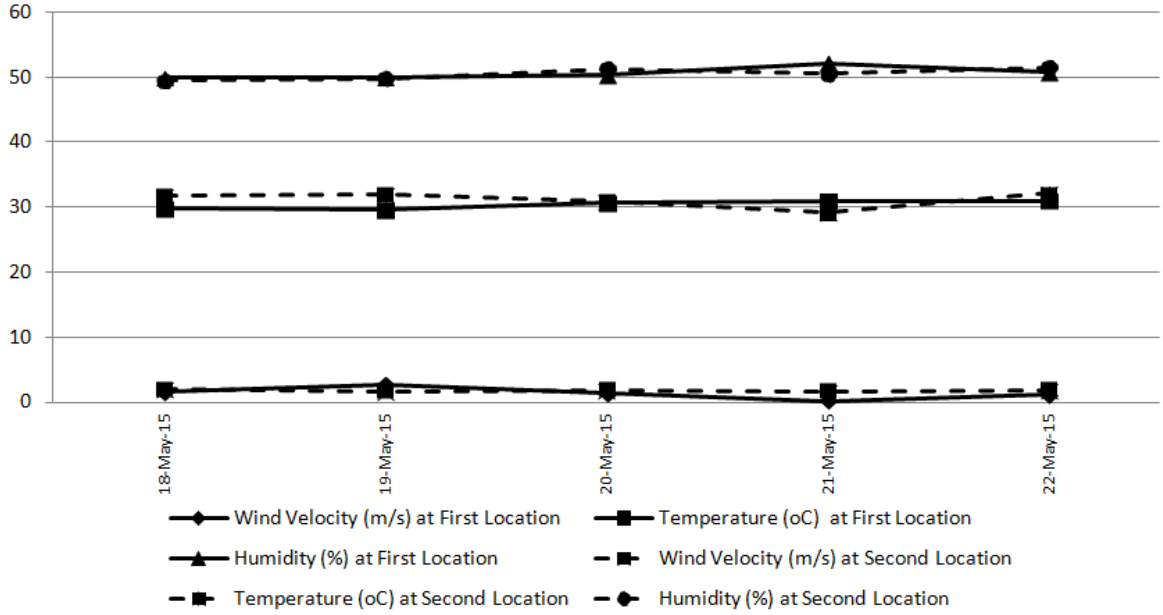

Figure 1 Morning Meteorological Condition

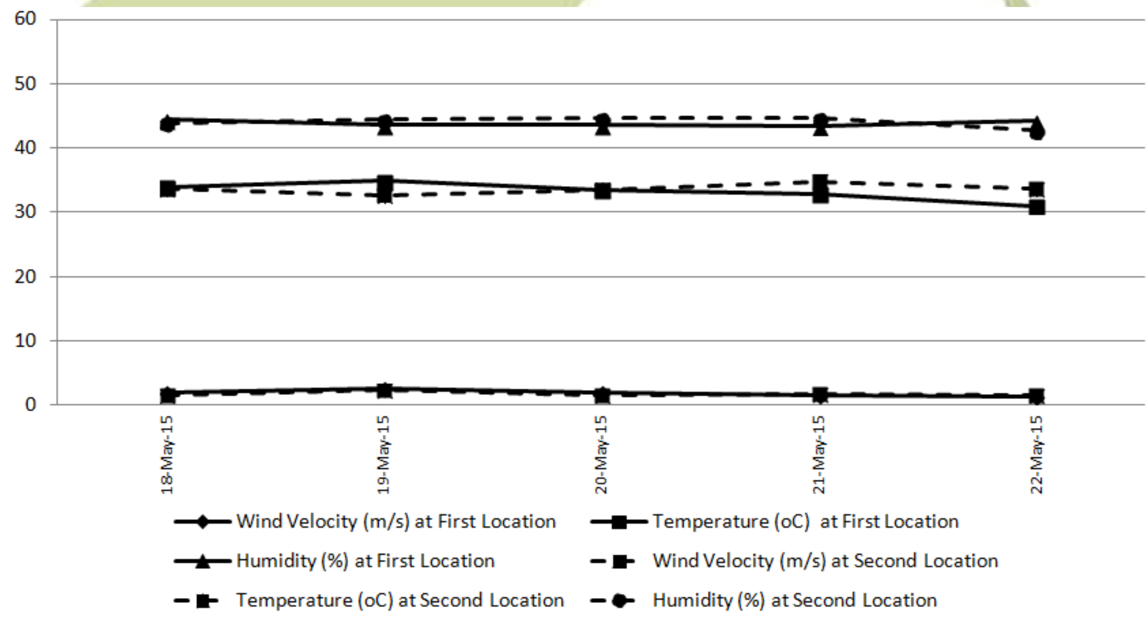

Figure 2 Meteorological Condition in the Afternoon

From figure 1 and 2, the Humidity in the morning is little above 50% which is higher than the afternoon humidity (below 50%). Meanwhile, the Temperature is around 32^{o}C and wind speed is below 5 m/s. In addition, the Pressure is 748 mmHg in the morning and afternoon.

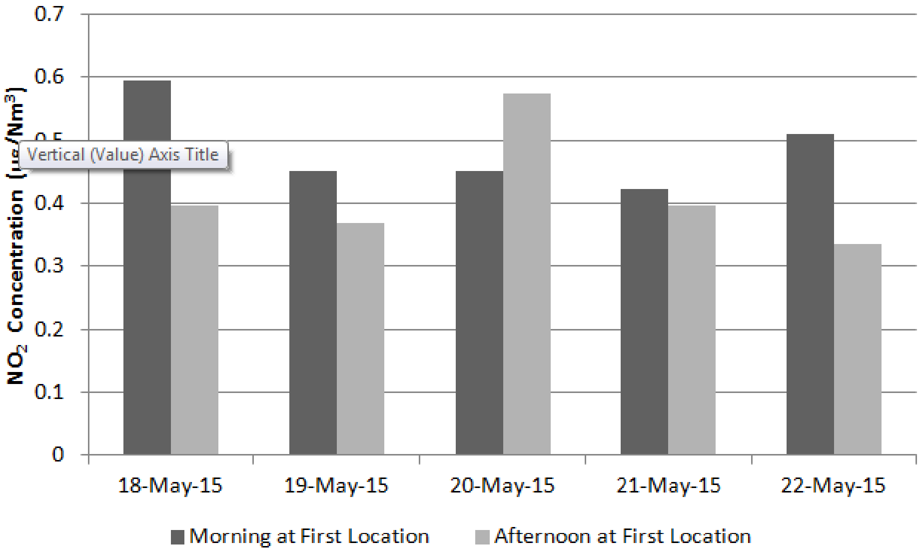

Figure 3 Experiment for NO_2 Concentration at First Point

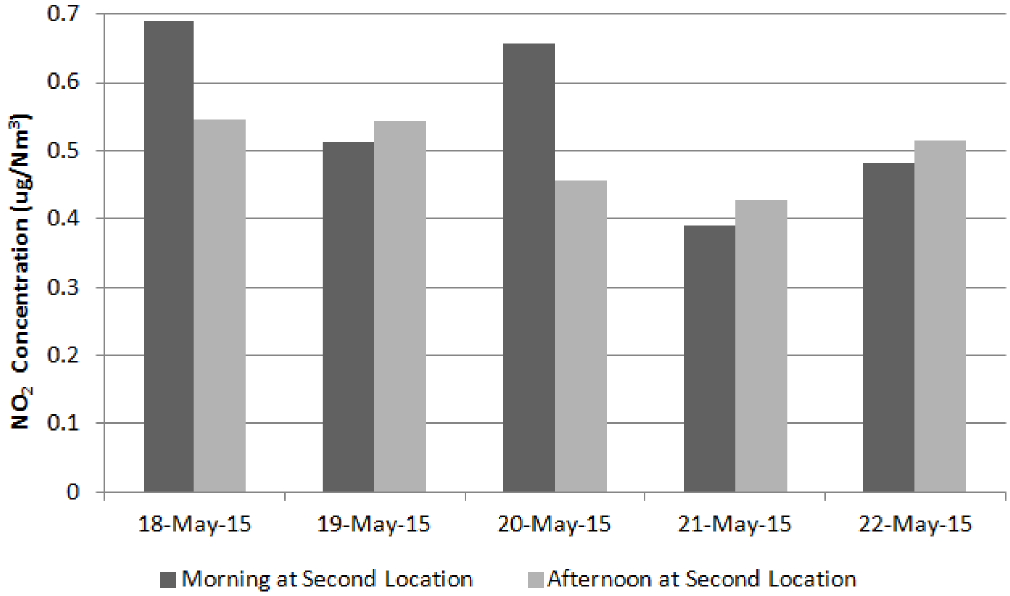

Figure 4 Experiment for NO_2 Concentration at Second Location

Figure 3 and 4 show that NO_2 concentration is very low (below 1 µg/Nm^3) and below the standard regulations (400 µg/Nm^3). At the First Location, NO_2 decreases from 0.48 µg/Nm^3 in the morning to 0.41 µg/Nm^3 in the afternoon. At the Second Location, NO_2 reduces from 0.55 µg/Nm^3 in the morning to 0.50 µg/Nm^3 in the afternoon.

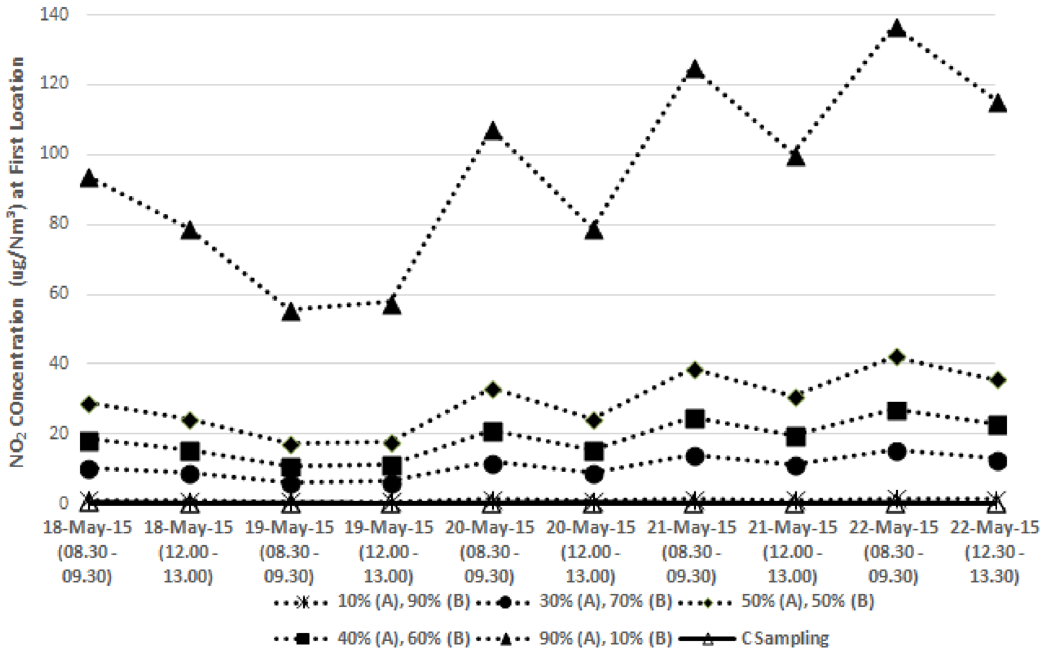

Figure 5 NO_2 concentration from experiment (solid line) and (dash line) at first location A=Stack, B=Cooking

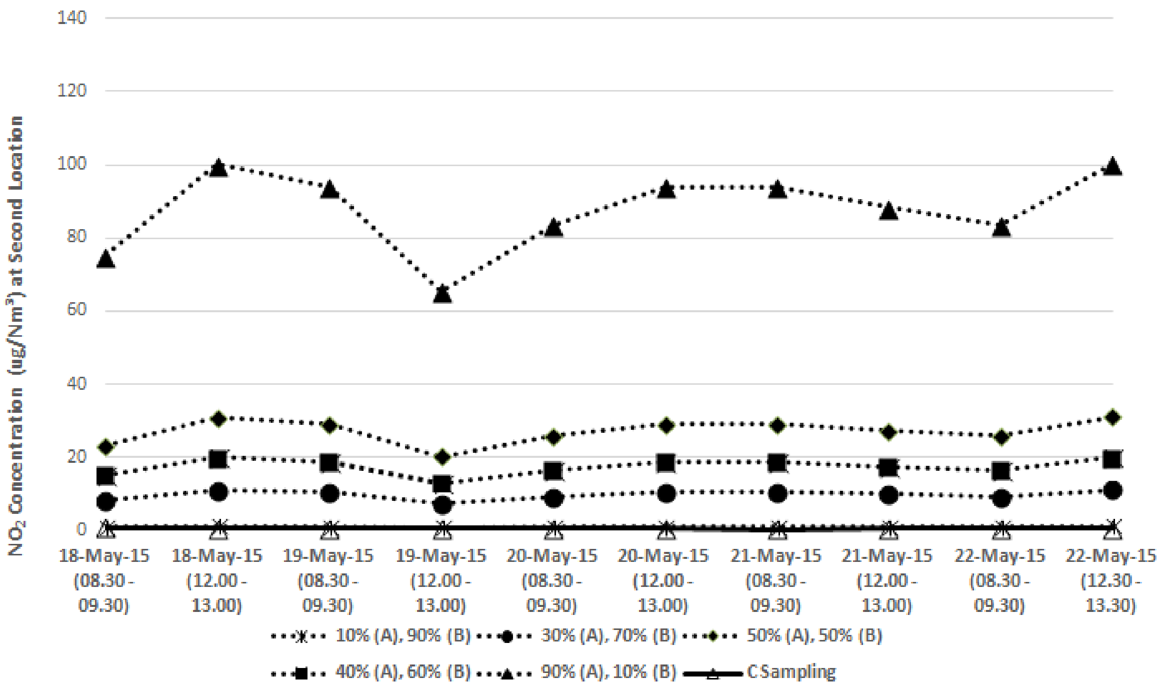

Figure 6 NO_2 concentration from experiment (solid line) and (dash line) at second location A=Stack B=Cooking

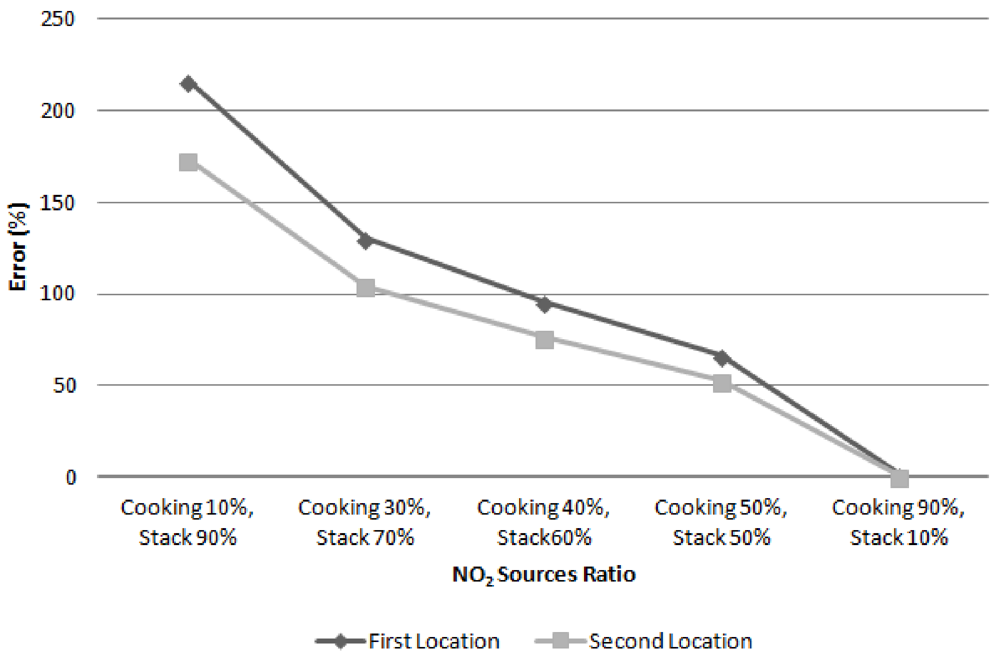

Figure 7 Error calculation of ratio variable

Figure 5 and 6 explain the ratio between 10% stack and 90% cooking in the experiment. The errors are below 10% and it is presented in Figure 7.

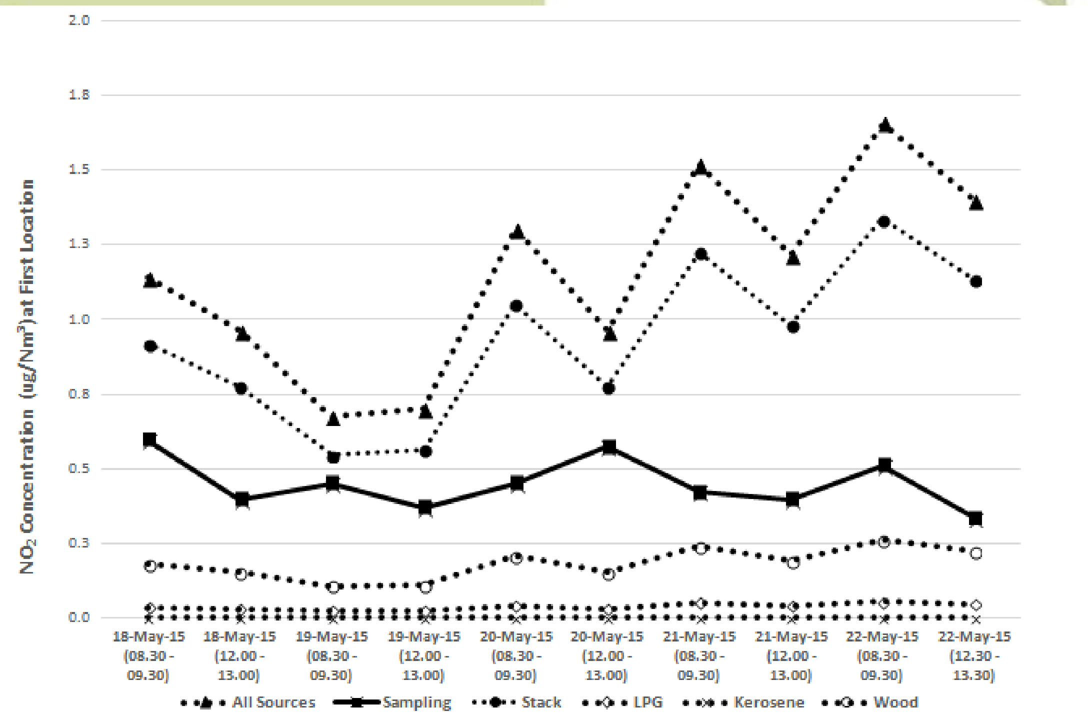

Figure 8 NO_2 sources from experiment (solid line) and model (dash line) at first location

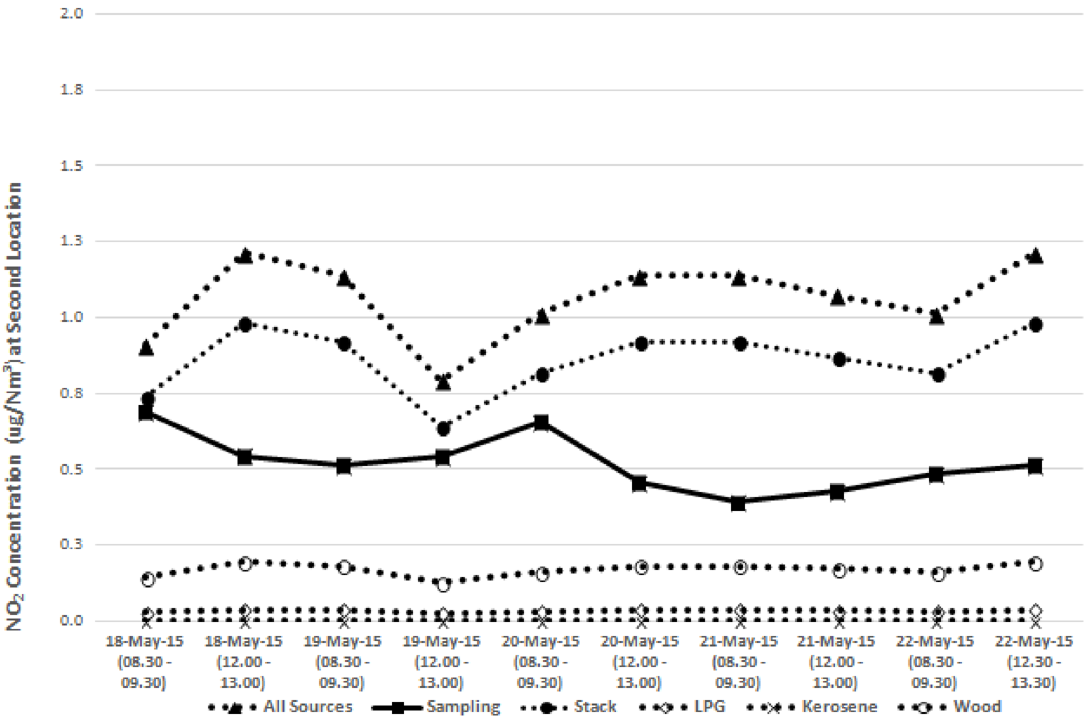

Figure 9 NO_2 sources from experiment (solid line) and (dash line) at second location

Based on the model, the two largest contributions of NO_2 sources are from Stack (average of 1.1 µg/Nm^3) and cooking with wood (average of 0.17 µg/Nm^3). The other sources come from LPG and kerosene.

4. CONCLUSIONS

Based on the results and discussion, this study concludes that:

a. The average concentration of Ambient Air Quality at the first point is 0.450 µg/Nm^3 and at the second point is 0.522 ug/Nm^3. It is below the Indonesian National Standard which is 400 µg/Nm^3.
b. The highest to the lowest NO_2 concentration is stack, wood, LPG, and kerosene.
c. The model calculates that NO_2 sources come from 10% stack and 90% cooking.

5. ACKNOWLEDGEMENT

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