Alternative Environmental Management in The Split Making Industry

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Abstract.

The purpose of this study is to carry out environmental management in the split-making industry, especially on the spread of dust. In the field of building construction, at the stage of casting activities, various construction materials are needed, such as cement, sand, water, iron, and splits. The existence of a split will further increase the strength of the cast. Therefore, splits are indispensable in the field of construction. The raw material for the split is andesite stone. In the split production process using a stone crusher called a stone crusher. In the operation of this stone crusher, the dust appears generated from andesite stone flakes which are being reduced in size to split. The dust will spread to the surrounding environment because it is carried away by the wind. This condition will cause a negative impact, namely a decrease in air quality. Therefore, steps/actions should be taken to minimize the spread of dust, namely by capturing the dust that comes out of the stone crusher tool carried by the exhaust gas flow. The equipment used in this research is a laboratory-scale using a fogging method dust catcher. The sprayer hole diameter is the independent variable, while the other quantities are the dependent variable. The research was conducted on the nozzle diameter as much as 5 quantities and carried out 3 replications for each quantity, then averaged the results. After the research was carried out, the data obtained from the research showed that the optimum condition for the mass of dust that was caught by the fog was the diameter of the sprayer hole 1, 45 mm with an average dust mass that can be caught by the fog is 14,068.33 µg and average efficiency value of 72.67%. The line equation which states the relationship between the variable sprayer hole diameter and the mass of dust caught by the fog is $Y = -14.722.X^3 - 782.86 X^2 + 4978.5X +6265.7$ with a percent error of 1.53%, while the line equation states the relationship between diameter nozzle with an efficiency value that is $Y = 0.1042X^3 - 5.3775X^2 + 28.608X + 30.564$ with an average percent error of 2.37%.

Keywords: Spread, control, stone crusher, dust, fog

I. INTRODUCTION

Indonesia as a developing country is carrying out development activities in all fields, one of which is in the field of infrastructure. It takes a lot of good buildings that function as office buildings, business space, and community housing. This physical infrastructure construction activity is important because it involves building safety and comfort. The strength of the building must be good so that the standing

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building must have good construction strength so that it has a maximum economic age of the building. One of the determinants of the strength of building construction is the casting activity. The composition of the material mixture for the complete cast and the quantity of each substituent construction material according to the rules, will greatly affect the strength of the construction that is formed. The mixture of construction materials needed is cement, sand, water, split, and iron. One of the efforts made by the government to meet the availability of material splits is that the government grants business licenses to business actors, in this case, the private sector, to contribute. After fulfilling all the regulations related to licensing, the private sector will establish a split-making industry.

II. LITERATURE REVIEW

The raw material for making split is andesite. The andesite stone, which was originally large and lumpy, was inserted into a stone crusher to reduce the size of the andesite stone. One of the efforts made by the government to meet the availability of material splits is that the government grants business licenses to business actors, in this case, the private sector, to contribute. After fulfilling all the regulations related to licensing, the private sector will establish a split-making industry. The raw material for making the split is andesite. The andesite stone, which was originally large and lumpy, was inserted into a stone crusher to reduce the size of the andesite stone. One of the efforts made by the government to meet the availability of material splits is that the government grants business licenses to business actors, in this case, the private sector, to contribute. After fulfilling all the regulations related to licensing, the private sector will establish a split-making industry. The raw material for making split is andesite. The andesite stone, which was originally large and lumpy, was inserted into a stone crusher to reduce the size of the andesite stone.

According to Fityatur (2015), the existence of this industry will bring positive and negative impacts. From this split production process, then dust arises that is blown by the wind as a carrier to the environment around the industrial site. If this condition occurs continuously, the scattered dust will be accumulative, that is, the amount of dust will increase over time, and one day the dust content in the air will exceed the standard quality threshold of 230 $\mu g / m^3$. As a result, there will be a decrease in air quality. Respiratory tract obstruction is one result of exposure to the dust. (Thaib et al (2014) . Air pollution will cause climate change, the greenhouse effect, acid rain, and others. Reviewed based on their physical properties, dust generated from split production is almost the same as dust generated in cement production. Both types of dust are all small, although the size of dust generated in cement production is smaller than in split production. Therefore, the tools used to control the spread of dust in the two production processes are almost the same.

According to Abishek and Ramachandran (2015), industries that have the potential to generate dust, such as the cement industry, have generated billions of tons of dust per year. This condition will certainly get worse if the emergence of this split-making industry is not well anticipated by entrepreneurs with various steps that can be taken to control dust so that dust emissions can decrease from year to year. Usually using high-efficiency cyclone / multi cyclones, fabric filters (FF), Electrostatic Precipitator (ESP), and various types of baghouses. In controlling the spread of cement dust, Otaru et al (2013) explained that cement factories usually use cement dust control equipment in the form of Electrostatic Precipitators (ESP) and Bag Filters (BF). However, according to Khattak, et al (2013), There are 5 types of particulate control engineering designs, namely gravity settling chamber, particulate wet scrubbers, mechanical collectors, electrostatic precipitators, and fabric filters. Therefore, these tools can also be used to control the spread of dust in the production of the split. However, to control the spread of dust in the production of the split, use a fog catcher method, and as a medium for capturing dust is fog.

III. RESEARCH METHODOLOGY

III.1. Research sites

This research is located in the Hargomulyo area, Kokap District, Kulon Progo Regency, DIY, which is a production location for making splits from andesite stone.

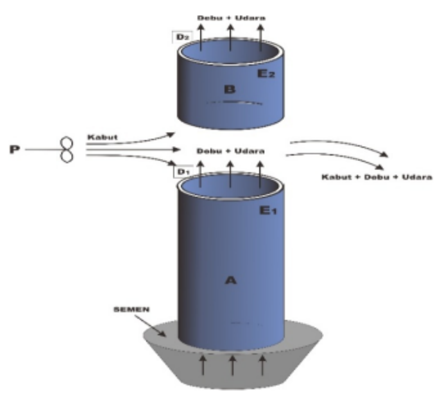
III.2. Material and equipment

This research uses tools and materials in the form of tubes, nozzles, fog generator, water, andesite rock dust, and dust gauges.

Optimizing equipment operating conditions on the variable sprayer hole diameter (Dn)

Fogging method dust capture equipment

Humidity, temperature, and changes in air quality are factors that influence the fog formation process. The fogging method dust capture equipment can be seen in Figure 1.



Information:
A: Pipes AE: exhauster
B: Pipe BP: Toolkit
D: Dust Collector

Figure 1. The circuit schematic tool on the fogging method
(Source: the author, 2020)

Dust catcher laboratory-scale test

The fogging method dust catcher and the material will be tested on a laboratory scale. The nozzle diameter on the sprayer (Dn) is an independent variable, while the dependent variable is the amount of dust caught by the fog. As a fixed variable, namely the velocity of the water going into the sprayer (Va = 110 ml/min), the distance between the sprayer and the tool (L = 2.00 m), the airspeed in the column (Vu = 430 m per min), and the distances between the top end of the chimney with the gauge (Z = 100 cm).

III.3. Data Analysis

Andesite rock dust which is very fine will be caught by the tiny grains of fog. ANOVA analysis with a percent error rate below 5% can be used to calculate the speed of dust capture. Efficiency shows the level of performance of the tool which is calculated based on the amount of dust trapped by the fog, namely the following:

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

Efficiency indicates the level of performance of these tools is calculated based on the amount of particle of dust arrested by the mist.

IV. FINDING AND DISCUSSION

The working efficiency of the dust catcher with the fogging method can be calculated and is shown in Tables 1 and 2.

Table 1. Dust Trapped by the Mist in the Fogging Method with a Variable Sprayer Nozzle Diameter (Dn)

No.	The diameter of the nozzle (mm)	The measurement sequence to	Dust mass (g) before misting	before misting
1	2.60	1	19,280.00	8,675.00
		2	19,420.00	8,960.00
		3	19,405.00	8,975.00
2	2.10	1	19,385.00	6,750.00
		2	19,350.00	6,890.00
		3	19,415.00	6,210.00
3	1.45	1	19,245.00	5,215.00
		2	19,450.00	5,375.00
		3	19,380.00	5,280.00
4	0,90	1	19,270.00	6,890.00
		2	19,520.00	6,910.00
		3	19,480.00	6,955.00
5	0,30	1	18,720.00	8,760.00
		2	18,675.00	8,850.00
		3	18,590.00	8,980.00

Source: Sports Data, 2020

Table 2. The dust mass average Caught by fog and working efficiency Dust Catcher Equipment fogging method average with Variable Diameter of the nozzle (Dn)

No.	Distance sprayer to the tool (m)	The measurement sequence to	The dust mass is caught fog (g)	The average mass of dust caught in the fog (g)	Efficiency (%)	Average efficiency (%)
1	2.60	1	10,605.00	10,498.33	55.01	
		2	10,460.00		53.86	54.21
		3	10,430.00		53.75	
2	2.10	1	12,635.00	12,766.67	65.18	
		2	12,460.00		64.39	65.86
		3	13,205.00		68.01	
3	1.45	1	14,030.00	14,068.33	72.90	
		2	14,075.00		72.37	72.67
		3	14,100.00		72.76	
4	0,90	1	12,380.00		64.24	
		2	12,610.00	12,505.00	64.60	64.38
		3	12,525.00		64.30	
5	0,30	1	9,960.00		53.21	
		2	9,825.00		52.61	
		3	9,610.00	9,798.33	51.69	52.50

Source: Sports Data, 2020

Based on experimental data from the variable nozzle diameter, a graph can be made to see the relationship between the effectiveness of dust capture by fog.

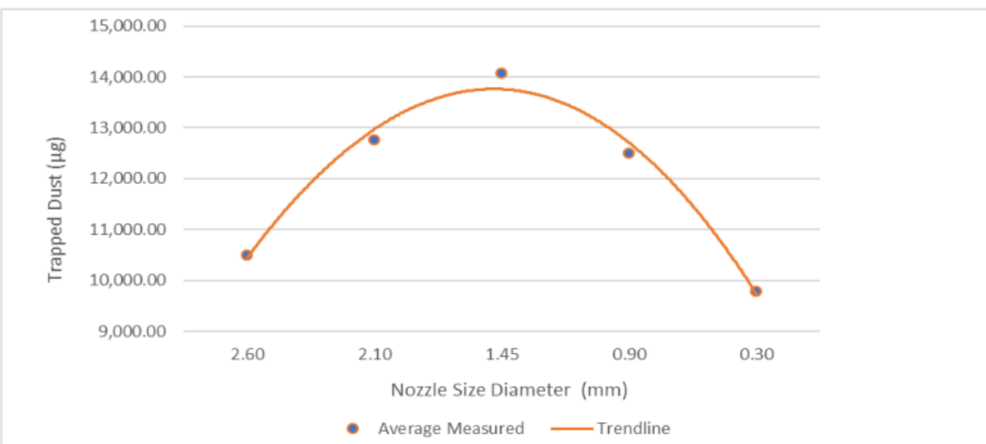


Figure 2. The relationship between the nozzle diameter on the sprayer and the dust material caught in the fog

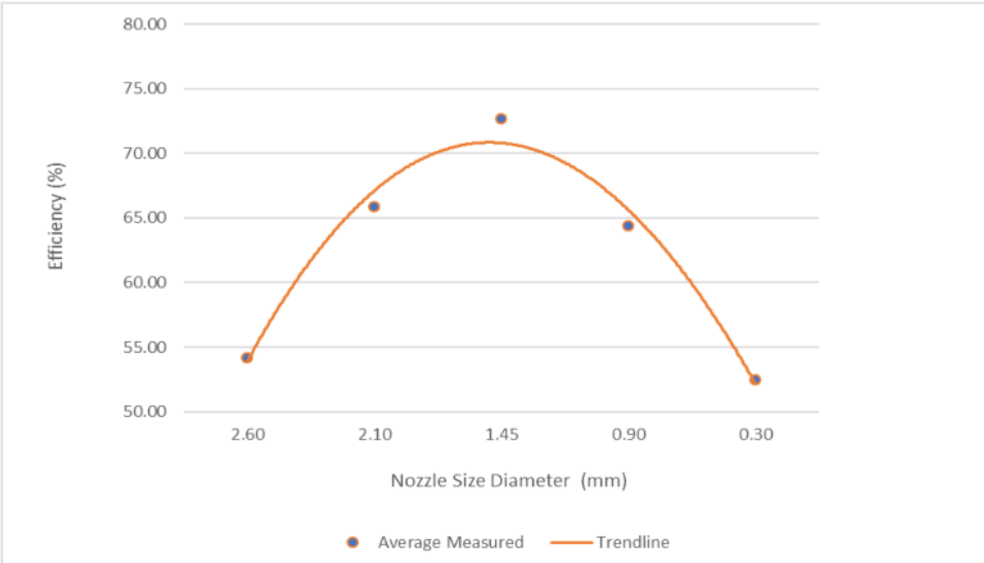


Figure 3. The relationship between the nozzle diameter and the efficiency of the fogging method dust catcher

Based on the graph above, it can be seen that the larger the diameter of the nozzle used in the sprayer, the greater the amount of dust caught by the mist. However, if the diameter of the nozzle is greater than 1.45 mm, the amount of dust caught by the fog will be smaller. This is because the larger the nozzle diameter, the greater the volume of fog required so that the amount of dust caught by the dust will also increase. However, if the nozzle diameter is more than 1.45 mm, it turns out that the amount of dust trapped by the fog is getting smaller because if the diameter of the nozzle is too large, the ejection power of the fog will be shorter so that only part of the fog can catch the dust. The optimal condition occurs at a nozzle diameter of 1.45 mm with an average mass of dust that can be caught by the fog, namely 14,068.33 µg. The optimal condition occurs at 1.45 mm nozzle diameter with an efficiency value of 72.67%.

While the analysis of the recommended mist quality related to the nozzle diameter variable is as follows:

1) 2.60 mm : The mist that is sprayed towards the dust is not entirely up to the dust so that the amount of dust caught by the fog will be less.
2) 2.10 mm : The mist that is sprayed towards the dust is not entirely up to the dust so that the amount of dust caught by the fog will be less.
3) 1.45 mm : which is assumed to be in the form of a perfectly formed fog, its position is right about the airflow carrying dust so that it can capture dust optimally.
4) 0.90 mm : which is assumed to be in the form of a mist that is less than perfect, it cannot bind the dust completely so that the difference in weight obtained is

relatively small.

5) 0.30 mm : What is suggested is not fog, because the fog has not yet been realized, the dust catching power is very little.

Based on this analysis, the best condition for the variable diameter of the nozzle 5 of these kinds occurs at 1.45 mm with the mass of dust caught by the fog is 14,068.33 µg and the average efficiency of 72,67%.

V. CONCLUSION AND FURTHER RESEARCH

The optimum operating conditions for the fogging method dust catcher occur at a nozzle diameter of 1.45 mm with an average mass of dust that can be caught by the fog, namely 14,068.33 µg and the average efficiency value is 72.67%. In these operating conditions, this fogging method of collecting dust can optimally capture fine dust to reduce dust spread to the environment and improve air quality. One of the latest innovations in the application of an environmentally friendly dust capture method is to use fog as a medium for capturing dust. This method is quite environmentally friendly and extensible.

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