Air Quality in Wood-Based Small and Medium Enterprises in Selangor

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ABSTRACT

Wood-based Industries was known to generate various airborne pollutants such as wood and dust. This study was conducted to determine air quality in wood-based Small and Medium Enterprises (SMEs) in Malaysia. The determination of total dust and respirable dust was conducted based on National Institute of Occupational Safety and Health (NIOSH) 0500 and 0600. Study found that 38.1% (n=16) of the total dust exceed 5 mg/m³ in Schedule 1 of USECHH 2000. None of the respirable dust concentration exceeds 5 mg/m^3 of wood dust concentration by Schedule 1 of USECHH 2000 and OSHA but 4.8% (n = 2) had exceed 3mg/m^3 by ACGIH. In conclusion, dust and total volatile organic compound was found in wood-based SME where few total dust concentrations for both workplace environment level had exceeded 5mg/m^3 but none was seen for respirable dust concentration.

Keywords: *wood-based industries, volatile organic compound, respirable dust, total volatile organic compound, small medium enterprises*

INTRODUCTION

Over the years, studies have found the relationship between occupational exposures to respiratory diseases where during inhalation process, respiratory tract comes into contact with approximately 14000 liters of air during a normal working week which cause any part of respiratory tract from nose to alveoli can be adversely affected by exposure to airborne contaminant [1].

In industrial context, 6300 people die each day due to either occupational accidents or work-related diseases thus leading to 2.3 million deaths per years globally. Application of safety and health conditions at work are different between countries, economic sectors and social groups with developing countries taking particularly high numbers in deaths and injuries [2] in comparison to developed countries with well established safety and health management system.

In wood-based industries, wood dust was known to cause adverse health effect where based on a journal review, despite the limitations in study design and exposure assessment the study has supported that exposure to dry wood dust may cause asthma, asthma symptoms, coughing, bronchitis and acute and chronic impairment of lung function [3]. Therefore, this study was conducted to determine the air quality of wood-based small at medium enterprises (SMEs) in Selangor, Malaysia.

EXPERIMENTAL

Measurement of air quality was conducted in 14 wood-based small and medium enterprises (SMEs). Forty-two samples of total and respirable dust were collected workplace environment. Workplace measurement of total dust was based on NIOSH Method 0500 (Particulates Not Otherwise Regulated, Total). Measurement of total dust involved the use of sampling pump (Gilian Sensidyne) with flow rate of 1.3 L/min and 132 L of air was pumped through Polyvinyl Chloride (PVC) filter with pore size of 5 µm (National Institute for Occupational Safety and Health, 1994).

Respirable dust was measured by using NIOSH Method 0600 where sampling was done by collecting the respirable dust using air sampling pump (Gillian Sensidyne) equipped with Dorr- Oliver unit that meet NIOSH sampling requirements for 10mm nylon cyclone. The flow rate was set at 1.7 L/min and volume of air collected was 357L with 2 field blanks samples which were collected at each studied location. Mixed cellulose Ester (MCE) filters with pore sizes of 0.8µm was prepared to measure respirable particulate (< 10µm). The filters used were supported by 37mm filter cassette holder.

All filters were weighed before and after sampling using Microbalance (Sartorius) with sensitivity of 0.001mg [4]. Total of 3 consecutive samples were taken for each 42 sampling points and two field blanks was taken in each wood-based SMEs as control during for dust samples collected. Total of field blank collected were 24 samples. All sampling was conducted in production area in wood-based SMEs for total of 8-hours which is equivalent to a normal shift in the industry.

Relative humidity, carbon dioxide and temperature were measured by using EVM-7Quest Technologies where one or two measurements were taken at each wood-based SME while air flow was measure using Anemometer (Kestrel). EVM-7 is multiple parameter equipment capable of measuring various parameter such as carbon dioxide, relative humidity and temperature simultaneously. It contains various sensor for volatile organic compound and selected toxic gases as well as built-in impactor for gravimetric analysis of dust.

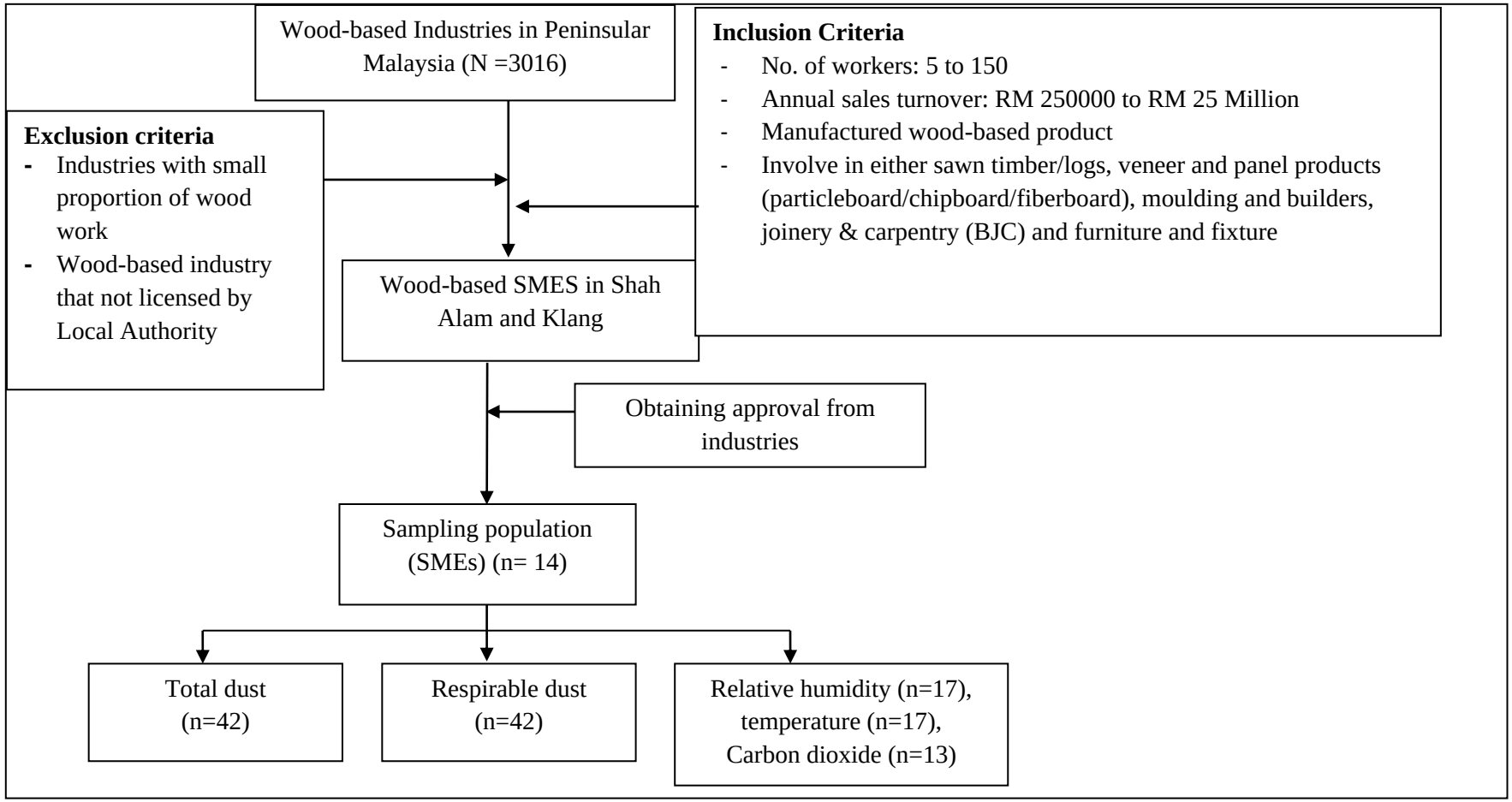

Figure 1 : Sampling frame

RESULTS AND DISCUSSION

Minimum concentration for workplace total dust was 0.705mg/m^3 while the maximum concentration of total dust was 7.72 mg/m^3 with mean and standard deviation of total dust was 4.469±1.712. This finding is contravened with previous study who found that wood dust level in wood processing plant was between 0.59 mg/m^3 to 16.2 mg/m^3[5].

Meanwhile, respirable dust in workplace environment has mean and standard deviation of 1.451±0.763 with minimum respirable dust concentration of 0.417 and maximum concentration of 3.608. This result similar with previous study who found that respirable dust concentration from sawing and sanding of medium density fiberboard (MDF) and softwood in typical cabinet making workshop generated respirable fraction (<10 μm) of dust were found ranging from 0.4 to 13 mg/m^3 for MDF and 0.4 to 2.9 mg/m^3 for softwood [6]. This finding shows that wood-based SMEs may produce less amount of total and respirable dust compare to bigger industries due to the smaller production activities.

Study has also found that, relative humidity for all 14 wood-based SMEs ranges between 45 to 65.9% with mean and standard deviation of 55.78±6.28. Temperature for the production area of these SMEs had respectively minimum and maximum of 27.1ºC and 33.2ºC with mean and standard deviation of 31.04±1.68. Air flow in the wood-based SMEs had mean and standard deviation of 0.22±0.0062 and ranges between 0.05 to 0.75 m/s while CO_2 had mean and standard deviation of 381.85±226.3 and ranges between 111 to 1023 ppm. (***Table 1***).

Table 1: Descriptive analysis of Air Quality Measurements

Parameter	N	Minimum	Maximum	Mean (SD)
Workplace total dust (mg/m^3)	42	0.705	7.720	4.469 (1.712)
Respirable dust (mg/m^3)	42	0.417	3.608	1.451 (0.763)
Relative humidity (%)	17	45	65.9	55.78 (6.28)
Temperature (ºC)	17	27.1	33.2	31.04 (1.68)
Air flow (m/s)	17	0.05	0.75	0.22 (0.062)
Carbon dioxide, CO_2 (ppm)	13	111	1023	381.85 (226.3)

Based on **Figure 1**, although 38.1% (n=16) of the sampling points had exceed 5 mg/m³ of wood dust (soft wood) concentration by Schedule 1 of USECHH 2000, none of the concentration exceed 15 mg/m^3 of OSHA and 10 mg/m^3 of ACGIH. The remaining 61.9% (n = 26) of the collected samples were found to have concentration between 0.705 mg/m^3 and 5 mg/m^3.

This finding is supported by previous study that found 16% of total 328 workers in wood industries were exposed to respirable wood dust at various levels higher than 5 mg/m^3[7]. This was seen in 79% of the workers who were exposed to respirable dust at concentration higher than 0.5 mg/m^3 of maximum admissible respirable wood dust level recommended by The Scientific Committee for Occupational Exposure Limits of Turkey. This called for better, control and preventive measures in protecting workers against wood dust.

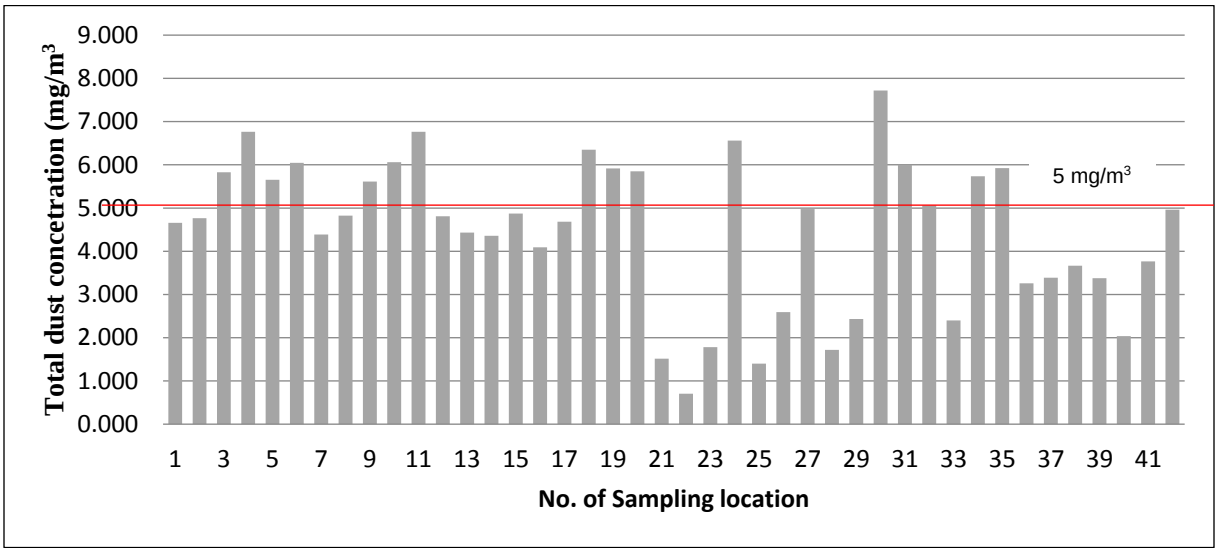

Figure 1: Total dust concentration in workplace environment of Wood-Based SMEs

Figure 2 shows the concentration of respirable dust in Wood-based SMEs. None of the respirable dust concentration exceeds 5 mg/m^3 of wood dust concentration by Schedule 1 of USECHH 2000 and OSHA but 4.8% (n = 2) had exceed 3mg/m^3 by ACGIH. 33.3% (n= 14) of the sampling points had respirable dust concentration were found to be below than 1 mg/m^3 while 61.9 % (n= 26) of the samples had respirable dust concentration between 1 mg/m^3 to 3 mg/m^3.

Study has found than respirable dust was found to be in lower concentration compare to total dust as total dust usually consist of different fractions of dust while respirable dust only consists of respirable fraction of dust. Moreover, respirable particles of wood dust were known to be generated less compare than other particles size where only 25% of air-borne wood dust particles have <10µm in size although size of particulate for wood dust found in rubber tree (*Hevea Brasiliensis*) furniture manufacturing industry varies between 0.56µm to 18µm [8].

Similar study had also found that size distribution of wood dust in a rubber wood sawmill in Thailand indicate high proportion of large size particle in which inhalable particles concentration was found to range between 0.2 to 59.4mg/m^3 compare to respirable particles 0.1 to 6.0 mg/m^3 [9].

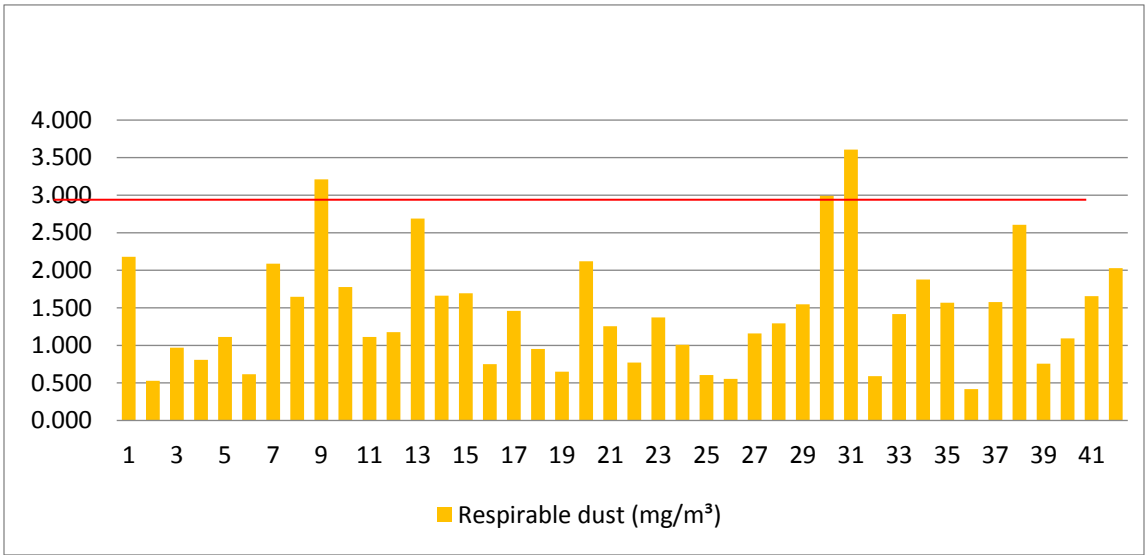

Figure 2: Respirable dust concentration in workplace environment of wood-based SMEs

Based on Table 2, it found that there is significant difference between mean of workplace respirable dust and wood dust where $p<0.001$. It also found that there is no significant difference between workplace total dust and wood dust where $p>0.05$ (95% CI: -1.064, 0.003) (***Table 2***). Previous study which involved personal long-term samples taken for total dust had found 2 out of 37 samples were greater than 5 mg/m^3 with total dust concentration ranging between 0.1 to 6.1 mg/m^3[10].

Table 2: Significance difference of workplace total dust and respirable dust to 5 mg/m^3 of wood dust

	Test value = 5					
	t	df	Sig. (2-Tailed)	Mean Difference	95% CI Lower	95% CI Upper
Workplace Total dust	-2.010	41	0.051	-0.531	-1.064	0.003
Workplace Respirable dust	-30.16	41	0.000	-3.549	-3.787	-3.311

*t-test

CONCLUSIONS

In conclusion, air contaminants such as dust was found in wood-based SME where few total dust concentrations for workplace environment had exceed 5mg/m^3 but none was seen for respirable dust concentration. Further study needs to be done to determine the effect of different particle size of wood dust to health effect among workers in wood-based SMEs. Relative humidity and temperature are the indicator for comfort, it also can relate to the poor ventilation of workplace environment in the wood-based small and medium enterprises. Poor ventilation will result accumulation of dust in the workplace environment and discomfort among workers due to increase in humidity and temperature.

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