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Engineering of Cement Dust Catching Nozzle Diameter Optimization On the Tools Fogging Method

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Abstract. The research aim of this study was to perform the engineering optimization tool diameter nozzle at the cement dust catcher fogging method. The research background is the amount of cement dust was still flying around the location of a cement plant in Tuban. The distribution of very fine cement dust in size have a negative impact on public health. It is necessary to control the spread of the cement dust from chimney cement plant with the flow of exhaust gases. This research was conducted in the laboratory and simulation using cement dust extraction equipment fogging method. Variables that are optimized sprayer nozzle diameter, while the other parameters were made permanent. The research result is optimal operating conditions dust extraction equipment fogging method on a variable nozzle diameter is 1.40 mm in diameter with an average efficiency of 70.79%. The conclusion is in such operating conditions, a tool for cement dust fogging method can capture the fine cement dust optimally. This can reduce the spread of cement dust into the environment so as to improve air quality.

Keywords : Cement dust, Fogging method, Air quality

INTRODUCTION

The existence of a cement plant in Tuban area while contributing positively to the increase in people's income and revenue (PAD) Tuban, also had a negative impact especially air quality deterioration. The decline in air quality caused by the spread of cement dust emitted together with the exhaust through the chimney. According Thaib et al [1], exposure to cement dust can interfere with the respiratory community. The size of cement dust is so fine that it can be inhaled into the respiratory tract of humans and results in impaired lung function, lung disease chronic obstructive pulmonary disease restrictive lung, pneumoconiosis and carcinoma of the lung, stomach and colon. (Ather Sultan [2]). According Dimitriou and Christidou [3], 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 man-made environment. Air pollution is also responsible for climate change, greenhouse effect, acid rain, and others. According Otaru et al [4], cement dust control equipment used at the cement plant is the Electrostatic Precipitator (ESP) and Bag Filters (BF).

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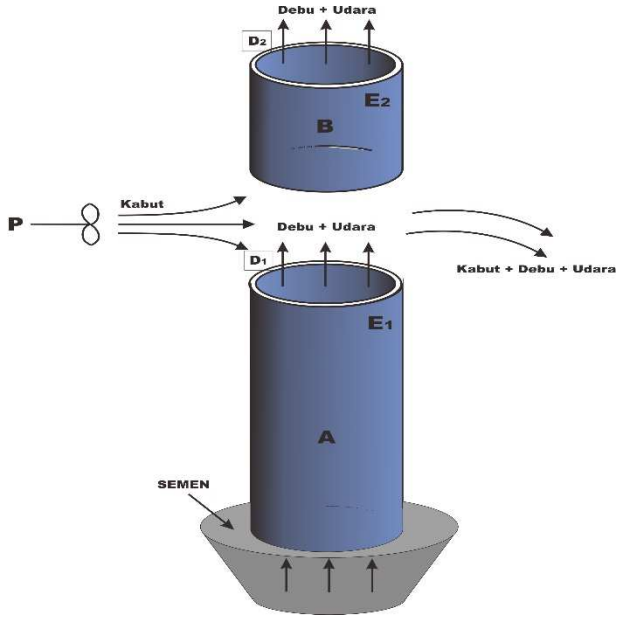
MATERIALS AND METHODS

- **Research sites :** The research location in Tuban, East Java province which is in the vicinity of the cement factory PT. Semen Indonesia, Tbk.
- **Material and equipment :** This study using materials and tools in the form of water, cement, nozzles, tubes, generating tools fog, and dust gauges. While the cement raw materials, namely sand, clay, shale, chalk, and limestone. To become the cement raw materials are taken, crushed and mixed with the correct chemical composition [3]. The optimization of operating conditions of equipment in the variable nozzle diameter
- **Equipment cement dust catcher fogging method :** In this study, the value of humidity, changes in air quality, and temperature is an influential factor in the formation of fog. Cement dust extraction equipment misting method can be seen in Figure 1st. Cement dust flow from the part bottom, and the cement will be flow upside . In the upside pipe, dust will be catch by fogging. Distance between the cement mass of before dan after through the fogging is dust that be catching the fogging.



Information:

A: Pipes A	E: exhauster
B: Pipe B	P : Tool kit
D: Dust Collector	

FIGURE 1. The circuit schematic tool on fogging method (Source: the author, 2018).

- **Dust catcher laboratory scale test :** Materials and tools cement dust catcher fogging method will be tested by a laboratory scale. As the independent variable is the nozzle diameter (Dn), while as a variable fixed at airspeeds in column (Vu = 430 m per min), the distances between the top end of the chimney with the gauge (Z = 100 cm). the distance between the sprayer with chimney simulator (L = 2.5 m), and the velocity of the water going into the sprayer (Va = 110 ml / min).
- **Data Analysis :** The granules are very small mist managed to capture very fine cement dust. Cement dust capture rate can be determined by ANOVA analysis with an error rate of less than 5% percent. The percentage reduction in dust emissions can be calculated as the level of efficiency that is as follows:

% Reduction (efficiency) = 100% - 100 x (avg. dust caught fog / avg.before fogging)

The efficiency is calculated based on the amount of cement dust captured by the mist. This shows the level of performance efficiency of the tool.

RESULTS

The working efficiency of cement dust extraction tool misting method can be calculated and shown in **TABLE 1** and **2**.

TABLE 1. Data dust before and after passing through the dust catcher tool fogging method with

No.	Nozzle diameter (mm)	The measurement sequence to	Cement dust mass (µg)	
			before misting	after misting
1	1.40	1	18,854	5,523
		2	18,899	5,520
		3	18,947	5,521
2	1.06	1	15,569	5,489
		2	15,760	5,477
		3	15,663	5,481
3	0.80	1	13,407	5,642
		2	12,847	5,658
		3	13,139	5,662
4	0.60	1	11,208	5,521
		2	11,469	5,533
		3	10,978	5,542
5	0.40	1	8,937	5,497
		2	8,673	5,497
		3	9,198	5,496

Sources: Primary data, in 2018

TABLE 2. The dust captured by the mist and dust extraction tool work efficiency method of misting with nozzle diameter (Dn)

No	Nozzle diameter (mm)	The measurement sequence to	Cement dust mass (µg)			Efficiency (%)
			before misting	after misting	Dust caught fog	
1	1.40	1	18,854	5,523	13,331	70.71
		2	18,899	5,520	13,379	70.79
		3	18,947	5,521	13,426	70.86
2	1.06	1	15,569	5,489	10,080	64.74
		2	15,760	5,477	10,283	65.25
		3	15,663	5,481	10,181	65.00
3	0.80	1	13,407	5,642	7,764	57.91
		2	12,847	5,658	7,190	55.96
		3	13,139	5,662	7,477	56.91
4	0.60	1	11,208	5,521	5,686	50.74
		2	11,469	5,533	5,936	51.76
		3	10,978	5,542	5,437	49.52
5	0,40	1	8,937	5,497	3,439	38.48
		2	8,673	5,497	3,176	36.62
		3	9,198	5,496	3,702	40.24

(Source: Data processing constituent, 2018)

TABLE 3. Relationship Diameter nozzle (Dn) with Dust caught in fog (CDust)

Diameter nozzle (Dn) (mm)	Dust caught in fog (C_{Dust}) ($\mu g/m^3$)
1.40	32.5111
1.06	24.7417
0.80	18.1699
0.60	13.8186
0.40	8.3571

(Source: Data processing constituent, 2018)

DISCUSSION

TABLE 1 shows the mass of cement dust before being captured by the mist with a mass of cement dust haze upon arrest. Based on these data are then calculated the mass of cement dust haze arrested shown in **TABLE 2**. The mass of cement dust that caught most on the nozzle diameter of 1.40 mm ranging from 13,426 to 13,331 µg, while the mass of cement dust that caught at least occur in the nozzle diameter of 0.40 mm ranged between 3,702 to 3,439 µg. If we use the nozzle diameter is better than 1.40 mm, the tools is not produce the fog but the drain of water and this condition is bad. So we need the produce shape of fog. Because the fog can catch cement dust. The order of the diameter of the nozzle to produce a fog that can capture cement dust is calculated from the amount of cement dust at most 1.40 mm; 1.06 mm; 0.8 mm; 0,6mm, and 0.4 mm. This is due to the nozzle diameter of 1.40 mm, the quality of the fog that formed already perfect and optimal amount.

If the fog is fully formed and the amount of fog is maximal then the fog will be able to capture cement dust with the optimal amount.

Analysis of the quality of the mist formed by the variable size of the nozzle diameter, namely:

1) 1.40 mm : which dispraykan shaped fog formed, its position fitted on air flow which carries dust so that it can optimally capture dust.
2) 1.06 mm : which dispraykan tangible haze is less than perfect it can not bind the perfect dust thus obtained weight difference is relatively small.
3) 0,80 mm : which dispraykan tangible haze is less than perfect it can not bind the perfect dust thus obtained weight difference is relatively small.
4) 0,60 mm : which dispraykan tangible haze is less than perfect it can not bind the perfect dust thus obtained weight difference is relatively small.
5) 0,40 mm : which dispraykan not fog because fog had not realized the dust catching very little power.

Based on this analysis, the best conditions for variable nozzle diameter occurs on the 5 kinds of 1.40 mm.

CONCLUSIONS

The optimum operating conditions in cement dust extraction tool method fogging occurs on the size of the nozzle diameter of 1.40 mm with an average efficiency of 70.79%. In such operating conditions, a tool for cement dust fogging method can capture the fine cement dust optimally. This can reduce the spread of cement dust into the environment so as to improve air quality.

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Cement dust extraction tool with fogging method is the latest innovation tool that can be developed environmentally-friendly well from the operation and equipment variables to obtain products of better efficiency.

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