Sapporo Medical Journal
Volume 54, Issue 09, September, 2020

BIOFILTER APPLICATION IN REDUCING TOTAL DUST PARTICLES IN THE AIR

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Abstract— Air is an environmental component needed for human survival. This means that the respiratory organs are constantly exposed to particles contained in the air, including harmful particles that interfere with health such as dust. As we know that the presence of dust in the industry. is something that is certain so that the dust must be controlled. On the other hand, the small scale industrial sawmill industry with thousands in number and spread in rural areas, this waste has not been utilized optimally. Sawdust can be used as a filter for air dust. The purpose of this study was to determine the effectiveness of various variations of wood sawdust in multiplex applications to reduce the level of Total Dust Particles. The type of research used is a quasi-experimental laboratory scale to be applied in the field. This study uses the Pretest-Posttest One Group design. Measurements were made using HVS with 24 study samples with 3 different thicknesses of 10 cm, 15 cm and 20 cm. The results showed a decrease in thickness of 10 cm by 2.31%, 15 cm by 4.01% and 20 cm by 9.08%. Statistical testing using the ANOVA test and obtained an alpha value of 0,000, it can be concluded that there is a relationship. Then it can be concluded that the most effective thickness is 20 cm.

Keywords: Dust, Thickness, Sawdust, Air

INTRODUCTION

Air is an environmental component needed for human survival. Every day the amount of air entering the respiratory tract is around 10 m3 per person. This means that the respiratory organs are constantly exposed to particles contained in the air, including harmful particles that interfere with health. Air quality is very influential on a person's health, especially in the respiratory system (Yunus, 2003).

Wood sawdust is produced from sawing processes, such as wood craftsmen that produce wood waste. The total production of Indonesian sawn timber reaches 2.6 million m3 per year, assuming that the amount of waste formed is 54.2% of total production, resulting in sawmill waste of 1.4 million m3 per year.

Based on data from *BPS* in 2006, the production of wood sawdust in Indonesia amounted to 679,247 m3 with a density of 600 kg / m3 obtained 407548.2 tons. The amount of wood sawdust waste originating from the sawmill industry is 15% which consists of 1.5% of the main unit powder, 13% of powder from the second unit and 0.5% of the trimmer unit.2 For large and integrated industries, sawn wood powder waste has already used for sale commercially.

Industry progress has a positive impact such as the opening of jobs and increasing socio-economic level of the community. But the industry's progress was accompanied by an increase in pollutants. Industrial development is a potential source of pollution that is detrimental to health and the environment. One of

the exposure materials that creates the risk of work is dust. The end result of industrial dust side effects depends on the type of dust that is inhaled and where dust is attached to the airway, it depends on the size of the dust particles, the structure of the airway and the breathing process itself (Kouppien, 2006). WHO defines dust as an aerosol consisting of particles that do not belong to living things. Dust acts as a cause of lung disease determined by the nature of dust itself, namely the size of dust, dust levels, fibrogenity dust and the level of dust exposure (Yunus, 1993). Another definition says dust is one of the pollutants that can interfere with work comfort. Dust can also cause respiratory problems for workers in the industry associated with dust in the production process. Dust is also often referred to as suspended particulate matter (SPM) with a size of 1 micron to 500 microns. Pollutants are materials that are in the air that can endanger human life (Amin, 1996).

The severity of the disease is determined by the amount of particles buried, the length of exposure time, and the average level of dust in the air. For workers, the work period and average dust levels in the work environment are taken into account. That level must really represent the level of dust that exposes the work environment as long as they work throughout the day. Sampling for 8 working hours or 1 shift, usually in work a worker moves around where the dust level is different (Yunus, 2003).

Previous research conducted by Denis Zulkan found that if dust levels exceed ambient quality standards in PP 41 of 1999 dust can affect lung function. Based on these studies, the authors are interested in analyzing the effectiveness of various variations of the thickness of deep sawdust to reduce Total Dust Particle level.Industrial dust contained in the air is divided into two, namely (Yulaekah, 2007):

1 Deposit particulate matter Dust particles that are only temporarily in the air. These particles immediately settle because of the earth's attraction.
2 Suspended particulate matter Dust particles that remain in the air and do not settle easily with a size of 1 micron to 100 microns.

LITERATURE REVIEW

Wood dust is produced as a result of sawing, shrinking and sanding processes which can cause the work environment to become airborne and dangerous for the workforce. To anticipate the negative effects of wood dust exposure in the workplace, prevention and protection of workers' safety and health needs to be done. One of the prevention efforts is to set the Threshold Value (*NAB*) of chemicals in the workplace air into the Indonesian National Standard (SNI) so that entrepreneurs can control the work environment of their company by referring to this Standard. This standard contains the Threshold Value of time-weighted average (TWA) chemicals in the workplace air, where there are workers who can be exposed to daily chemicals for no more than 8 hours per day or 40 hours per week , and ways to determine Threshold Values Limit mixture for workplace air containing more than one type of chemical (Yunus, 2006).

Particles in the inhaled air do not all reach the lungs, large particles in general are filtered in the nose. Particles with a size of 0.5 - 0.1 micron called sucked particles can reach the alveoli, these particles can settle in the alveoli and cause pneumolinosis (Yulaekah, 2007). Particulates are substances with a diameter of less than 10 microns. Based on the size of particulate particles divided into two, namely: a). Diameter less than 1 micron: aerosol and fume (smoke) and b). Diameter of more than 1 micron: dust and mists (liquid grains). The course of dust entering the respiratory tract is influenced by the size of the particle. The size of particulate dust that endangers health generally ranges from 0.1 micron to 10 microns.

The amount of exposure to dust is defined as a number of terms, namely total dust, respirable dust and cumulative dose of dust. Total dust is calculated using passive dust collectors. This total dust is less influential on health because the dust size is not specific. Inhaled dust levels are dust particles with an average aerodynamic diameter of 4 microns (0-100 microns), inhaled particulates are particles captured by a 10 mm diameter nylon cyclone filter with a speed of 1.7 liters / minute. Whereas cumulative dust levels are multiplications between inhaled dust levels and length of exposure (ACGIH, 1997).

METHODS

The type of research used is a quasi-experimental laboratory scale to be applied in the field. This study used a design before and after one group or Pretest-Posttest.

Research is planned to be conducted at a workshop in the Department of Environmental Health, Ministry of Health, Bandung. The preparation and implementation of the research was carried out for 8 months, namely in March-November 2018.

The object of the research is sawdust waste produced from the wood industry around Bandung Regency. The amount of sawdust needed in making is calculated based on the number of repetitions performed on each treatment. The number of treatments in this study were 3 treatments, namely:

1. Making sawdust biofilter with thickness of 10 cm.
2. Making sawdust biofilter 15 cm thick.
3. Making sawdust biofilter 20 cm thick.

Sampling of Total Suspended Particulate (TSP) in ambient air refers to the SNI 19-7119.3-2005 method using High Volume Air Sampler (HVAS), this tool sucks ambient air with a speed pump of 1.1 - 1.7 m^3 / minute , 0.1-10µ diameter dust particles will enter with the air flow through the filter and accumulate on the surface of the glass fiber, can be used for dust sampling for 24 hours, and if the dust particle content is very high then the measurement time can be reduced to 6-8 hours . The maximum level of Total Suspended Particulate (TSP) allowed in ambient air is 230 µ / Nm3 for 24-hour dust sampling based on PP No. 41 of 1999 concerning national ambient air quality standards.

Data is processed by univariate and bivariate. Univariate analysis to see the description of each variable studied. Bivariate analysis to see the effect of independent variables on each dependent variable. Univariate analysis with a percentage value and average value. Bivariate analysis using ANOVA test if the data is normally distributed or the Kruskal Walls test if the data is not normally distributed.

RESULT

The results of measurement of dust in the room using HVAS equipment according to the method of SNI Number 16-7-58-2004 with an average sampling range of 10 minutes and each treatment was taken 6 times. Based on the measurement results, the minimum value is 1.125 gr / m3 and the maximum value is 1.345 gr / m3. While for the treatment of 10 cm thickness the results obtained a minimum value of 0.942gr / m3, the maximum value of 0.968 gr / m3 and obtained an average dust reduction of 2.31%. In treatment 2 with a thickness of 15 cm, the minimum value was 0.958 gr / m3, the maximum value was 0.966 gr / m3 and the average dust reduction was 4.01%. In treatment 3 with a thickness of 20 cm, the

minimum value of 0.989 gr / m3 was obtained, the maximum value was 1,051 gr / m3 and the average dust reduction was 9.08%, the results are as follows (Table 1).

The percentage of effectiveness in reducing the dust content in the room is a test conducted to determine how effective sawdust is in eliminating the total dust content of the room.Based on the measurement results, the total amount of dust sucked by HVAS is 7.53 gr / m3, while in treatment 1 the total dust sucked by HVAS is 5.707 gr / m3 with a total decrease of 2.31%, then in treatment 2 It was found that the total dust sucked by HVAS was 8.618 gr / m3 with a total decrease of 4.01% and in treatment 2 the total dust sucked by HVAS was 6.078 gr / m3 with a total decrease of 9.08% (Figure 1).

The statistical test uses Anova because the data are normally distributed with a value of 0.708 at the pre and 0.059 on the Post. The homogeneity test also found that the sample was declared homogeneous with a value of 0.313 at the pre and 0.088 at the post. At the time of the Anova test the value of 0.911 was obtained on the pre so it can be concluded that there was no relationship, but the post value obtained a value of 0,000 so it can be concluded that there is a relationship between the use of filters to reduce dust in the room. The follow-up test, Post Hoc, obtained the value for treatment to 3 which is equal to 0,000, so it can be concluded that the most influential is treatment 3 with a thickness of 20 cm. (Table 2),

Sapporo Medical Journal
Volume 54, Issue 09, September, 2020

Table 1. Dust Measurement Results

Treatment	Minimum Value (gr/m^3)	Maximum Value (gr/m^3)	Average Decrease (%)
Control	1.125	1.345	-
Treatment 1 (10 cm)	0.942	0.968	2.31 %
Treatment 2 (15 cm)	0.958	0.966	4.01 %
Treatment 3 (20 cm)	0.989	1.051	9.08 %

Figure 1. Comparison Results of Filter Thickness

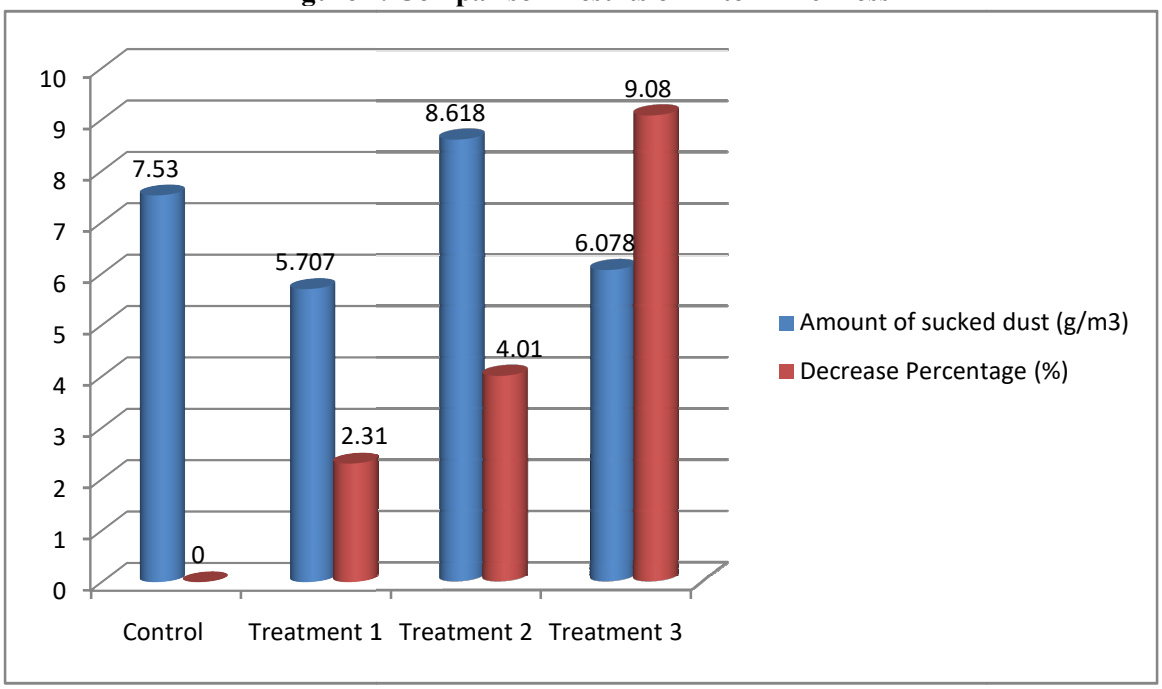

Table 2.Statistical Test Results

Treatment	Normality	Homogenity	Anova
Pre	0,708	0,313	0,911
Post	0,059	0,088	0,000

DISCUSSION

Rapid industrial development in Indonesia not only has a positive impact on state revenues and people's welfare, but also has a negative impact on health. This is due to the potential for environmental pollution caused by industrial activities, for example air pollution from smoke and dust from industry (Suhariyono, 2002). Data from the World Resource Institute (2006) states that Indonesia is ranked 14th in the world based on the absolute emissions value of 503 tons for CO2. This shows that pollutant emissions that occur in Indonesia are quite high (Niam et al., 2009). Air pollution means a decrease in air quality so that the air experiences a final deterioration in quality which cannot be used properly according to its function. The source of air pollution is divided into two, namely moving sources such as motorized vehicles and immovable sources such as industrial activities.

The use of wood powder must be done because wood waste still causes many problems in its handling, which are left to rot, stacked and burned, all of which cause negative impacts on the environment so that the countermeasures need to be considered. One way that can be taken is the use of an applicative product, one of which is a filter to filter dust and this tool can also be a simple model that can be applied in a place that produces a lot of dust in a room.

The results showed that in general the use of sawdust had a significant influence on all types of filter thickness used to filter dust in the room, besides that the use of media derived from sawdust as well as an effort to utilize waste is a useful thing. Wood powder itself has an effective ability to filter because it has a size of up to 850 microns so it is effective for filtering both dust and water. Due to the nature of dust, if the weight is too low, the dust will float in the air, so the use of this tool is very effective in reducing dust in a room. 15 cm can reduce up to 4.01% and at the thickest size of 20 cm can reduce dust to 9.08%. Because dust has hygroscopic properties where this dust can bind water containing chemicals in the air, then sawdust can also be a suitable material to absorb the chemicals contained in the dust. The chemical particles carried by dust can be reduced by sawdust that has been equipped with a suction blower, however there are several factors that affect the severity of the effects of dust exposure, namely the type of dust, exposure time, concentration of dust in the workplace around workers and the size of dust particles. In the search results for the best filters, it can be seen that thickness is one of the factors that influence the adsorption process and affects the ability to reduce dust concentration in the room.

Determination of reducing effectiveness in dust using teak sawdust, variations in thickness of 10, 15 and 20 cm were measured using HVS in a span of 15 minutes for each sample. The thickness of sawdust has a very significant effect on dust adsorption in the calculation room using the gravimetric method. The thickness of 20 cm can reduce dust as much as 9.08%. This treatment shows the highest adsorption results, when compared with other treatments.

CONCLUSION

1. Based on the results of the study, it was found that the reduction of dust for filters with a thickness of 10 cm was 2.31%
2. Based on the results of the study, it was found that the decrease in dust for filters with a thickness of 15 cm was 4.01%
3. Based on the results of the study, it was found that the reduction of dust for filters with a thickness of 20 cm was 9.08%
4. It can be concluded that the filter is the most effective in reducing dust with a thickness of 20 cm

RECOMMENDATION

1. Use other media to compare with sawdust media
2. An experiment is done outside the room

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