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ENVIRONMENTAL HEALTH RISK ASSESSMENT OF TOTAL SUSPENDED PARTICULATE EXPOSURE TO EMPLOYEE OF PT SEMEN PADANG

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Abstract: The cement industry has negatively impacts in air pollution that affect to the respiratory system. The aims of this study was to determine the level of environmental health risks through the risk analysis of Total Suspended Particulate (TSP) exposure to employee of PT Semen Padang, West Sumatra, Indonesia. This study uses environmental health risk analysis (EHRA) method that aims to calculate the level of risk received by a population due to environmental exposure. Research was conducted on December 28, 2015 until June 27, 2016. The number of sample were 32 respondents. The sampling technique used was accidental sampling. TSP concentration measurements by using the tool Staplex Model TFIA series High Volume Air Samplers (HVAS). The results based on the value of the intake lifetime exposure to TSP inhaled indicate that the area Coal mill and Cement mill on the employees in the Production Department II / III PT Semen Padang at risk of developing respiratory problems to the value of RQ > 1 and based on the value of the intake realtime exposure TSP inhaled were not at risk respiratory disorders with RQ <1. Based on the research value of the intake lifetime exposure by inhalation TSP indicates that the area Coal mill and Cement mill employees in the Production Department II / III PT Semen Padang at risk of developing respiratory problems due to exposure to TSP. Suggested to the company to immediately carry out control measures to reduce the risk of respiratory disorders in employees.

Keywords: total suspended particulate, exposure, environmental health risk assessment

Introduction

The cement industry is now one of the sectors that play a role in regional and state economic development. The positive impact of this industrial activity is contributing to job creation, economic growth, investment, and increase state revenues, and various other contributions both in the economic, political, and social. The negative impact is to cause air pollution inside or outside the work environment that affects the respiratory system.

One of the air pollutants that can cause health problems is rough or total suspended particulate (TSP) particles. TSP is a floating dust particle is a very complex mixture of various organic and inorganic compounds such as sulfate, nitrate, ammonia, sodium chloride, carbon, mineral dust, and water with compositions of various sizes. TSP is commonly used to describe the total particle concentration measuring ≤ 100 microns in air in a region (Lead, 1998).

According to WHO, a person exposed to TSP particulates may have acute respiratory infections (ARI), asthma, enfisema, lung cancer, cardiovascular disease, and chronic obstructive lung disease (WHO, 2010). Based on the results of epidemiological studies of PT Semen Padang is known that the area is a high level of exposure to dust that can cause lung disease and respiratory symptoms. Respiratory disease caused by TSP exposure is chronic obstructive pulmonary disease (COPD), one of the lung diseases caused by exposure to cement dust and respiratory infection (Devita, 2015; K3LH (2015).

Based on data obtained health effects resulting from exposure to TSP has been experienced by many employees of the production department. TSP exposure plays a role in the increased risk of respiratory and lung diseases in workers (Mangunnegoro and Yunus, 1992).

The results of epidemiological research on pulmonary function disorder and the factors that influence on the employees of PT Semen Tonasa Pangkep South Sulawesi showed the level of cement dust in the packing 18.47 mg / m^3, raw mill 1.63 mg / m^3, limestone cruser 14.98 Mg / m^3, mine 20,23 mg / m^3, kiln 4.56 mg / m^3, and cement mill 5,98 mg / m^3. The results of pulmonary function examination on PT.Semen Tonasa employees showed the average lung function capacity of respondents 88.22% FEV1 / FVC with standard deviation of 12.174 (Mengkidi, 2006).

TSP in the Cement Industry contains many ingredients such as tricalcium silicate, dicalcium silicate, some alumina, tricalcium aluminate, iron oxide and a small amount of hexavalent chromium (Mwaiselage et al, 2005). In addition to the cement industry many silicone, ferro and lead particles . These different circumstances also provide different toxicological properties and levels that provide different health risks to the human body (Zeleke et al, 2010).

Based on this background, the researcher encouraged to conduct research related to the level of environmental health risk of TSP exposure to the employees of Production Department II / III PT Semen Padang. The results of this study are not only useful in risk control, but also can be used as a scientific framework in decision making and Policies to address health and environmental issues.

Methodology

This research is a quantitative research in the form of descriptive method of environmental health risk analysis (EHRA) which aims to calculate the level of risk received by a population due to the exposure of TSP in the environment. This study was conducted on December 28, 2015 until June 27, 2016, with a total sample of 32 respondents. Sampling technique is accidental sampling. Anthropometric data collection and activity pattern by interview using questionnaire and TSP concentration measurement using Staplex Model TFIA series High Volume Air Samplers (HVAS).

Some of the procedures involved include hazard identification and risk sources, dose-response analysis, exposure assessment, and risk characterization. The risk level is expressed in the Risk Quotion (RQ) expressed as the ratio between the value of the intake and the reference dose (RfC). Intake is the amount of inhaled concentration per kilogram of body weight, while RfC is an approximate daily exposure dose that has no health effects in lifetime exposure. A situation is considered risky and management of control is required if RQ> 1.

Result

TSP Concentration in Environment

Table 1: Shows TSP Concentration in Air Environment of Production Department II/III PT Semen Padang

No	Location	Distance	Time	Lenght of Measurement	consentration
1	*Raw mill*	15 m	09.30-15.30	6 hour	11.9 mg/m^3
2	*Coal mill*	15 m	08.43-15.43	7 hour	30.6 mg/m^3
3	*Kiln*	15 m	09.00-16.00	7 hour	20.4 mg/m^3
4	*Cement mill*	15 m	09.00-16.00	7 hour	40.8 mg/m^3

Table 2: Shows Temperature and Humidity in Air Environment of Production Department II/III PT Semen Padang

No	Area	Temperature (ºC)	RH (Relative Humudity) (%)
1	*Raw mill*	32.05	66.3
2	*Coal mill*	3.4	67
3	*Kiln*	28.8	78.4
4	*Cement mill*	29.5	75.2

Anthropometric Characteristics and Activity Patterns

Table 3: Shows Anthropometric characteristics and Activity Patterns Respondents

No	Element	Mean	Median	Mode	Min	Max	SD
1	Body Weight (w) (Kg)	66,22	64	78	47	88	11,22
2	Lenght of Exposure (t_E) (hour/day)	8	8	8	8	8	0,00
3	Frequency of Exposure (f_E) (day/year)	270	270	270	270	270	0,00
4	Duration of Exposure (D_t) (year)	7,47	5	3	2	35	7,32

Exposure Assessment

Table 4: Shows Lifetime and Realtime Intake of TSP Exposure to Employees of Production Department II/III PT Semen Padang

No	Point of Sample	*Lifetime Intake*	*Realtime Intake*
1	*Raw mill*	0.88 mg/Kg/day	0,22 mg/Kg/day
2	*Coal mill*	2.27 mg/Kg/day	0.56 mg/Kg/day
3	*Kiln*	1.52 mg/Kg/day	0.37 mg/Kg/day
4	*Cement mill*	3.03 mg/Kg/day	0.7 mg/Kg/day

Dose-Response Analysis

The reference dose (RfC) is a dose of a risk agent that is used as a reference for the body's safe value on non-carcinogenic effects. To know the RfC of a risk agent can be seen in the US-EPA Integrated Risk Information System (IRIS) of 2.42 mg / Kg / day (Ministry of Health of RI, 2012).

Risk Characterization

Table 5: Shows Values of Risk Quotient (RQ) for Lifetime and Realtime Intake

Point of Sample	*Lifetime*			*Realtime*		
	Intake life time	RQ	Risk	*Intake real time*	RQ	Risk
Raw mill	0.88	0.36	Not Risk	0.22	0.09	Not Risk
Coal mill	2.27	1.00	Risk	0.56	0.23	Not Risk
Kiln	1.52	0.62	Not Risk	0.37	0.15	Not Risk
Cement mill	3.03	1.25	Risk	0.70	0.30	Not Risk

Discussion

Based on the measurement of TSP air emission concentration conducted by researchers in four areas of Production Department II / III PT Semen Padang, the value of TSP concentration of Row mill area is 11,9 mg / m^3, Coal mill 30,6 mg / m^3, Kiln Of 20.4 mg / m^3, and Cement mill of 40.8 mg / m^3. The data showed that the largest concentration of TSP was in the Cement mill area of 40.8 mg / m^3 and the smallest in the Raw Mill area of 11.9 mg / m^3, the concentration value passed the inhalation particulate threshold value for the employees based on the Minister of Labor Regulation Work and Transmigration Number PER.13 / MEN / X / 2011 of 2011

on threshold value of physics factor and chemical factor is 10 mg / m^3 (Minister of Manpower and Transmigration of the Republic of Indonesia, 2011).

Based on research conducted by Mengkidi in Semen Tonasa Industry also stated that the content of cement dust in packing part 18,47 mg / m^3, raw mill 1,63 mg / m^3, limestone cruser 14,98 mg / m^3, mine 20,23 mg / m^3, kiln 4.56 mg / m^3, and cement mill 5.98 mg / m^3 causing lung function disorder in the worker (Mengkidi, 2006). Looking at the level of production capacity of the Semen Padang plant on a daily basis the value of TSP concentration dispersed in air Which is inhaled by the employee while working in the area will affect the respiratory system. Based on research conducted by Huang stating that cement dust causes respiratory distress symptoms in cement workers (Huang et al, 1996). Another study conducted by Zeleke in cement industry also stated that exposure to cement dust caused respiratory problems in cement workers (Zaleke et al, 2006).

The results of temperature and humidity measurements in four areas of Production Department II / III PT Semen Padang, obtained temperature results in four areas exceeds the requirements issued by the minister of health in the attachment of Decree of the Minister of Health of the Republic of Indonesia No. 1405 / Menkes / SK / XI / 2002 on environmental health requirements of office and industrial offices for temperatures not exceeding 28°C and 60% humidity (Ministry of Health of the Republic of Indonesia, 2002). Decree of the Minister of Health of the Republic of Indonesia No. 1405 / Menkes / SK / XI / 2002 on Health (Ministry of Health of the Republic of Indonesia, 2002). In areas with hot and slightly humid temperatures particulate levels of TSP will be dispersed in air.

Based on the results of a survey of employees working at the Department of Production II / III PT Semen Padang, obtained an adult body weight range of 47 to 88 kg and an average of 66 kg. Average weight is greater than the standard weight of Indonesian adults is 55 Kg (Rahman, 2007). So that the smaller the weight the received intake will be greater because the weight serves as a denominator. Weight is an important anthropometry variable that is greatly influenced by the actual dose of an individual acceptable risk agent. The greater the individual body weight the smaller the internal dose received (Nukman et al, 2005).

Based on the results of the survey on the employees who work in the Department of Production II / III PT Semen Padang, the length of work daily employees are divided according to shift ie 3 shifts in 24 hours, the first shift at 07.00 - 15.00, the second shift 15.00 - 22.00, the third shift 22.00 - 07.00. The length of employment of employees of PT Semen Padang refers to the Decree of the Minister of Manpower no. 13 year 2003 on Employment Article 77 paragraph 2, ie each worker has a working time of 8 hours per day with a total time of 40 hours per week (Law of the Republic of Indonesia, 2003). So the data obtained average daily exposure for 8 hours / day and the average value The frequency of individual exposure in a year for 270 days / year without a holiday on the red date, in the sense that employees continue to work even on national holidays (PT Semen Padang, 2015).

Based on the results of a survey of employees working in the Department of Production II / III PT Semen Padang, the duration of realtime exposure that has been received by individuals from the largest employment period of 35 years and the smallest for 2 years. From the data, the duration of exposure 35 years actually has passed the exposure of non-carcinogen lifetime duration is 30 years, whereas at 35 years of exposure can be expected someone has had pernyakit on him. However, it is necessary to undertake an advanced epidemiological study to see the magnitude of respiratory disorders in employees who work over 30 years.

Based on the description of the anthropometric data and the activity pattern, it can be concluded that the average body weight (wb) of the employee is 66 kg, daily exposure time (tE) is 8 hours / day, the average exposure frequency (fE) is 270 days / Year and the duration of exposure (Dt) realtime is 7.47 years. So it can be concluded that the duration of work of employees working in the research area can cause respiratory disruption, because employees exposed to TSP particulates every day in a long time. This is in line with research conducted by Mengkidi in 2006 there is a working relationship with lung function disorder (Mengkidi, 2006).

Based on the results of the determination of exposure assessment conducted by incorporating the anthropometric characteristic values and activity patterns into a formula expressed as intake, so that the highest intake lifetime and real time values can be found in the Cement Mill area and the lowest in Kiln. This higher intake value can make the area more risky than other areas. So it can be assumed that respondents who have high intake value will be easier to be exposed to health problems related to risk agent exposure. Meanwhile, based on the calculation of the value of intake and risk, the areas that are still assumed to be safe are Raw mill and Kiln areas.

However, this intake is not necessarily the same as the intake received by the actual individual. Intakes received may be smaller or larger. This is because the measurement of TSP concentration is not done personally using personal dust sampler (PDS), because measurements with PDS can more represent the concentration level that is inhaled each time based on individual activity pattern respectively. While emission air measurements only show a concentration picture in suatau area that can change at any time. The risk level (RQ) value was calculated based on the duration of the lifetime and realtime exposure with RfC value of 2.42 mg / Kg / day obtained from IRIS US-EPA data.

Based on the description of health effects resulting from exposure to TSP has been experienced by many employees of production. TSP exposure plays a role in the increased risk of respiratory and lung disease diseases in workers. This is in line with the results of the epdemiological research of the PTSP production plant is known that the area is a high level of dust exposure that can cause lung disease and respiratory symptoms.

The risk control that can be done to reduce the particulate concentration of TSP in air emissions can be done with some controls, first by installing air filtering devices on pollutant sources in the factory area, secondly reducing the concentration can also be done by reducing the daily capacity of the production capacities. However, the large reduction of production capacity is very difficult because it is related to the management of the industry itself.

Daily and annual exposure time of respondents is not possible to reduce because this work schedule of employees of PT Semen Padang refers to the Decree of Minister of Manpower no. 13 of 2003 on Employment Article 77 paragraph 2, ie each worker has 8 hours of work per day with a total time of 40 hours per week (Law of the Republic of Indonesia, 2003).

Conclusion

The calculation of the lifetime risk quotion (30 years) obtained from the comparison between intake and RfC values indicates the area of Coal mill and Cement mill at risk of respiratory disturbance with RQ> 1 and the calculation of realtime risk obtained from TSP exposure is assumed safe with RQ <1.

It is suggested to PT Semen Padang to install a high efficiency TSP particulate filter device on each production machine, monitoring and maintaining existing filtering tools regularly so that the filtration system can run well and control the particulate emission at predefined standard , And the management of temperature and humidity in the production plant room. It is advisable to employees to be more concerned about the health of themselves from the dangers of exposure to TSP in the workplace by getting used to wearing masks while working at a cement plant.

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