

Respiratory Effects of Exposure to Respirable Dust at Paper Based Mill in Malaysia

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Abstract. Work environment factor such as air quality in industry become public concern recently especially due to issues related to respirable dust. Most of the workers from paper based industry were exposed to dust during on their daily work activities. A preliminary study and measurement was conducted at tissue mill and packaging area at one of the selected paper based mill in Malaysia to monitor the personal exposure of respirable dust. Series of a direct reading measurement for area sampling of respirable dust (PM₁₀) and questionnaires were administrated in purposed to determine the respiratory health symptoms. The result of the study showed most of the workers are exposed to respirable dust when the Time Weightage Average (TWA) result was above the permissible exposure limit which is 5 mg/m³ and 3 mg/m³ from Occupational Safety and Health Agency (OSHA) and American Conference of Governmental Industrial Hygienists (ACGIH) standard respectively. From the survey feedbacks several workers sometimes exposed with the symptoms but claims that it was happen with no noticeable trend they relief when they leave the workplace. For respiratory symptoms problem, seem like majority of workers never experienced a prolonged cough. However, for a better mankind in future, some engineering control and approach has been suggested to the safety and health team to control the machine that fully operated and consider contribute to the dust concentration. Lung function tests need to be done due to workers respiratory health status.

Keywords: Industrial hygiene, occupational safety and health, personal exposure, respirable dust, respiratory health symptoms

1. Introduction

Paper based industry's workers exposed to high concentrations of dust during on their daily work activities, especially respirable dust. The exposure is associated with increased respiratory symptoms and illness, and potentially, cardiopulmonary disease, mortality and morbidity. [1] However, in fabrication of paper product, starting from selection of raw material till the end of production dust was generated. Current study on the effects of particulate matter and dust exposures to the workers in industry had been conducted in many parts of worlds and variety of ages [2]-[5]. A numbers of researchers had published proves of significant epidemiological effects of respiratory symptoms towards wild land fire-fighters, cricket bat manufacturing workers, school children, rural and urban residential area that exposed to the particulates.

Most study concluded that the weather also plays roles in influencing the concentration of dust and particulate matters in atmosphere. The epidemiological evidence shows adverse effects of particles associated with both short-term and long-term exposures. Adverse health effects have been demonstrated at levels just above background concentrations which have been estimated at 3–5 µg/m³ in the United States and Western Europe for PM_{2.5} [6], [7]. Table 1 shows the selected number of occupational diseases by causal

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agent and target organ system cases reported to Malaysia Social Security Organization (SOCSO) for the year 2007, 2008 and 2009 [8]-[10].

Although this numbers is in general and comprise of miscellaneous types of industries, the main concerns would be the poor health status of workers were due to lack of awareness towards the causal agent of the diseases in their working environment and its target organ in human respiration systems.

Table 1. Selected occupational disease by causal agent and target organ respiratory system by SOCSO for the year 2007, 2008 and 2009.

Occupational Disease by Causal Agent	No. of Cases Reported		
	2007	2008	2009
Dusts	167	107	56
Gases, vapors, fumes	34	36	34
Liquids not elsewhere classified	133	118	74
Chemicals not elsewhere classified	94	57	56
Others - dusts, gases, liquids, chemicals	189	91	87
Occupational Disease by Target Organ Respiratory System	No. of Cases Reported		
	2007	2008	2009
Pneumoconioses caused by sclerogenic mineral	5	7	5
Bronchopulmonary diseases caused by hard metal	1	3	2
Bronchopulmonary diseases caused by cotton	0	1	1
Occupational asthma caused by sensitizing agents or irritant inherent to the work process	4	10	10
Extrinsic allergic alveolitis	0	2	2
Chronic obstructive pulmonary diseases	2	3	4
Diseases of lung, due to aluminium	0	2	17
Upper airways disorders	3	0	1
Any other respiratory diseases	9	21	11

Currently, there is still very limited study that discussed the effects of exposures of dust and particle matters in Malaysia's industry. Thus, this preliminary study was conducted in a tissue paper fabrication to get the basic experiences and fundamental knowledge on respirable dust issues and their effects to human. The purpose of this study is to monitor the concentration of personal exposure of paper based industrial worker to the respirable dust. Some qualitative feedbacks of workers health status was conducted through the questionnaire in relation of respiratory symptoms issue.

2. Methodology

This study was conducted during a typical eight hours working shift from 8.00 a.m. until 5.30 p.m. A walkthrough inspection and observation work process was done by a site visit and interviewing person in-charge and relevant personnel. The assessment was focused in the following work area which believe contribute to the respirable dust emission source are Tissue Mill (TM) and packaging area (KLU2) which are contain rewriter and converting proses. This is because these locations were generating dust due to tissue paper fabrication processes. Out of 15 workers at tissue paper fabrication, there are ten workers that direct handling with the machine and four workers in control room were selected as respondent. While in packaging area, 14 workers was selected. The workplace does not have any extractor but uses fan at certain area workstation by means of controlling dust. Based on visual inspection, this workplace seems highly exposed with the dust especially during the process and end of work shift whereby the workers blow the dust from machineries for cleanliness. The situation is getting 'snowy' during windy and rainy day. This is because the wind blows back the dust into the building from the existence window. In this study, there are three main measurements conducted in this study:

2.1. Personal Sampling Monitoring

This respirable dust personal exposure was carried out using sets of personal environment monitoring, which is contain of sampling pump, filter media, cassette and attach with 10 mm nylon cyclone. Selected workers by the management will brief and attached with personal sampling pump with no hesitate in helping them due to the stuff [11].

2.2. Area Sampling Monitoring

Area sampling particulate matters $10\mu\text{m}$ or less in diameter size (PM₁₀) was done by using a direct reading instrument (Dustrak). The instrument was located at several points of the selected processes area approximately 150 cm from the floor [12]. The measurements were done in four slot time from 8.00 a.m to 5.30 p.m with interval time were set to 15 minutes per sampling point.

2.3. Respiratory Health Symptom Survey

The questionnaires were then translate to Malay language by fluent speaker and try out with 2 to 4 native speakers. The questionnaires were translated back to its original language using certified translator. Set of questionnaire were drafted to seek information from workers in term of:

- Demographic background
- Basic information on current health status
- Persistence symptoms experiences by the respondent for past three (3) months
- Respiratory health symptoms

3. Result and Discussion

3.1. Personal Sampling Monitoring

Based on the data collected, it's showed that the highest concentration in TM was 21.51 mg/m^3 per Time Weighted Average (TWA) and the lowest concentration is 0.44 mg/m^3 . Meanwhile the highest concentration of respirable dust concentration in KLU2 was 63.08 mg/m^3 per TWA and the lowest was 2.29 mg/m^3 . In TM and KLU2 area, based on the result obtained in Figure 1 (a) and (b), shows that most of the workers are exposed to respirable dust when the TWA result was above the permissible exposure limit which is 5 mg/m^3 and 3 mg/m^3 from OSHA's and ACGIH standard respectively [13]-[14].

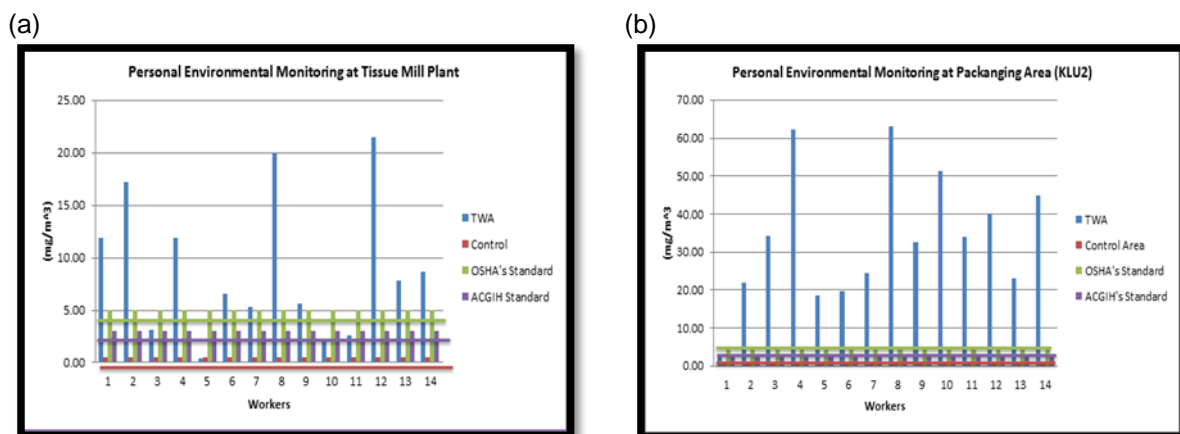


Fig. 1: Distribution of personal exposure of PM₁₀ concentration in (a) tissue mill (TM) and (b) packaging (KLU2)

However, between TM and KLU2 areas, the concentration of respirable dust for respondent at KLU2 is higher than TM. This is due to the main activities of each area. Even TM is the production line of tissue and always scattered with paper tissue dust, the higher concentration was found in KLU2.

3.2. Area Sampling Monitoring

The profile of PM₁₀ concentration levels of the selected sampling point is shown in Figure 2. The figure depicts the temporal distribution of PM₁₀ concentrations, where the concentration varied with four (4) slot time depending on the corresponding changes of daily work activities inside the plant. The profile for each

plant appears to be different from each other. Overall, the PM_{10} mass concentration distribution in the six sampling point in each three sampling area appear to be different from each other. In Figure 2 (a) and (b), there is a trend of respirable dust distribute high during morning and afternoon session. This resulted obtained due to the location of sampling point is near with the Tissue Mill Kitchen Reel and the motion of workers doing their daily work activities.

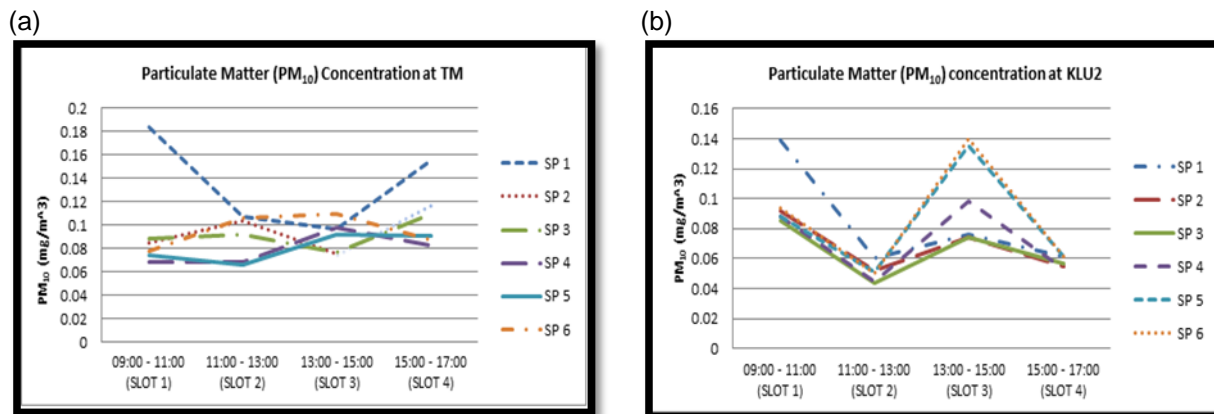


Fig. 2: Distribution of respirable dust PM_{10} concentration in (a) tissue mill (TM) and (b) packaging (KLU2)

3.3. Respiratory Health Survey

A total of eighteen [18] survey questionnaires were conducted for the workers at TM and KLU2 area respectively. With reference to the area distribution, there were nine (9) workers responded to the survey for both area. The age group of the workers is ranged between 31 to 40 years old (66.7%) in TM and 55.6% in range group of 21 to 30 years old in KLU2. Most of KLU2 workers have been working in the mill for more than 1 to 10 year (33.3%). While in TM, there were 33.3% of worker was served to the mill for 1 to 10 years and 20 to 30 years. The feedbacks received were deemed to be valid and representative since they have been repeatedly working at the same activities and mill for more than eight hours respectively.

In general, based on table 2, majority of the office staffs spent more than 30 hours in a week at their work station and was surrounded with dusty condition at working area. It was noted that majority of the workers were in healthy condition. Majority of the workers experienced the itchiness at eyes, nose throat during breathing in mill (66.7% for both mill). There is a possible risk that those respondents exposed to the dust and dry air. Several workers sometimes exposed with the symptoms but that claims that it was happen with no noticeable trend they relief when they leave the building for both TM and KLU2 workers. The symptoms were likely associated with prolonged working hours, respirable dust exposure and factor of sick building syndrome as most of the respondents were reported to get better when they were away from building.

4. Conclusion

As a conclusion, this study will give a better understanding regarding the association of respirable dust concentration with health symptom at the industrial area and consequences happen for exposure of air pollutants. The result that obtained is very significantly to be used as part of the characteristic in risk management process. To get a crystal clear procedure, the process flow of manufacturing production had to be understood and identified the source of emission of particulate matter (PM). There were several sizes of particulate matter (PM) especially respirable dust that will give adverse health impact to exposed personal.

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Table 2: Questionnaire analysis for health symptoms

Health Symptom	Yes, Always, caused by working environment (YAY) %	Yes, Sometimes, caused by working environment (YSY) %	Yes, Always, not caused by working environment (YAN) %	Yes, Sometime not caused by working environment (YSN) %	No, Never %	Mean	Mean Criteria
Headache	0	22.2	0	16.7	61.1	4.17	YSN
Feeling Heavy-headed	0	16.7	0	0	83.3	4.50	YSN
Fatigue/Lethargy	0	27.8	0	5.6	66.7	4.11	YSN
Drowsiness	11.1	16.7	0	27.8	44.4	3.78	YSN
Dizziness	0	5.6	0	5.6	88.9	4.78	No, Never
Nausea/Vomiting	0	5.6	0	0	94.4	4.83	No, Never
Cough	16.7	27.8	0	11.1	44.4	3.39	YSN
Irritated, stuffy nose	11.1	27.8	0	0	61.1	3.72	YSN
Hoarse, dry throat	22.2	33.3	0	5.6	38.9	3.06	YAN
Skin rash/itchiness	0	38.9	0	0	61.1	3.83	YSN
Irritation of eyes	0	0	0	0	100	5.00	No, Never
Scaling/itching scalp or ears	5.6	44.4	0	0	50	3.44	YSY
Over fatigues	0	5.6	0	0	94.4	6.78	No, Never
Headache	0	33.3	0	0	66.7	5.67	YSN
Focus Difficulty	16.7	0	0	11.1	72.2	6.22	YSN
Depression	0	11.1	0	0	88.9	6.56	No, Never
Feel uneasy in stomach	5.6	0	0	11.1	83.3	6.56	No, Never
Body Imbalance Problem	0	0	0	0	100	7.00	No, Never
Stress, nervous	16.7	33.3	0	0	50	4.78	YAN
Pain in finger or toe	0	0	0	0	100	7.00	No, Never
Sleep Disturbance	22.2	33.3	0	5.6	38.9	4.39	YAN

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