RISK ANALYSIS OF CO EMITED FROM MOTOR VEHICLES TO PEOPLE LIVING AND DOING ACTIVITIES IN ROADSIDE (CASE STUDY: JOGJAKARTA'S MAIN STREETS)

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ABSTRACT

Air pollution problems have been progressively set attention to the world specifically in industrial countries recently. This problem not only gives affect at health like emphysema, bronchitis, and other inhalation disease but also makes plants and property destruction that causing loss. Research concerning in the level of risk which is accepting by people who living and doing activities in roadside which most of air pollutants come from transportation facilities such as motor vehicles. This research focuses on CO exposure which penetrates the body through respiration. There are four steps in this research, first, hazard identification showing CO concentration in 15 sampling locations resulting highest CO concentration is equal to 17.250 µg/m^3; second, exposure assessment involves population exposed that are Pedi cab worker, parking man, and cloister merchant to know CO intake each person using calculation of CO intake range from 1,0703-2,6089 mg/kg . day; third, dose-response assessment to know what people will be experiencing if exposed by CO at certain dose; fourth, risk characterization resulting that risk value/Hazard Index (HI) less than 1. This research concludes that CO concentration of most main streets in Jogjakarta do not adverse to people's health who living and doing activities in roadside .

***Keyword** : CO, air pollution, roadside, risk analyze, Jogjakarta*

INTRODUCTION

Rapid development of transportation facilities and the amount of motor vehicles in developing countries would automatically increase the emission level of air pollutions. At this time, air pollutions become a serious problem faced by people in developing countries. Air pollutions effect is very harmful. The pollution not only affects directly to human being but also causes environmental destruction. For human being, at the beginning, the pollutant will affect respiration system, skin, and mucous membrane. Furthermore, if the contaminant enters the blood circulation, therefore systematic effect cannot be avoided (USEPA, 2005).

Major air pollution emitted from motor vehicle combustion are CO, SOx and NOx. Specifically CO, this would reduce the ability of blood to take and to transport O_2 in the human body. CO will attach stronger to Hb than O_2 and the impact can be seen directly. The higher amount of CO concentration in the air, the higher the risk accepted by individual exposure too.

Risk is the probability that an event or action will damage health or the environment. Risk assessment is, by definition, a scientific process by which one attempts to characterize in as quantitative manner as data permits, the dose (exposure)-response curve in humans to provide scientific support for management decisions designed to decrease risks from chemical exposure. Scientific procedure and methods are used to identify hazard, define the dose response relationship, and conduct exposure assessment. (Ruchirawat,1996)

The first step of risk analysis is hazard identification. One approach is to examine data for all chemical contaminants detected in any media and select a subset of chemicals, consisting of the specific chemicals of concern and representative of all detected chemicals. The surrogate chemicals are selected based on which compounds best represent the risk posed by the site:

a. the most toxic persistent and mobile
b. the most prevalent in terms of spatial distribution and concentration
c. those involved in the more significant exposures, (Gratt, 1996).

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Second, exposure assessment is the process of measuring or estimating the magnitude, frequency and duration of human exposure to a compound in the environment, or estimating future exposure for one that has not yet been released (Ruchirawat, 1996). The pathway of chemicals exposure divides in three ways, those are: ingestion, inhalation, and dermal contact. The affect factors contaminant intake are: lifestyle, frequency, duration exposure, and receptor body weight. The equation to measure contaminant intake is:

$$I = \frac{CxCRxEFxED}{BWxAT}$$

Where :

I = Intake (mg/kg of body weight. Day)
C = Chemical concentration in air (mg/m^3)
CR = Contact rate (m^3/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (Years)
BW = Average body weight (kg)
AT = Averaging time (days)

Third, dose-response assessment defines the toxicity (dose-response relationship) for each surrogate chemical, (Peavy, 1985). Dose-response evaluation involves describing the quantitative relationship between the amount of exposure to a substance and the extent of toxic injury or disease (Ruchirawat, 1996).

Fourth, risk characterization estimates health risk posed by the compound under the conditions modeled in the exposure assessment based on integration of information on toxicity and exposure. Risks are calculated for exposure to each individual substance, then, the overall risks are assessed by assuming additives of the individual risks, (Ruchirawat, 1996).

a. Carcinogenic risk
Risk = CDI x SF
Where :
CDI = chronic daily intake (mg/kg.day)
SF = carcinogen slope factor (kg.day/mg)

b. Non-carcinogenic risk

$$HI = \frac{CDI}{RfD}$$

Where :

HI = hazard index (dimensionless)
CDI = chronic daily intake (mg/kg.day)
RfD = reference dose (mg/kg.day)

If the acceptable level of intake is deemed to equal to the reference dose, then by definition, a hazard index less then 1 is acceptable. An exposure typically involves multiple chemicals, and an index must be calculated for each surrogate chemical for all pathway and exposure routes. For exposure to multiple non-carcinogens, the hazard index scores for all non-carcinogens normally are summed to provide the final measure of the risk for non-carcinogenic toxic effects. It should be noted that the acceptable target for the sum of hazard indices remains less than 1, (USEPA, 1993).

According to Governor DIY Regulation No. 153/2002 about ambient air quality standard, maximum concentration CO is 30.000 $\mu g/m^3$. Based on those facts, this research is conducted to find out the CO concentration in the Jogjakarta roadside and to know the amount of risk that will be accepted by people who inhabit in the roadside because of CO exposure. The scope of this research is broken down as follows: Analyze of CO concentrations in the roadside equal to the standard of air quality; Analyze of road user in the roadside who affected by CO; Analyse the risk level that covering: hazard identification, exposure assessment, dose-response assessment, and risk characterization to the road user in the roadside.

RESULT

1. Identification of Selected Location.

All of the selected research locations spread in Jogjakarta and assumed was representative of Jogjakarta because condition of locations are the roads that have density traffic level which vary that is :

A. The roads which have high density level
   1. Prambanan street (Janti)
   2. Sudirman street
   3. C. Simanjuntak street
   4. Ahmad Dahlan street (PKU Muh)
   5. Godean street

B. The roads which have medium density level
   1. Magelang street
   2. Malioboro street
   3. Solo street
   4. Diponegoro street
   5. kaliurang street

C. The roads which have low density level
   1. Wates street
   2. Parangtritis street
   3. Gedongkuning street
   4. Bantul street
   5. Menteri Supeno street

2. Ambient Air Quality Analyze

Following is the result of CO concentrations analysis table in 15 sampling locations that have been done in BTKL laboratory of Jogjakarta.

Table 1 CO Concentrations

No	Locations	CO
1	Wates Street	8625,00
2	Diponegoro Street	16862,50
3	Prambanan Street	10637,50
4	Magelang Street	10662,50
5	Sudirman Street	14950,00
6	Godean Street	17250,00
7	Parangtritis Street	12937,50
8	Jl. Solo Street	12937,50
9	Ahmad dahlan Street (PKU Muh)	11068,75
10	Gedongkuning Street	10062,50
11	Malioboro Street	16387,50
12	C. Simanjuntak Street	17250,00
13	Mentri Supeno Street	10925,00
14	Bantul Street	8077,50
15	Kaliurang Street	14950,00

Source : Analysis result, 2006.

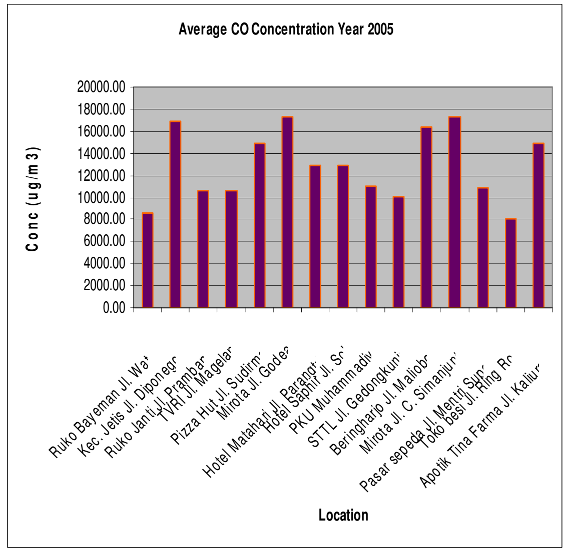

Figure 2. Average Gas Concentrations of CO

3. Hazard Identification

The first step in risk analysis is hazard identification. Hazard identification is the step **to know if contaminant exposure can cause harmful impact to health of human being and what possibility happened if exposure of contaminants**. In this research, the possibility of air contaminants which give negative impact to health is CO that identified in sampling locations. The contaminant is non-carcinogen where respiration diseases like emphysema which often happened. The effect of CO is chronic if it is accumulated in long-exposure of the contaminants and the air contaminants concentration in ambient is still under of the standard of health quality. If the contaminant concentration is above of the standard of health quality causes acute effect in short-exposure.

From measurement result of ambient air quality of CO, parameter can be known almost in all sampling locations with different concentrations. This is influenced by the contaminant sources which in this study come from motor vehicles emissions. The CO maximum concentration which no health adverse according to EPA is 10 mg/m^3, while in some locations the mean of CO concentration over than quality standard that possibility can give health adverse of human being who exposed of this contaminant. The highest concentration of

CO is equal to 17.250 μg/m^3 in Mirota Godean street and C. Simanjuntak street. In all sampling locations of ambient air quality measurement result show that the concentration is still under standard of health quality so that no adverse to human being health in short-exposure, hence will accumulate in the body if it happen in long-exposure.

From questionnaire spreading which have been done in 15 sampling locations have been known that the responder which possibly exposed CO is the responder who reside in the roadside for along time of day where they do not wear the protector for contaminant intake minimization come into the body. This is more seriously with some responder who have smoke habit so that the contaminant concentration in the body rises up to be cause of cigarette smoke sipped that can getting bronchitis excelsior.

4. Exposure Assessment

a. The population exposed identification

Health risks related to air pollutions has been progressively getting much attention. In metropolis, motor vehicles emission cause discomfort condition to people who reside in the roadside. From field observation result, it can be known that the individual populations which air contaminants exposed with high risk level. Population exposure who have high risk is individuals in roadside residing because close to the contaminant sources that is from motor vehicles emission. Potential population exposure in this research are : pedicab worker, park worker, and cloister merchant.

b. The Contaminants pathway identification

The air contaminants entrance into the body through three ways that is: inhalation, ingestion, and dermal contact. The pathway of this research is inhalation. The main source of air contaminants comes from motor vehicles emission which spreading on the air and influence to ambient air quality entering into the body through respiration.

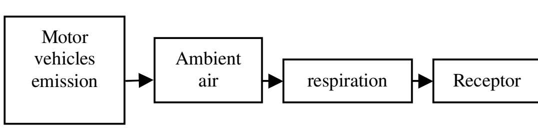

Figure 3. CO contaminants pathway into the body

c. The Contaminants intake into the body measurement

CO, NO_2, and SO_2 intake into the responders body influenced by contaminants exposure duration, the highest average intake suffered by responders who have profession as pedicab worker because they have longer average time to work so the possibility of contaminants exposure is higher. Besides, pedicab need much of the energy hence requirement of the oxygen getting high and the contaminants which enter into the body by means of the oxygen getting high. Most of the pedicab worker who have smoke habit that very influencing of CO rate in the body.

5. Dose-Response assessment

a. Carbon monoxide (CO)

The comparison to calculate %COHb of blood with relation CO concentration in air is

%COHb of blood = 0,16 (CO in air)+0,5

Table 5 %COHb of Blood Because of CO Concentration in Air

No	Locations	CO (μg/m^3)	CO ppm	% COHb Darah
1	Wates Street	8.625,0	7,566	1,711
2	Diponegoro Street	16.100,0	14,123	2,760
3	Prambanan Street	10.637,5	9,331	1,993
4	Magelang Street	9.966,7	8,743	1,899
5	Sudirman Street	14.950,0	13,114	2,598
6	Godean Street	17.250,0	15,132	2,921
7	Parangtritis Street	12.937,5	11,349	2,316
8	Solo Street	12.937,5	11,349	2,316
9	Ahmad Dahlan Street	11.068,8	9,709	2,054
10	Gedongkuning Street	10.062,5	8,827	1,912
11	Malioboro Street	16.387,5	14,375	2,800
12	C. Simanjuntak Street	17.250,0	15,132	2,921
13	Mentri Supeno Street	10.925,0	9,583	2,033
14	Bantul Street	8.077,5	7,086	1,634
15	Kaliurang Street	14.950,0	13,114	2,598

Source : Analysis result, 2006.

Tabel 2. CO Intake

No.	Locations	CO Intake			Average Intake
		Pedicad Worker	Park Worker	Cloister Merchant	
1	Wates Street	1,079	1,294	0,839	1,0703
2	Diponegoro Street	2,529	1,874	1,405	1,9360
3	Prambanan Street	1,182	1,773	1,098	1,3507
4	Magelang Street	1,092	1,126	1,304	1,1737
5	Sudirman Street	1,827	1,543	1,827	1,7322
6	Godean Street	2,588	1,678	1,941	2,0686
7	Parangtritis Street	2,372	2,013	2,911	2,4320
8	Solo Street	2,695	1,438	1,582	1,9048
9	Ahmad Dahlan Street	1,661	1,230	1,476	1,4555
10	Gedongkuning Street	1,118	1,118	1,160	1,1321
11	Malioboro Street	3,414	2,458	1,912	2,5947
12	C.Simanjuntak Street	3,738	1,917	2,172	2,6089
13	Mentri Supeno Street	1,973	1,154	1,366	1,4972
14	Bantul Street	0,898	1,459	0,898	1,0848
15	Kaliurang Street	2,617	2,492	1,827	2,3118

Source : Analysis result, 2006.

6. Risk Characterization

Table 6 The average risks pursuant to work type

No.	Locations	Work Type of Risks			Average Risks
		Pedicab worker	Park Worker	Cloister Merchant	
1	Wates Street	0,166	0,199	0,129	0,1647
2	Diponegoro Street	0,389	0,288	0,216	0,2977
3	Prambanan Street	0,195	0,293	0,169	0,2190
4	Magelang Street	0,172	0,177	0,205	0,1847
5	Sudirman Street	0,278	0,235	0,278	0,2637
6	Godean Street	0,386	0,250	0,274	0,3033
7	Parangtritis Street	0,354	0,300	0,434	0,3627
8	Solo Street	0,413	0,220	0,242	0,2917
9	Ahmad Dahlan Street	0,300	0,222	0,249	0,2570
10	Gedongkuning Street	0,176	0,176	0,170	0,1740
11	Malioboro Street	0,517	0,372	0,272	0,3870
12	C. Simanjuntak Street	0,554	0,275	0,307	0,3787
13	Mentri Supeno Street	0,300	0,175	0,207	0,2273
14	Bantul Street	0,145	0,236	0,136	0,1723
15	Kaliurang Street	0,391	0,373	0,254	0,3393

Source : Analysis result, 2006.

The risk level of CO, contaminants still under 1, hence the risks are acceptable into the body. The highest risk level is in Malioboro street which equal to 0,3870 and the lowest is in Wates street which equal to 0,1647. The responders which have highest average risk is the padicab worker.

CONCLUSION

1. During 2005, concentrations of CO in 15 sampling locations are still under standard quality according to DIY Governor Regulation No. 153 / 2002 about concerning ambient air quality standard. The highest CO average concentration was happened in Mirota Godean street and C. Simanjuntak street (17.250 μg/m^3).
2. The risks level of CO, that responder accepted in the surrounding sampling locations is still safe/acceptable because of total HI value <1. The highest risk level was suffered by responder who reside in Beringharjo market, Malioboro street (0,3870) and the lowest was suffered by responder in wates street (0,1647). The risk value was measured only when the responders work / reside in the roadside and the probability to the different concentrations were exposed in another place, along with different type of contaminants so the real risk to be suffered will be higher.

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