Determination of Safe Benzene Concentration at Ciputat Gas Station

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Abstract

Benzene is a simple cyclic organic compounds whose concentrations are found usually low dilikungan. Benzene is often used in the industrial world, both home industry and the oil and gas industry. Benzene can enter into the body through the lungs, it can be through inhalation, gastrointestinal tract, and through the skin, If someone exposed to benzene at high concentrations, the levels of benzene into the lungs roughly half of the levels of benzene is absorbed, so that the incoming kealiran blood.This research is descriptive. The population in this study is a gas station worker Ciputat region totaling 10 people. The results of the study then analyzed quantitatively to determine the concentration secure benzene for workers obtained from the data concentration of benzene in the workplace, height workers, the weight of workers, heavy mice, respiration rate workers, time spent working, the surface area of the worker's body surface area the body oflaboratory mice, the highest dose of the toxin no effects in animal experiments (NOAEL), Km factors in animals (animal Km), Km factors in workers (Human Km), and the safe limit for workers toxin dose (SHD). The results of measurement of the concentration of benzene in petrol stations in the region Ciputat is 0,58mg / m3 (0.18 ppm), which means it is still below the Threshold Limit Value (TLV) according Permenakertrans 13 / MEN / X / 2011, the year 2011 is equal to 0, 5 ppm. In contrast to the NAB which have been set at 0.18 ppm, based on manual calculations for safe concentration limit of benzene obtained value of 0.02 ppm.

Keyword: *Benzene, Safe Concentration, Gas Stations, Workers*

Introduction

In the era of the fastest growing technology, transportation is a very necessary thing humans in performing daily life. Means of transport is a tool that has a main component of a machine that needs fuel to run, usually referred to by fuel oil (BBM). In Indonesia alone type of fuel oil used on a variety of vehicles, such as gasoline and diesel.

There are various kinds of chemical substances contained in the fuel dinataranya benzene, toluene, xylene, ethylene, etc.which is certainly harmful to human health. The nature of the chemicals benzene, namelycolorless liquid with a sweet odor. Benzene evaporates into the air very quickly, slightly soluble in water but soluble in fats, and flammable. Benzene can be found in air, water, and soil2. Benzene is a chemical that is harmful and carcinogenic to humans and is a colorless liquid and volatile. Benzene is widely used in the rubber industry, oil refining, shoe factories, chemical plants and other industries related to oil including age refueling stations (gas stations)3.

Indonesia itself has created rules limit benzene exposure in the work environment specified in the Threshold Limit Value (TLV) of benzene of 0.5 ppm in accordance with the Regulation of the Minister of Manpower and Transmigration Republic of Indonesia number PER / 13 / MEN / X / 2011 on the Threshold Limit Value Physical and chemical factors in the Workplace4.

Acute benzene exposure would have an impact like that cause disturbances in the nervous system, lack of oxygen supply to the brain, dizziness, rapid heart

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rate, headaches, tremors, confusion and fainting5.6, While chronic benzene exposure can cause decreased production of red blood cells causes anemia.7 Benzene can also get to the bone marrow and impair the production of blood cells so that persons exposed to benzene can suffer diseases related to decreased production of blood cells in the bone marrow.8 Some studies indicate a relationship between the quantity of benzene exposure by inhalation to the trans, trans-Muconic Acid (ttMA) as a biomarker of exposure to benzene.9 trans, trans-Muconic Acid (ttMA) is a minor metabolite of benzene that can be used as biological indicators of exposure to benzene. 9.10The occurrence of abnormalities in the hematopoietic system caused by exposure to benzene is a major concern. Examination and laboratory testing conducted on workers at risk of benzene exposure include a Complete Blood Count (CBC) with leukocyte count, hematocrit, hemoglobin (Hb), red cell count, erythrocyte indices (MCV, MCH, MCHC), and platelet counts.11-13

Based on previous studies of benzene in the workplace, there is very little research on the safe concentration (C safe) in the work environment that have exposure to benzene. Area gas stations as a working environment that has a high exposure to benzene, should the concentration of benzene in the safe limits so as not to cause health problems for workers. Therefore, based on the explanation above, the writer will measure the safe concentration limit of benzene in the area of the pump.

This study aims to determine safe concentrations of benzene in petrol stations in the region namely Ciputat. The results of this study are expected to be on filling stations in protecting workers from exposure to benzene.

Material and Method

This research is descriptive.The population in this study were gas station workers who worked at number 1 and point 2, totaling 10 people. The collection of primary data that the air concentration of benzene in the workplace, the duration of working time, and the weight of workers. It also conducted a secondary data collection on laboratory animals, namely the weight of mice.

The variable in this study is the concentration of benzene in the workplace, height workers, the weight of workers, heavy mice, respiration rate workers, time spent working, the surface area of the worker's body, body surface area of mice, the highest dose of the toxin no effects in animal experiments (NOAEL), Km factors in animals (animal Km), Km factors in workers (Human Km), the safe limit for workers toxin dose (SHD), and the concentration of benzene in the air that is safe for workers (C safe).

Findings

A. **Characteristics of Animals Try and Try Animal Body Surface Area (Rats)**

The toxicity of compounds in general can be interpreted by the potential chemicals that cause damage when it entered into the human body. In the implementation of toxicity tests using experimental animals are mice. In general, the human response to toxicant is qualitatively similar to the response of the animals, so that this fact is the basis of extrapolation from animal data to humans.

Table 1. Characteristics of Animal Experiments (Rats)

Animals Try (Rats)	W(kg)	BSA (m2)
1	0.1405	0.024165
2	0.1405	0.024165
3	0.1410	0.024223
4	0.1410	0.024223
5	0.1395	0.024050
6	0.1405	0.024165

Based on data from white rat body weight, it can be calculated body surface area white mice using the following formula:

$$BSA\ hewan = 0.09\ W^{0.67}$$

Information :

BSA : Body Surface Area / body surface area (m2)

W : Weight / Weight (kg)

B. **Characteristics of Workers, Body Surface Area Workers and Workers Respiratory rate**

Characteristics of workers in this study include the weight and working time of 10 respondents working

in the area of gas stations in Region Ciputat. Based on Table 2, the highest known weight 67 Kg, 44 Kg lowest weight, and average weight of 51.4 kg. Long time working day is 8 hours. As for the height using the average value of height of an adult male Indonesia is 159 cm. Based on data from trade body weight and height workers, can be calculated body surface area workers and workers breathing rate using the following formula.

1. Full Body Surface Area

$BSA = \sqrt{W}, h / 3600$

Information :

BSA : Body Surface Area / body surface area (m2)

W : Weight / Weight (kg)

h : Height / Height (cm)

2. Respiratory rate of Workers

$BR = 5.3 \ln W - 6.9 / 24$

Information :

BR : Breathing rate / respiratory rate (m3 / h)

W : Weight / Weight (kg)

Table 2. Characteristics of Workers, Respiratory rate and Older Workers Working Time

Workers at the pump Territory Ciputat

worker	W(kg)	h (cm)	BSA (m2)	BR (m3 / hr)	t (hours / day)
1	50	159	1.49	0.58	8
2	50	159	1.49	0.58	8
3	58	159	1.60	0.60	8
4	60	159	1.62	0.61	8
5	49	159	1.47	0.57	8
6	45	159	1.40	0.56	8
7	44	159	1.39	0.54	8
8	46	159	1.42	0.55	8
9	67	159	1.72	0.64	8
10	45	159	1.40	0.56	8
Average	51.4	159	1.50	0.57	8

Based on Table 2, the highest known weight of workers at gas stations Ciputat region that is 67 kg, while the lowest body weight 44 kg. The length of time worked in a day is all of 8 hours and height using the average value of height of an adult male Indonesia is 159 cm.

The results of the analysis of body surface area calculation and respiratory rate workers according to table 2 shows that the average worker's body surface area is 1.59 m2 and the average worker respiratory rate is 0.57 m3 / h.

C. **Benzene concentration**

The results of measurement of the concentration of benzene in the workplace stations in Ciputat area is either at point 1 and point 2 equals that is 0,58 mg / m3 (0.18 ppm)

Table 3. Distribution of Benzene concentration at the pump stations in Region Ciputat

location Measurement	Benzene concentration	
	ppm	mg/m3
Point 1	0.18	0.58
Point 2	0.18	0.58

Based on the results of measurements taken, the concentration of benzene in the working environment Ciputat Regional gas station is 0.18 ppm. The benzene concentration is below the Threshold Limit Value (TLV) of 0.5 ppm in accordance with the Regulation of the Minister of Manpower and Transmigration No. PER.13 / MEN / X / 2011 on the Thresho ld Value Factor of Physical and Chemical Factors in the Workplace. However, the benzene concentration is above the Minimum Risk Level (MRL), inhalation of benzene exposure levels set by ATSDR, namely for acute exposure (≤14 days)= 0.009 ppm, exposure to moderate (15-364 days)= 0.006 ppm, and chronic exposure (≥365 days)= 0,003 ppm.

D. **Animal and Human Km Km**

The determination of safe dose limit for workers toxin begins prior to the calculation of Animal and Human Km Km.

1. animal Km

Animal Km=

Information :

Animal Km: Km factors in animals

W : Weight of experimental animals (rats)

BSA : Body Surface Area of experimental animals (rat White)

Animal Km ditunjukka calculation results in Table 4, with an average of Animal Km on white rats is 5.81.

Table 4. Calculation Results Km Animal Animal Try (Rats)

Animals Try (Rats)	animal Km
1	5.81420952
2	5.81420952
3	5.82102947
4	5.82102947
5	5.80052067
6	5.81420952
Average	5.81

2. HumanKm

Human Km=

Information :

Human Km: Km factors in human / workers

W : Weight workers

BSA : Body Surface Area workers

Table 5, with an average of Human Km at gas station worker is 34.09.

worker	Human Km
1	33.55
2	33.55
3	36.25
4	37.03
5	33.33
6	32.14
7	31.65
8	32.39
9	38.95
10	32.14
Average	34.09

E. **NOAEL**

One objective of the research activities in the field of Tiksikologi is to be able to evaluate the safety of a substance. To determine the safety limit concentration of a chemical substance toxicity test begins with the

determination of the highest dose without effect on animal or No Observed Adverse Effect Level (NOAEL). The research results Swaen et.al (2010) states that benzene NOAEL was 3.0 mg / m3, equivalent to 0,022 mg / kg obtained from the following calculation formula.

Benzene NOAEL (mg / m3) =

= 0,022 mg / kg

F. **Safe Human Dose**

Safe Human **D**ose safe dose limits for workers or Safe toxin Human Dose (SHD) found begin using the formula from Shaw et.al (2007) below.

SHD=NOAEL

Information :

SHD : Safe Human Dose (mg / kg)

animal Km : Km factors in animals

Human Km : Km factors in human / workers

Based on this equation, the calculation results obtained from the SH**D** NOAEL value, average animal Km, and the average human Km are:

SH**D** = 0.022 x

= 0.003 mg / kg

G. **Safe limit concentration of Benzene**

Determining the safety limit concentration of benzene in the workplace (filling station) using the formula (William, 1985; Soemirat, 2003; Davis, 1991) the following:

$C\ aman = mg/m^3$

To convert the units of mg / m3 to ppm use the following formula.

$C\ aman$ = x 24.5 ppm

Information :

C safe : The concentration of toxins in the air that is safe for workers (mg / m3)

SHD : Safe Human Dose (mg / kg)

W : Weight (kg)

δ :% Of the absorbed substances lungs

BR : Human respiratory rate (m3 / h)

t : Long working time (hours)

MW : Molecular Weight / Molecular Weight

Based on the formula above, the result of calculation of a safe concentration of benzene in petrol stations Ciputat region derived from SH**D** value, the average weight of workers, the percentage of absorption of the average worker respiratory rate and the average length of working time is:

C safe (mg / m3) =

= 0,067 mg / m3

$C\ aman$ (Ppm)= x 24.5 ppm

= 0, 02 ppm

The result of the calculation of the safety limit in the air that is safe for workers above can be used for (William, 1985 in Tualeka, 2013): predict the concentration of toxins in the air a safe working environment for the workers when there has been no determination of the Threshold Limit Value (TLV), and for comparison with NAB has been established by various agencies both by Manpower, the National Standardization Agency, ACGIH, NIOSH and OSHA.

Conclusion

The results of measurement of the concentration of benzene in petrol stations in the region Ciputat is 0,58mg / m3 (0.18 ppm), which means it is still below the Threshold Limit Value (TLV) according Permenakertrans 13 / MEN / X / 2011, the year 2011 is equal to 0, 5 ppm. In contrast to the NAB which have been set at 0.18 ppm, based on manual calculations for safe concentration limit of benzene obtained value of 0.02 ppm. While based on the Minimum Risk Level (MRL) set ATSDR 2007, the concentration of 0,009 ppm benzene every day can give the effect of acute and 0,003 ppm daily for chronic effects, so as the concentration of benzene in petrol stations work environment has the potential to provide health effects for workers.

Thus the necessary control measures so that workers are protected from the adverse effects of benzene on health. Control recommendations are to consume the

enzyme CYP2E1 contained in beef liver and salmon which serves to reduce the levels of benzene in the body, use of personal protective equipment appropriate in the form of half-mask respirator with organic vapor cartridge for meminimalisisr exposure to benzene, and planted a number of plants that can absorb and lowering the concentration of benzene such as Boston and Golden Phothos[14],

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Ethical Clearance : This study was approved by the institutional Ethical Bord Airlangga University, Faculty of Public Health.

All subjects were fully informed about the procedures and objectives of this study each subject prior to the study signed an informed consent form.

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