

Health Risk from Exposure to Benzene: Study in Oil Industry Workers

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Abstract

The purpose of this study was to analyze the health risks of benzene exposure, on human health, especially for workers/employees engaged in the oil industry. To assess the health effects of benzene on workers, it was obtained from health data of workers exposed to benzene in the work environment. Acute exposure (14 days), moderate exposure (15-364 days) and chronic exposure (365 days) are workplaces where benzene exposure is below the Minimum Risk Level (MRL) value of inhaled benzene exposure that is reduced by ATSDR by acute, moderate and chronic exposure, respectively, to benzene. The threshold value of physical and chemical variables in the workplace (1.59 mg/m³) is also set by the Regulation. ATSDR-reduced exposure to toluene (7.6 mg/m³) is below the MRL for chronic inhalation exposure, while acute exposure (3.8 mg/m³) is well below the MRL for chronic inhalation exposure. Symptoms of headache, weariness, and respiratory irritation can be caused by Benzene exposure that exceeds the threshold value and biological exposure index. blood-forming cells and bone marrow dysfunction as well as neurological or reproductive system disorders. After conducting a risk analysis, an overall picture of the risks will be obtained. The results of risk analysis can be qualitative or quantitative depending on the technique or method used. Risk analysis will also provide an overview of the level of risk from various potential hazards that exist.

Keywords: Benzene, Worker, Industry, Oil

Introduction

Industry has a very big role in supporting the current development. There are many small industries and preventing them from growing is the metal industry. There are quite a number of small and preventative industries engaged in the metal sector, but the way this industry is managed is generally still done traditionally with limited capabilities in metal casting techniques. As a result of manufacturing chimney emissions and the air inhaled by foundry workers, metal contaminants, as well as other pollutants, will be released into the atmosphere. In the metal foundry business, industry has a significant impact on metal air pollution.

The industrial sector is the primary focus of economic development. People's quality of life improves as their income rises, whereas pollution can harm public health (Jiang et al., 2020). As one of these, human activity causes water quality to degrade to a point that it no longer meets the standards set for it, water pollution is defined as the introduction or inclusion of live organisms, substances, energy, or other components into water. It is common to find heavy metals in industrial effluent, and heavy metal pollution tends to grow with development.

Occupational Safety, both public and private organizations are required to make efforts to prevent accidents, fires, and occupational diseases. When an accident or occupational disease occurs, the corporation must take action in order not to lose money because of these incidents (Ak et al., 2022). Economic losses and non-economic losses are two types of losses

that can occur at the same time. In addition to direct financial losses, non-economic losses include damage to a company's reputation.

Workplace accidents are those that occur as a result of interactions between coworkers, including diseases that develop as a result of these interactions, as well as accidents that occur on the way from one's house to one's workplace and back again (Megasari, 2022).

Carbon and hydrogen-containing organic molecules are the building blocks of crude oil's complex combination. Aromatic hydrocarbons are a type of hydrocarbon component found in petroleum. There will be a strong black smoke and some aromatic hydrocarbons are hazardous if they are burned (causing cancer). Benzene compounds are aromatic hydrocarbon compounds found in petroleum.

Benzene, toluene, xylene, and ethylene are among the oil's harmful and poisonous compounds, according to the Agency for Toxic Substance and Disease Register ATSDR (Whelton et al., 2019). Exposure to benzene, the most toxic of the four, is the most dangerous. A hydrocarbon aromatic with the molecular formula C_6H_6 , benzene is a common chemical in everyday life. Due to their pleasant scent, several benzene derivatives are referred to as aromatic chemicals. Benzene differs from other hydrocarbons in its chemical makeup. Benzene vapor, which is poisonous and carcinogenic, is one of the chemical features of benzene.

Crude oil contains benzene at amounts of up to 4 g/l, and human activities in using petroleum contribute to exposure (Bücker et al., 2012). Toluene, xylene and other aromatic chemicals are produced, as well as their application in industry, as part of these activities. Benzene, a chemical in gasoline components, evaporates during use, posing a serious health risk to workers and emitting harmful emissions into the environment. Benzene can enter the human body through inhalation, ingestion, or contact with the skin, based on its effects on human health. Due to its very volatile nature, benzene exposure is mostly by inhalation and inhalation (WHO, 2010).

Benzene exposure can have both short-term (acute) and long-term (chronic) health impacts. Asthma, dizziness, sleepiness and confusion are among symptoms of acute benzene exposure, as are headaches, tremors and loss of consciousness. As an additional complication, it might cause eye and skin irritation. Chronic exposure to benzene results in anemia, pancytopenia, and thrombocytopenia in humans as a result of a reduction in the synthesis of red and white blood cells from the bone marrow. Aplastic anemia, acute myeloblastic leukemia, and acute erythroleukemia are the most serious consequences of chronic exposure.

Based on evidence from epidemiological studies or convincing clinical evidence from exposed humans, benzene is classified as a chemical proven carcinogen (Confirmed Human Carcinogen). As a result, benzene exposure in the workplace has a threshold value of 0.5 parts per million.

As a result, the company has implemented numerous safety measures to limit the risk of benzene exposure, including the installation of blowers, the installation of benzene hazard signs, the shift change, and the use of personal protective equipment. It is the goal of this study to examine the health effects of benzene exposure on human health, particularly for oil industry workers/employees (Filter et al., 2019).

Effects of Benzene on Health

Data on the health of workers who had been exposed to benzene in the workplace were used to analyze the substance's impact on their well-being and safety (Obrecht et al., 2019). Printing, shoe and bag manufacturing, rubber processing, and raincoat manufacturing (in the chemical process) are among the industries where workers are exposed to benzene. Inhalation is the

primary route of exposure, however dermal (skin contact) and oral exposure are also possibilities. It is important to note that the period of exposure to a toxic substance is broken down into acute, intermediate, and chronic exposure (365 days or more).

Effects of Acute Exposure to Benzene

Toxic exposures in the general population are usually linked to accidents and benzene addiction (Tilt & Xiao, 2010). Intentional exposure to benzene, whether via sniffing glue or other items containing benzene as a solvent, is responsible for many fatalities and major health problems. Exposure to concentrations has been linked to death. 30 minutes in a concentration of 24,000 mg/m³ (7,500 ppm) is dangerous to human life. Four thousand milligrams per cubic meter of air per minute for 60 minutes, 1,600 milligrams per cubic meter for five hours, and 80 milligrams per cubic meter of air for eight hours have no clinical effect. Acute benzene toxicity symptoms include depression of the central nervous system (CNS), cardiac arrhythmias, and, if exposure levels are high enough, shortness of breath and respiratory failure.

An acute oral benzene dose of approximately 110 milliliters is considered deadly (8.8 g). Vomiting, sleepiness, loss of consciousness, psychosis, pneumonitis, CNS depression, and collapse are all symptoms of acute oral poisoning. These symptoms include dizziness, visual abnormalities, euphoria and excitement, pallor, flushing, shortness of breath and chest tightness, headaches, weariness, drowsiness and fear of death, all of which can be caused by high oral doses but are not deadly. Benzene usage can also lead to ulcers in the gastrointestinal tract. Because it is fat soluble, benzene can injure skin when exposed repeatedly and over an extended period of time. It causes the skin to feel scorched and can induce erythema and swelling of the skin when exposed to liquid benzene. When benzene is inhaled, it can cause nausea, vomiting, and diarrhea in the intestines.

Effects of Chronic Exposure to Benzene

Haematotoxicity, immunotoxicity, neurotoxicity, and carcinogenicity are the most significant health impacts of short-term and long-term benzene exposure. Additionally, benzene exposure can cause aplastic anemia, chromosomal abnormalities, and carcinogenesis in the bone marrow, all of which can lead to bone marrow failure.

In an epidemiological research, benzene was found to be a human leukaemogen in cases where the majority of exposures were industrial. At an exposure level of 480-2100 mg/m³ (150-650 ppm), Aksoy & Erdem, 1978, studied 44 individuals with pancytopenia who had been exposed to benzene adhesive (adhesive) for four months to 15 years. There were six cases of metaplastic myeloid leukemia among the 44 individuals. There are numerous other studies that suggest that benzene exposure is linked to leukemia. When it comes to leukemia deaths, Tsai et al., 1983 found no correlation between the number of oil refinery workers who had been exposed to benzene and leukemia deaths during the period 1952 to 1981.

How likely is it that exposure to a substance in a certain amount and through a specific channel will have negative health effects on an organism, system, or subpopulation? (IPCS, 2004). Risk is a mix of a danger or exposure occurring, and the degree of the damage or illness produced by the hazard or exposure, according to another definition. Furthermore, risk management is a procedure for managing the hazards inherent in any activity.

It is possible to conduct risk assessments for environmental hazards that have already been exposed (post exposure) and for those that have yet to be exposed (forecasting future exposures).

There is a difference between a potential threat and a potential risk. Any property of an agent or condition that may have the potential to harm the organism, system, or subpopulation to which it is exposed is considered a danger by scientists. In addition, a hazard can be described as a cause, circumstance, or activity that has the potential for injuring or infecting humans with disease or a combination thereof. There are five categories of workplace hazards: worker body risk, health behavior risk, work environment risk (hazard factor or physical risk, chemical risk, and biological risk factor), ergonomic risk, and workplace organization and culture risk. Each of these five categories has a subcategory.

A risk analysis is essential in risk management. An organism, system, or subpopulation may be exposed to harm if a risk analysis is performed. There are three parts to the risk analysis process: risk assessment, risk management, and risk communication. Health risk assessment is a method for determining the likelihood and severity of certain health issues occurring over the course of a specific period of time.

Hazard Identification

Hazard identification is the initial stage of MRL to identify sources of risk. The information can be traced and the source and use of risk agents using an agent oriented approach (WHO, 1983). Hazard identification can also be done by observing symptoms and diseases related to the toxicity of risk agents in the community that have been collected in previous studies, either in the study area or in other places. Such a search is known as a disease-oriented approach (WHO, 1983). In this way, identification of the potential and actual presence of risk agents in environmental media can be used for dose-response analysis.

Identification of the risk of Benzene exposure to workers

Inhaled benzene concentrations were lower than the ATSDR's Minimum Risk Level (MRL) because of short-term exposure (14 days), long-term exposure (>364 days), and long-term exposure (>365 days). The threshold value of physical and chemical variables in the workplace (1.59 mg/m³) is also set by Regulation. MRL for chronic inhalation exposure to toluene decreased by the ATSDR of 7.6 mg/m³ was met, as was the acute exposure limit of (3.8 mg/m³), which was likewise restricted by the same laws as chronic exposure.

Benzene exposure to workers mostly indicates a non-carcinogenic health risk. To estimate risk factors in the coming year, anticipatory protection or early detection by exposure to Benzene is carried out in order to reduce the incidence of exposure to hazardous chemicals. Health effects arising from Benzene exposure that exceeds the threshold value and biological exposure index include symptoms of headache, fatigue, and respiratory irritation. Disorders of the hematopoietic system, bone marrow, central nervous system, and reproductive system. Smoking habits are also one that can worsen the health condition of workers. This has a negative effect on the impact of exposure.

Exposure is the process by which organisms come into contact with hazards. Exposure is the link between harm and risk. Exposure may occur due to inhalation of the risk agent in the air, ingestion with water or food, absorption through the skin or direct contact in the case of radiation.

Exposure assessment or exposure analysis, also called contact assessment, aims to identify risk agent exposure pathways so that the amount of intake received by individuals in the at-risk population can be calculated.

Risk characterization is the link between risk and risk management. Human intake (intake) is compared with a reference concentration (RfD or RfC). In the environmental health risk

analysis, RQ states the possibility of a potential risk occurring. The greater the RQ above 1, the greater the likelihood that the risk will occur. And conversely, if the RQ value is less than 1, the less likely the health risk will occur.

Methods of implementing risk management for workers

Based on the risk characteristics of Benzene exposure in a food industry, the selection of risk management implementation is to minimize RQ and ECR which aims to calculate or estimate the risk to a target organism, system or population, including identification of:

Determination of safe concentration limits for workers

One of the risk management activities is risk control by determining safe concentration limits for workers. The safe limit of concentration was calculated using the exposure time and frequency of exposure, the inhalation rate using the default value (Kolluru, 1996) of 20 m³/day or 0.83 m³/hour and the exposure period for 30 years.

Tegal Aspect

A review of the Tegal aspect was carried out on the threshold value (NAV) of the chemical BTX in the workplace air. To find out whether the NAV is safe enough for the workers. Then the calculation can be done before and after work.

Risk Management Implementation, Planning;

In developing risk management, it is necessary to have good planning which includes the following: (a) Setting targets to be achieved; (b) Evaluate the required requirements; (c) Create or establish company policies in risk management; (d) Adopt risk tolerance guidelines; (e) Planning a risk management program.

Risk Analysis

Risk analysis is the process of collecting data and synthesizing information to gain an understanding of the risks of a company. In conducting a risk analysis, the following steps are required, namely: (a) Determining the appropriate or appropriate risk analysis technique. There are various risk analysis techniques that can be used, but the selection of the right method will result in more accurate conclusions (b) Identifying hazards in all areas of operation; (c) Perform risk estimation from previously identified hazards; (d) Identify major/major risks that can cause disaster for the company; (e) Conduct sensitivity studies of existing risks.

Control Program

After conducting a risk analysis, an overall picture of the risks will be obtained. The results of risk analysis can be qualitative or quantitative depending on the technique or method used. The risk analysis will also provide an overview of the level of risk from the various potential hazards that exist. In this control stage, we can determine which risks will be prioritized to be controlled or all potential risks will be controlled. In the control system there are several programs that must be run, namely: (a) Identifying improvements that can be made to minimize the level of risk; (b) Evaluate risk reduction program options; (c) Determine the life cycle cost for risk reduction program options (d) Determine the most effective risk reduction program both in terms of cost and implementation.

Monitoring

Monitoring or supervision is a very important component in the implementation of a risk management system. The purpose of supervision is to ensure that the planned program runs as it should. Monitoring can be carried out in the form of an audit with the following stages: (a)

Developing an audit program; (b) Implement an audit program; (c) Provide feedback on audit findings; (d) Identify changes that require re-risking.

Communication

Although the communication program is tucked away at the end of the planning process, it has been in use since the beginning. This communication program has a significant impact on the success of risk management. (a) Providing information to all levels to get their support and involvement; (b) Communicating all risk management programs to all levels within the company; (c) All SOP program documents, policies, and risk analysis reports must be made in an easy-to-understand format; (d) Emphasizing limitations or assumptions made.

Solutions from Risk Management for Workers

Personal Protective Equipment (PPE) is a tool that has the ability to protect someone in work whose function is to isolate the workforce from hazards in the workplace. PPE is used after the engineering efforts and safe work practices have been maximized. However, the use of PPE is not a substitute for these two efforts. As a last resort in an effort to protect the workforce, PPE must be comfortable to wear, does not interfere with work and provides effective protection against hazards.

Respiratory protective equipment serves to provide protection against sources of danger in the workplace air such as lack of oxygen, pollution by particles, pollution by gas or steam. There are three types of respiratory personal protective equipment, namely: 1) respirators that purify the air, 2) respirators that are connected to a clean air supply and 3) oxygen-supply respirators.

Several things should be taken into account before deciding on the best respiratory protection: It is important to consider (a) the type of hazard that is present (particulates, gases, vapours etc.); (b) the presence of contaminants and their levels; (c) the emergency consequences if the breathing apparatus fails; (d) the length of time spent in a polluted environment; (e) the location of the polluted area; and (f) the roads that lead to and from the polluted area. There are three types of respirator masks that are utilized for BTX inhalation exposures of less than or equal to 10%, 50% and 100%: half mask respirators, full faceplace respirators, and full faceplace powered respirators (Gunawan, 2000).

Conclusion

Benzene exposure in the work environment varies. In the environmental health risk analysis, RQ states the possibility of a potential risk occurring. The greater the RQ above 1, the greater the likelihood of that risk occurring. And conversely, if the RQ value is less than 1, the less likely the health risk will occur.

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