Occupational Exposure to Styrene Vapor and Determining Risks of Health Consequences in Petrochemical Industry Workers


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ABSTRACT

Introduction: Styrene (C₆H₅CH=CH₂) is known as one of the volatile organic substances produced or used in petrochemical industries. Exposure to this chemical compound can thus lead to respiratory diseases. Therefore, this study aimed to evaluate occupational exposure to styrene vapor and to determine the risks of its health consequences in petrochemical industry workers through a quantitative method.

Material and Methods: In this descriptive cross-sectional study, a total number of 150 samples from 50 employees were studied using the National Institute for Occupational Safety and Health (NIOSH) 1501 method. The samples were then analyzed by the Varian CP-3800 chromatograph. Upon determining exposure to styrene vapor, the risk assessment of the health consequences of styrene in the workers in the given industry was evaluated via the relationships established by the United States Environmental Protection Agency (US/EPA).

Results: According to the results, the polybutadiene latex unit (PBL) was observed with the highest average exposure (0.44 mg.(kg-day)-1). Therefore, the top predictors of carcinogenic and non-carcinogenic risks were valued 0.44 and 0.71, respectively, for the PBL unit. Given the lowest average exposure (0.0012 mg.(kg-day)-1) in the drying unit, the prediction revealed the most moderate carcinogenic (0.1 ×10⁻⁵) and non-carcinogenic risks (2×10⁻³) for the same employees.

Conclusion: Overall, the health risk was higher than the permissible limit in the petrochemical industry studied, especially in the PBL unit. Therefore, it is recommended to make use of artificial ventilation, notably the local type, in addition to the natural ones.

Keywords: Health Risk Assessment; Styrene; Occupational exposure; Petrochemical

1. INTRODUCTION
Styrene (C₆H₅CH=CH₂) is known one of the volatile organic substances produced or used in petrochemical industries (1). Exposure to this chemical compound can thus bring about toxic effects, including changes in the central and peripheral nervous systems, such as drowsiness, headache, imbalance, skin irritation, problems in respiratory system, and mild liver damage (2, 3). The United States Environmental Protection Agency (US/EPA) has also proposed the Integrated Risk Information System (IRIS) method to decide on controlling measures and protecting employees from chemical injuries (4).

2. MATERIALS AND METHODS
In total, 50 workers were randomly selected from similar exposure groups to be included in the present study. Sampling was further performed according to the NIOSH 1501 method. Three samples (namely, two samples before the rest time and one after it) were taken from each worker. Accordingly, 150 samples were collected. The samples were then injected into a Varian CP-3800 gas chromatography following their preparation and the analyte was extracted using carbon disulfide (CS₂). The results of the analysis of the samples were subsequently utilized to calculate respiratory exposure as well as carcinogenic and non-carcinogenic risks through the EPA method (5, 7). Finally, the results were
compared with the values recommended by the World Health Organization (WHO).

3. RESULTS AND DISCUSSION
As shown in Fig. 1, it is predicted, according to the WHO classification, that if exposure to styrene lasts for 30 years, there will be definitive carcinogenicity in 22% of cases. For 34% of exposure, the agency also forecasts a probable risk. Overall, an 82% risk of cancers is predicted for styrene. In this sense, the results of the Kruskal-Wallis test also revealed significant differences between the units in terms of exposure concentration, exposure level, and health risks of styrene (P<0.05).

4. CONCLUSION
The carcinogenic and non-carcinogenic risks of styrene in some units, especially in the PBL unit, were higher than that within the EPA recommended limit. Therefore, one of the most prominent measures to improve operating conditions and to reduce exposures to styrene vapor is the use of local artificial ventilation at specific places, including the area of melting extraction from the mixer with adequate suction power.

5. ACKNOWLEDGEMENT
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6. REFERENCES