Study on the alternative mitigation of cement dust spread by capturing the dust with fogging method

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Abstract. The existence of a cement plant impact the lives of people around the factory site. For example the air quality, which is polluted by dust. Cement plant has made various efforts to mitigate the generated dust, but there are still alot of dust fly inground either from the cement factory chimneys or transportation. The purpose of this study was to conduct a review of alternative mitigation of the spread of dust around the cement plant. This study uses research methods such as collecting secondary data which includes data of rain density, the average rains duration, wind speed and direction as well as data of dust intensity quality around PT. Semen Gresik (Persero) Tbk.Tuban plant. A soft Wind rose file is used To determine the wind direction propensity models. The impact on the spread of dust into the environment is determined using secondary data monitoring air quality. Results of the study is that the mitigation of dust around the cement plant is influenced by natural factors, such as the tendency of wind direction, rain fall and rainy days, and the rate of dust emission from the chimney. The alternative means proposed is an environmental friendly fogging dust catcher.

Keywords: dust cement, mitigation, fogging method

1. Introduction

According Fityatur (2015) where the cement plant impact on the live soft people around the factory site as public revenue and public health. Similarly, the existence of the activities of PT. Semen Gresik (Persero) Tbk. Tuban plant also caused some impact, both positive and negative. Some positive effects that create jobs; increase opportunities in the community such as the establishment of food stalls, grocery stores, boarding houses/rented, and others, to support the fulfillment of the daily needs of employees; as well as rising incomes as a result of subsequent/follow-up of work opportunities and increasing the business opportunity. On the other hand, the activities of PT. Semen Gresik (Persero) Tbk. The Tuban plant had a negative impact in the form of air pollution, especially dust. The emergence of dust from the production process can be dispersed into the environment around the plant site. In effect, then the environment will be exposed to dust. Exposure to dust is inhaled dust particles public both out doors and indoors. Exposure to this dust can interfere with the respiratory community outside the home. (Thaib et al, 2014). The purpose of this study was to determine the effect of the wind against the spread of dust and find alternative means of environmentally friendly dust catcher. One is a cement manufacturing technology with Dry Process. Lower operating cost sand greater production capacity required a major consideration using Dry Process Cement factory, but the negative impact is the emergence of dust which if not managed the nitwould be harmful to the environment. (Duda,1983).

According Dimitriou and Christidou (2011), air pollution is one of the important environmental issues that contribute to the effects of high temperatures that affect public health,
animal life, natural ecosystems and ma-made environment. Air pollution is also responsible for climate change, green house effect, acid rain, and others.

According Nurbiyantara (2010), exposure via inhalation of dust particles in the respiratory tract will cause a variety of lung function impairment. The dust particles will accumulate in the respiratory tract. According to the nature of chemistry, physics, and biology of the dust. According Naqpure (2014) termed TSP dust are defined as PM (Particulate Material) with aerodynamic diameter not more than 30 μm. Dust is one type of solid aerosols formed by a material separation process mechanically like the crushing, grinding and blasting. This process occurs because of the friction material with strong winds or shift to other materials. For example, cement dust (cement dust) and dust from the metal elements (metallurgical). Dust particles of solid material is regarded as finely divided with sizes ranging from 0.1 μm to 100 μm.

Dust particulate characteristics including size, size distribution, shape density, adhesiveness, corrosive properties, reactivity and toxicity. One of the most important characteristic of dust particle suspensions is particle-sizedistribution of aerosols. Generally, particles with a diameter of less than 2.5 μm is considered fine and larger particles 2.5 μm is considered rude (Suhariyono et al, 2003).

Control of dust emissions in the cement industry generally use mechanical collectors/collectors mechanical / dust collector, electrostatic precipitators, fabric filters, or a combination of such equipment (Kinsey, 1987). According Zimwara et al (2012), air pollution control technology that is Flexible Pulse Jet Filters, Electrostatic Precipitators, and Wet scrubbers. In wet scrubbers, the gas stream is polluted taken and contact with the liquid that is sprayed with a liquid,and the liquid will catch dust.

2. Methods
This research are : determining the trends in wind direction by collecting secondary data rainfall intensity, long average rainfall, and wind speed and direction in Tuban last few years. The data was then entered in to the file soft Wind Rose to know the trend of the wind direction and designing a dust catcher equipment fogging method.

3. Discussion

3.1. Determining the trends in wind direction

| Month       | Rainfall (mm/month) at Year | Average |
|-------------|---------------------------|---------|
| January     | 185.13 264 344 152 17    | 192.4260|
| February    | 107.79 219 161 187 45    | 143.9580|
| March       | 214.50 267 147 312 15    | 191.1000|
| April       | 205.25 0 232 170 36      | 128.6500|
| May         | 213.13 123 148 45 83     | 122.4260|
| June        | 20.54 61 52 86 -        | 54.8850 |
| July        | 21.88 0 93 117 -       | 57.9700 |
| August      | 0.67 0 - - -            | 8.8900  |
| September   | 9.29 0 - - -            | 4.6450  |
| October     | 47.04 77 16 - -        | 46.6800 |
| November    | 273.17 27 150 57 49    | 111.2340|
Table 2. The number of rainy days during the Year 2011-2015

| Month   | 2011 | 2012 | 2013 | 2014 | 2015 | Average |
|---------|------|------|------|------|------|---------|
| January | 15.79| 15   | 11   | 8    | 5    | 10.9580 |
| February| 8.54 | 12   | 7    | 6    | 12   | 9.1080  |
| March   | 12.83| 14   | 5    | 8    | 4    | 8.7660  |
| April   | 11.58| 0    | 11   | 5    | 9    | 7.3160  |
| May     | 9.88 | 4    | 12   | 3    | 2    | 6.1760  |
| June    | 1.50 | 2    | 9    | 4    | 0    | 3.3000  |
| July    | 1.75 | 0    | 7    | 3    | 0    | 2.3500  |
| August  | 0.08 | 0    | 0    | 1    | 0    | 0.2160  |
| September| 0.08 | 0    | 0    | 0    | 0    | 0.0160  |
| October | 0.92 | 3    | 1    | 0    | 0    | 0.9840  |
| November| 13.42| 2    | 11   | 2    | 2    | 6.0840  |
| December| 14.50| 9    | 18   | 13   | 7    | 12.3000 |
| Amount  | 90.87| 61   | 92   | 53   | 41   | 67.5740 |

Source: DPU Kabupaten Tuban (Bidang Pengairan) dalam Kabupaten Tuban dalam angka 2012-2016
Based on the picture above it can be seen that the highest number of rainy days in the month of December 2013 which is 18 days, so in about the month, the dust can not be spread with maximum because rain water is affected. While the number of rainy days was lowest in the few months in 2012-2015 with the number of rainy days 0 days of rain. In the months with the minimal number of rainy days it will contribute to increasing the deployment area of cement dust.

Table 3. Data monitoring wind speed and direction were done by. Semen Gresik (Persero) Tbk. Tuban at Some village in the district of Kerek, Tuban, East Java Province (2016)

| No | Measurement Locations (Village) | Measurement Time (Month) | Wind Speed (km/jam) | Wind Direction | No | Measurement Locations (Village) | Measurement Time (Month) | Wind Speed (km/jam) | Wind Direction |
|----|---------------------------------|--------------------------|---------------------|----------------|----|---------------------------------|--------------------------|---------------------|----------------|
| 1  | Temandang                       | 07-08March               | 0.90                | East           | 13 | Temandang                       | 01-02 August            | 0.60                | North          |
| 2  | Tlogowaru                       | 08-09March               | 0.70                | East           | 14 | Tlogowaru                       | 01-02 August            | 1.20                | West           |
| 3  | Kasiman                         | 11-12March               | 0.70                | West           | 15 | Kasiman                         | 02-03 August            | 1.00                | West           |
| 4  | Margomulyo                      | 14-15March               | 1.40                | East           | 16 | Margomulyo                      | 02-03 August            | 1.40                | North          |
| 5  | Sumberaram                      | 15-16March               | 1.30                | East           | 17 | Sumberaram                      | 03-04 August            | 1.10                | West           |
| 6  | Karanglo                        | 16-17March               | 1.30                | East           | 18 | Karanglo                        | 03-04 August            | 1.20                | West           |
| 7  | Temandang                       | 09-10May                 | 0.90                | West           | 19 | Kasiman                         | 20-21 Nov               | 1.30                | East           |
| 8  | Tlogowaru                       | 09-10May                 | 0.50                | South          | 20 | Sumberaram                      | 24-25 October           | 1.30                | West           |
| 9  | Kasiman                         | 11-12May                 | 1.10                | North          | 21 | Karanglo                        | 25-26 October           | 1.40                | North          |
| 10 | Margomulyo                      | 11-12May                 | 0.90                | North          | 22 | Margomulyo                      | 26-27 October           | 1.30                | East           |
| 11 | Sumberaram                      | 12-13May                 | 2.00                | South          | 23 | Temandang                       | 17-18 October           | 1.50                | East           |
| 12 | Karanglo                        | 12-13May                 | 1.00                | South          | 24 | Tlogowaru                       | 18-19 October           | 1.30                | East           |

Source: Laporan Pelaksanaan RKL-RPL FT. Semen Indonesia Semester I&II 2016, 2016

Figure 4. Wind rose on March-November 2016
(Source: data processing constituent, 2017)

In the picture above it can be seen that the dominant wind speed in the area of 0.5 to 2.1 m/s and the average wind speed is 1.16 m/s. The tendency of the wind direction is east. This means that the spread of dust tends to the east so that the area on the east side impact sources will be potentially affected by the spread of dust more than the territory in the other direction.

3.2 Designing tools dust catcher with fogging method

The spread of dust can be overcome by using a dust catcher fogging method is environmentally friendly appliance because it uses the mistatomized water demand will be less than with other methods, can catch cement particles whose size is very small and Clots/floc capture results of this appliance can be recycled. To determine the concentration of dust particles, base do the data results of sampling and substituted into the following equation: $C = \frac{(M_1 - M_0)}{(t.v)} [\mu g/m^3]$ .............. (1)

Information:

C : The concentration of dust particles measured
$(\mu g/m^3)$
M1 : Weight filter after dust measurements (pg)
$M_0$: Heavy dust filter before measurement (g)
$t$: Duration of measurement (hours)
$v$: velocity of volumetric air (m$^3$/h), in this study $v = 1.698$ m$^3$/h

Cement dust concentrations obtained in equation (1) to them odel equations Canter conversion to obtain cement dust concentration at the time of sampling/sample for 24 hours so in accordance with Government Regulation No. 41 of 1999. $C_1 = C_2 [(t_2/t_1) p]$ ........................................ (2)

Information:
$C_1$: The concentration of cement dust with long average sampling instance $t_1$ ($\mu$g/m$^3$)
$C_2$: an average dust concentration at the sampling time instance $t_2$ ($\mu$g/m$^3$)
$t_1$: The duration of sampling sample 1 (in this study = 24 hours)
$t_2$: The duration of sampling sample 2 (h)
p: conversion factor value between 0.17 to 0.2.
The $p$-value in equation (2) obtained from the Government Regulation No. 41 of 1999 with $C_1 = 150$ $\mu$g/m$^3$, $t_1 = 1$ day, $C_2 = 50$ g/m$^3$ and $t_2 = 365$ days in order to obtain the value of $p = 0.186$.
Factors temperature, humidity, and pressure greatly affect the air concentration including the Concentration of dust. Therefore the weather conditions recorded and accounted for in this study either temperature, humidity, wind direction, wind speed, and the season. (Suhariyono, 2003).
Equation (2) corrected for the effects of $T$, $P$, and RH normal to the following equation.
a. Normal wet air condition (≥50% RH): $C_{n,f} = C_B [T/T_N][P_N/P]$ ........................................ (3)
b. Normal dry air conditions (RH<50%): $C_{N,tr} = C_{N,f} [100/(100-F)]$............. (4)

Information:
$C_{N,f}$: The concentration of dust in normal conditions (µg/m$^3$)
$C_B$: The concentration of dust in the air in the normal condition at the measurement time = $C_1$ µg/m$^3$. $C_{N,tr}$ = concentration of dust in the dry air conditions (µg/m$^3$).
$T$ = temperature at the time of measurement (°K).
$T_N$= air temperature in normal conditions (°K) = 25°C = 298.15°K
$P_N$= The air pressure in normal conditions (Pa)= 760mmHg = 1Atm.
$P$ = absolute air pressure at the time of measurement (Pa).
$F$ = humidity at the time of measurement/TN][PN/P]

![Diagram](image_url)

**Figure 5.** The circuit schematic tool in fogging method
(Source: the author, 2016)
This research will use the variable of nozzle diameter ($D_n$) and distance between the sprayer toward the column ($L$).

4. Conclusion
The trend of wind direction identical with the trend towards the spread of dust which is to the east with average wind speed is 1.16 m/s. Found alternative means dust catcher with fogging method is more environmentally friendly.

5. Acknowledgments
I look forward to another opportunity to develop this research, namely by examining other variables to obtain optimal operating conditions for the dust catcher with the fogging method.

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