DOI Number: 10.5958/0976-5506.2018.00748.9

Analysis of Environmental Health Risks Resulting from Exposure to Pollution Materials

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ABSTRACT

Analysis of Environmental Health Risks is an approach to calculate or predict the risks to human health, including factors identify of uncertainty, tracking on specific exposures, consider the inherent characteristics to the concern agent and characteristics of the specific target. The research was descriptive study by risk agent which were SO2, H2S, NO2, PM2.5 and PM10. The research was conducted in five zones Purwodadi sugar factory area at Magetan. Variables in the study were the identification of hazards, exposure analysis, the level of risk (RQ), and environmental health risk management. Data analysis technique used was descriptive. The results of research showed that the highest levels of risk agent SO2 levels was 0.33 mg/ m3, the highest levels of NH_3 is 2.20 mg/ m3, highest levels of NO2 is 0.39 mg/ m3, highest levels of PM2.5 is 2.17 mg/m^3 and PM_{10} at 1.76 mg/ m^3. The distance value of the level of risk (RQ) for SO2, NH3 and NO2 was at ± 500 m from the source of the pollutants and showed above 1 mg/m3, it means the gas of NH3, PM2.5 and PM10 are highly risk to the health.

Keywords: *Environmental health risks, Risk level, Sugar factory, Risk agent*

INTRODUCTION

Analysis of Environmental Health Risk (ARKL) is a risk management tool that is used to protect the health of the community due to the effects of a bad environment. In Indonesia regualtions, ARKL is also a means of analysis of environmental health impact (ADKL) approach. Legal bases ARKL for ADKL are PerMenLH No 08/2006 on guidelines for the preparation of the Analysis of Environmental Impacts (AMDAL)[(1)], and KepMenKes No 876/Menkes/SK/VII/2001 on technical guidelines for ADKL[(2)].

ARKL that is used as ADKL approach is a great tool to get to know, understand, and predict the conditions and characteristics of the environment that could potentially pose a health risk as the basis for compiling or developing management and monitoring environmental health risks. ARKL also constitute an adequate method to do a study of the health effects of the pollution cases in general[(3)].

According to Louvar & Louvar, ARKL a scientific framework for the review of the Environment and Health to solve the problems[(4)]. US-EPA defines ARKL is the Scientific Evaluation of the potential health impacts Happens Certain substances exposure can because of or mixture specific conditions[(5)]. While PPCs defines ARKL is the process of predicting the risk on a biota, system or (sub)population objectives, with all non uncertainty the accompanying, taxable income exposure posted agents specific, with notice characteristics of agents and objectives, specific[(6)].

Air is a mixture of gases, which consists of approximately 78% Nitrogen, 20% Oxygen, 0.93% Argon, 0.03% carbon dioxide and the rest consists of Neon, Helium, methane and hydrogen. The air is said to be "normal" and able to support human life in a composition like above. Whereas in case of adding other gases cause interference as well as changes in the composition, then said the air already polluted/

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contaminated[7].

Purwodadi PG (sugar factory) in Karangrejo, Magetan as one sugar factory relics of the Dutch era, according to local residents the surrounding air polluted with particulate is emitted from chimney. It has been many years since the 1960s, and took place at a time when sugar factory ground, more or less during 6 months between May until October. Preliminary observations indicate that air pollution around Purwodadi PG felt already interfere with the health of the community, some citizens complained against their respiratory disorders, in addition to the presence of air pollution by the discovery of soot (former burnt leaves) above the ceilings of houses.

See the conditions then the need for environmental health impact analysis in the vicinity of Purwodadi PG to see the extent to which environmental quality resulting from pollution by emissions and liquid waste health effect on PG surrounding residents. This facts are needs to be done in terms of monitoring the air, liquid and solid wastes resulting from Purwodadi PG.

MATERIALS AND METHOD

Type of this research was descriptive, with risk agents were SO_2, NH_3, NO_2, $PM_{2.5}$ and PM_{10}. Environmental health risk analysis method used was the wearing method approach to the international programme on chemical safety (IPCS) and the WHO which has been developed by Health Ministry and the University of Indonesia to be applied extensively in Indonesia. The research was carried out around the region of Purwodadi PG between ±500 m – 4000 m to see the environmental health risks due to air pollution motor vehicles. Variable in this research was the identification of hazards, identification of sources, analysis of exposure, dose-response analysis, risk characterization, risk management health environment. The characteristics of the risk represented by the level of risk (Risk Quotient) are a division between the intake (I) and inhalation reference concentration (RfC). In addition to determining the inhalation intake also needed Anthropometry parameters (weight and inhalation rate), the pattern of activity (time, frequency and duration of exposure) and so on. The level of risk is calculated by equation 1 and inhalation intake (I) calculated using equation 2[4].

Description:

I= Inhalation Intake (mg risk agent/kg west of individual agencies/day)

C= Risk Consentration agent in the air (mg risk agent/m3 air)

R= lnhalation rate (m3 air/hour)

tE = long exposure (hour/day)

fE = exposure frecquension, 350 days/year for residensial default value

Dt= exposure duration, 30 year to default for resdensial population

Wb= west of individual agencies(kg)

tavg= The average time periode (Dt 365 days/ years for noncarsinogenic, 70 years, 365 days/years for carsinogenic)

Environmental health risk management was carried out by four main elements, namely the evaluation of risks, control of emissions and exposures and monitoring of risks. Risk management was calculated by using the formula:

• Maximum Concentration of safe human consumption (C.max).

• Maximum consumption Rate that is safe for humans (R.max)

• The assumptions used are RQ = 1

The calculation of the concentration of safe and secure consumption rate was:

Decision-making methods were:

If the initial concentration >max.secure concentration, it is necessary to take steps to reduce the concentrations of, improve environmental conditions, etc .

If the initial intake rate >max.secure intake rate, then the necessary measures to bring down the rate of intake by reducing dwell time / time said, etc.

RESULTS AND DISCUSSION

Sources of SO_2, NH_3, NO_2, $PM_{2.5}$ and PM_{10}

Pollution source of SO_2, NH_3, NO_2, $PM_{2.5}$ and PM_{10} most (70%) derived from the production process Purwodadi PG and fraction (30%) comes from transportation the transport of raw sugar cane. Purwaningsih reported that the air quality at present milled simply applied a two-fold compared to when not milled, it is shown that most of the pollution comes from the production process[8].

Hazard Identification

Table 1. The Concentration of Gases and Particles around Purwodadi PG

Zone	Area/ Location	Concentration (in mg/m^3)				
		SO_2	NH_3	NO_2	$PM_{2.5}$	PM_{10}
1	±500 m from the source of pollutan	0.33	2.20	0.39	2.17	1.76
2	±1000 m from the source of pollutan	0.26	1.73	0.35	1.52	1.13
3	±2000 m from the source of pollutan	0.23	1.21	0.30	1.06	0.77
4	±3000 m from the source of pollutan	0.18	1.13	0.24	1.01	0.76
5	±4000 m from the source of pollutan	0.13	0.02	0.21	0.98	0.75
	Environmental Quality Standards	0.26	1.36	0.92	0.26	1.00

Based on the raw quality of environment against ambient air concentration measurements around the sugar factory, indicating that all of the ambient air at a distance of approximately 500 m and 1000 m from the sugar factory on top of BML, which means that the ambient air at a distance of 1 km of sugar factories are not healthy or polluted conditions. BML is the size limits or levels of living things, energy, substances, or components in the environment. BML is an instrument for managing the environment, used to find out the level of or decrease in intensity of reduction environment[9].

Exposure Analysis

Table 2. Default value for antropometric parametes

Receptor	Inhalation rate (m^3/hour)	Exposure Frequency (hour)	Weight (kg)	Exposure Duration (year)	Frequency (day/year)
Children	0.5[a]	18 (6hour studying in the outside location)[c]	15[a]	2[c]	350[a]
Adult (IRT)	0.83[a]	24[c]	55[b]	2[c]	350[a]
Worker	0.83[a]	14 (10 hour working in the outside location)[c]	70[a]	2[c]	350[a]

Source: [a]U.S.EPA 1990[5], [b]Nukman et al (2005)[10], [c]author assumption

Table 3. Intake Risk Agent around Purwodadi PG

Zone	Location	Intake Risk Agent				
		SO_2	NH_3	NO_2	$PM_{2.5}$	PM_{10}
1	±500 m from the source of pollutan	0.0048	0.0318	0.006	0.0314	0.0255
2	±1000 m from the source of pollutan	0.0038	0.025	0.005	0.022	0.0164
3	±2000 m from the source of pollutan	0.0033	0.0175	0.004	0.0153	0.0111
4	±3000 m from the source of pollutan	0.0026	0.0164	0.003	0.0146	0.011
5	±4000 m from the source of pollutan	0.0019	0.0078	0.003	0.0142	0.0109

Dose-Response Analysis

Table 4. Value of Dose-Response

No.	Agent	RfC	Critical Effect and Sources of the Date (Referention)
1.	SO_2	2,6E-2	Respiratory Disorders[3],[5],[10]
2.	NO_2	2E-2	Respiratory Disorders[5],[11]
3.	H_2S	2E-3	Olfactory Mocus Nasal lesion on rat inhalation bioassay subcronic (Brenneman, James, Gross, & Dorman, 2000) in IRIS[12]
5.	TSP	2,42	Respiratory Disorders[3],[5],[10]

Dose-response assessment was conducted to determine the toxicity of the quantitative values a brisk agent for any form of chemical species, expressed as a RfD (for drinking water and food) or RfC (for air) for non carcinogenic effects and the Slope Factor (SF) or Unit Risk (UR) to the effects of carcinogens[12].

Risk Characteristic (Risk Level)

The characteristics of the risk is calculated based on each segment of the population with the default values for inhalation rate, weight, exposure duration and frequency. As for the mean time period – average (t_{avg}) is 6 years (365 days/year) for the subpopulations of children and 30 years (365days/years) to subpopulations of adults.

Table 5. Risk Level *(RQ)* SO_2, NO_2, H_2S, and TSP for adult (IRT) with W_b 15 kg, 55 kg and 70 kg and f_E 350 days/years

Zone	Location	Adult				
		SO_2	NH_3	NO_2	$PM_{2.5}$	PM_{10}
1	±500 m from the source of pollutant	0.1837	1.0612	0.282	1.3084	1.0612
2	±1000 m from the source of pollutant	0.1447	0.8345	0.253	0.9165	0.6813
3	±2000 m from the source of pollutant	0.128	0.5837	0.217	0.6391	0.4643
4	±3000 m from the source of pollutant	0.1002	0.5451	0.174	0.609	0.4582
5	±4000 m from the source of pollutant	0.0724	0.2605	0.152	0.5909	0.4522

The overall value of RQ for each risk agents in the location of the study population, there was some segmentation according to the indicate above 1 (RQ>1) and there are some which show brought 1 (RQ<1). It means some of the gas in the air that come from pollution emissions chimney Purwodadi PG takes control risk quotient for SO2 all under 1 (RQ<1), that is in the range 0.0724-0.1837. RQ NH_3 at a distance of approximately 500 m from the source of pollutants is more than 1 (>1), medium distance >500 m still under 1 (<1) RQ NO_2, SO_2 under 1 (RQ<1), RQ $PM_{2.5}$ in a distance of approximately 500 m from the source of pollutants is more than 1 (>1), medium distance >500 m still under 1 (<1), and RQ PM_{10} at a distance of approximately 500 m from the source of pollutants is more than 1 (>1), medium distance >500 m still under 1 (<1).

Risk agent according to the it risk quotient the most dominant is NH_3, $PM_{2.5}$ and PM_{10}, so that it can be concluded that the people who live in an area with a diameter of Purwodadi PG ± 500 m from the source of the pollutants risk of experiencing health problems. Aditama mention that the gases of SO_2, NH_3, NO_2, $PM_{2.5}$ and PM_{10} can cause abnormalities in the respiratory tract if the pollutants in the ambient air of breathe. Gas that the most harmful to the lungs are SO_2 and NO_2, if this item smoked, then the various complaints in the lungs will arise with the name CNSRD (a non specific chronic

respiratory disease) such as asthma and bronchitis[13].

Research held by Groneberg Kloft et al. showed that SO_2 concentrations are low though continuously can irritate the respiratory tract and cause chronic cough or bronchitis[14].

NH_3 exposure in the low levels can cause pulmonary disorders if the exposure takes place in a long time, it is in accordance with the studies by Heederick et al., namely in the form of a cohort study on farmers exposed to ammonia 1.60 mg/m3[15]. Cross sectional studies performed by Balla et al. show that male workers showed a relationship between exposure to ammonia gas with respiratory disorders such as asthma symptoms bronchial where the levels of ammonia in the interval 2.82-183.86 ppm[16].

Purwaningsih reported that respiratory disorders, such as cough, shortness of breath, fever, lethargy and perceived by respondents who live in the region of the dominant wind direction when the factory operates (milled) and at the end of a rolling pin. Respondents who live in the wind direction is not the dominant States that coughs, colds and Croup which is perceived is not affected by the pollutants Mojo PG. When associated with ambient air quality measurement results then it can be inferred that the pollutants Mojo PG respiratory tract disorders[8].

Risk Management

Various possibilities for risk management a risk agent needs to do. The first thing that is done is by means of lowering the value of concentration of each risk agent. For it takes a quantity value risk agent is needed so that the frequency of RQ=1 or RQ<1.

According to the information above, is not possible if it should reduce the exposure time of the daily and annual exposure because it is very small and is not realistic.

Altough the various risk management has been attempted and be scenario to cope with exposure risk agent to the population, but have not found a solution. Therefore, the last attempt is to evacuate in advance of the study on the location of residents to safety and avoid pollutants. If that intervention doesn't held, the possibilities of the population to accept the health risks resulting from exposures were higher.

CONCLUSION

SO_2 levels agent highest was 0.33 mg/m^3, the highest levels of NH_3 is 2.20, NO_2 levels highest 0.39, the highest levels of $PM_{2.5}$ is 2.17 and the highest level of PM_{10} is 1.76. The value of the level of risk (RQ) for SO_2, NH_3, and NO_2 at a distance of approximately 500 m from the source of the pollutants shows over 1 (one), it means the gases NH_3, $PM_{2.5}$ and PM_{10} are very risky against health.

The most urgent control is recommended for controlling the environment, such as the blue sky program, encouraged the planting of plants forbidding residents to live in the territory and population of the sugar factory could be moved to a safer place.

Conflict-of-Interest: None

Source of Funding: Authors

Ethical Clearance: Taken from University of Jember.

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