



Explorer of Natural Gases Happening to Damage of Humans Health

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Abstract

The use of industrial gas for the production of plastics, latex paints and coatings, synthetic rubbers, polyesters, and other materials, primarily styrene, raises concerns about the possibility of exposure to hazardous air pollutants such as Benzene, styrene, and Methyl Isocyanate (MIC), which are highly exposable chemical compounds and are currently used in the petroleum industries. Recently, the state of Andhra Pradesh Visakhapatnam saw the largest styrene gas leak into the atmosphere, which LG Polymer India Company Limited caused. The LG Polymers Company produces plastics, polyesters, synthetic rubber, latex paints, and coatings. This paper discusses the risks associated with a styrene gas leak occurrence.

Keywords: MIC; Benzene; Hazards; Styrene; Gas leakage; Polyesters

Introduction

Methyl Isocyanate, or MIC

The most significant tragedy in India occurred a few years ago, on December 2nd, 1984, when workers at the Union Carbide facility in Bhopal, India, were exposed to methyl isocyanate gas. The eyes, respiratory system, and skin were a few of the major organs. Acute irritating effects on the eyes and respiratory system were significant results.

Methyl isocyanate is a white liquid with a strong scent. Its molecular weight is 57.1, soluble in water and methylamine, and it breaks down into carbon dioxide when heated to its boiling point of 39°C [1]. The skin, eyes and respiratory membranes become immediately irritated when the human body is exposed to this gas [2].

Effects on health

Respiratory poisoning the upper and lower respiratory tracts were affected by this gas exposure, with the respiratory tract being the most severely impacted. The most common symptoms were coughing, a sense of suffocation and chest discomfort, dyspnea, irritation of the throat, and rhinorrhea [3].

Carcinogenicity of MIC

Ennever et al. [4] described the battery selection technique and carcinogen prediction methods to determine the MIC carcinogenicity. According to the results of several *in vitro* and *in vivo* investigations, the MIC gas had a 76% risk of being a genotoxic carcinogen, according to the study's authors. Negative assays in that test showed high specificity and low sensitivity, whereas positive assays had low specificity and high sensitivity. It suggests a mild to moderate carcinogenicity. Finally, the authors concluded that the MIC in this situation was an animal carcinogen due to its low potency. In a different research, an examination of the population-based cancer registry in Bhopal identified a relative risk of lung, buccal cavity, and oropharyngeal cancers. Because of tobacco usage, the ICMR Cancer Institute observed increased lung cancer rates and impacted parts of the tongue, mouth, and esophagus. Finally, the living style and other biological characteristics may lessen the danger of MIC exposure, according to research by the Jawaharlal Nehru Cancer Hospital and Research Center (JNCHRC) conducted in Bhopal. MIC has not been designated as a carcinogen by the International Agency for Research on Cancer (IARC) or the US Environmental Protection Agency [5-7].

Styrene Monomer

On May 7th, 2020, a new natural gas leak using styrene occurred in Vizag. Numerous individuals were affected, and 12 people died. This gas influences thousands of individuals within

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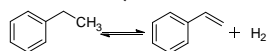
a 5-kilometer radius [8]. One of the most significant monomers in the contemporary petrochemical sector is styrene. In the year 1930, it was created. The most significant polymeric compounds made using styrene are polystyrene, styrene-acrylonitrile, and others. Styrene is mainly manufactured in the industry by dehydrogenating the ethylbenzene method. Styrene is a gaseous, liquid substance with no color and a strong smell. Styrene, sometimes referred to as vinyl benzene, is a crucial industrial chemical molecule utilized in producing a wide range of industrial resins, including polystyrene and hundreds of copolymers. One of the most significant monomers in the contemporary petrochemical sector is styrene. In the year 1930, it was created. Most polymeric compounds produced with styrene include polystyrene, styrene-acrylonitrile, and others. Styrene is mainly manufactured in the industry by the dehydrogenation of ethylbenzene.

Styrene is a gaseous, liquid substance with no color and a strong smell. Styrene was initially identified in 1831 as a Storax balsam distillation byproduct [9]. Its molecular mass is 104.15, and its chemical formula is $C_6H_5CH=CH_2$. Water, ethanol, Benzene, and petroleum ether have a small amount of solubility in styrene. A substance having a high boiling point is styrene. The organic molecule styrene has the chemical formula C_8H_8 . It is kept as a liquid in industries, but as it readily evaporates, it must be kept at low temperatures. One of the most significant monomers in the contemporary petrochemical sector is styrene. Polystyrene, styrene-acrylonitrile, and acrylonitrile-butadiene-styrene are the three most significant polymeric compounds produced primarily from styrene (ABS). Styrene can be found in consumer goods, including drinking cups, insulation for wiring and appliances, fiberglass, plastic pipes, and vehicle parts. Styrene from the Hazards gas was recently discovered to have spilled in Vizag on May 7th, 2020. Numerous individuals were affected, and 12 people died. This gas influences thousands of people within a 5-kilometer radius [8].

Preparation of styrene

From Ethyl Benzene: Most styrene monomer is made from ethyl benzene [10], and virtually all ethyl benzene generated globally is used to make styrene. Because of this, the two processes are frequently quite interwoven. A Friedel-Crafts reaction between Benzene and ethylene produces ethylbenzene. Originally, this process employed aluminum chloride as a catalyst, but in contemporary manufacture, zeolite has taken its place.

By dehydrogenation: Total styrene produced by the dehydrogenation of ethylbenzene is 80%. Using superheated steam and over an iron (III) oxide catalyst [11].



Finally, the crude product of ethylbenzene is purified by the distillation method. The differences in the boiling point between the two compounds were only 90°C at ambient pressure use of a series of distillation columns. It is complicated by the tendency of monomers to undergo thermally induced into polystyrene [12].

Synthesis of polystyrene

The polymerization of the styrene monomer creates polystyrene during its production. Styrene can be polymerized *via* free radical, anionic, and cationic reactions, as well as employing metal catalysts in this process.

Industrial gas leakage: As we consider the LG Polymers

accident in Vizag, memories of the Bhopal Gas Leak Disaster of 1984 immediately emerge. The same disregard for human life, the same disregard for conventional operating protocols, and the same absence of emergency measures. Recently, a gas leak was discovered in Vishakhapatnam, Andhra Pradesh. Numerous hazardous industries are located in the port city of Vizag, also known as Vishakhapatnam, which is found in the state of Andhra Pradesh on the southeast coast of India. The alarming news of a toxic chemical leak from a plant producing polystyrene-based products located about 15 km away on the outskirts of the city at a private plastic manufacturing plant owned by LG Polymers Pvt. Ltd. rudely awakened five million residents of the Vizag Metropolitan Region on May 7th, 2020, early in the morning. The styrene gas leak in Vishakhapatnam resulted in severe dyspnea. Up to this point, roughly 12 persons and 32 animals have perished from being exposed to deadly styrene vapors that escaped from the factory [13]. Over 800 of the estimated 1000+ victims of injuries who resided in nearby communities within a six-kilometer radius had to be hospitalized. A further 4,000 people were able to leave the area unharmed after being alerted to evacuate in time by a few volunteers. Nearly 10,000 more locals were compelled to flee their houses in a panic [14].

The death toll might have been far worse if the extremely combustible styrene vapors caught fire and the massive amount of styrene monomer housed in the plant's two giant tanks had been released. Most people living in the Vizag Metropolitan region are fortunate to have escaped the most recent calamity unhurt because, miraculously, that did not occur. Although styrene is much less toxic than MIC (Methyl-Iso-Cyanate), the chemical that had caused the Bhopal disaster in 1984, the enormous amount of styrene that had been stored at the plant at the time of the disaster (reportedly about 7,000 kiloliters compared to the 80 kiloliters of MIC at Bhopal) did have the potential to cause a massive disaster in the Vizag region that would have had much worse (Fortunately, the remaining styrene monomer in the concerned tank has been deactivated, and on May 11th, 2020, 5,000 kiloliters from the plant's unaffected tanks was sent back to Seoul.) Styrene is invisible, heavier than air, and very combustible. The Threshold Limit Value (TLV) for styrene, as defined by the safety guidelines established by the American Conference of Governmental Industrial Hygienists (ACGIH), is 20 pp, TWA (Time Tested Average) for an exposure duration of eight hours. The Short-Term Exposure Level (STEL) for styrene for fifteen minutes is 40 ppm [by comparison, the TLV of MIC is 0.02 ppm] (parts per million). While the Immediately Dangerous to Life or Health (IDLH) dose of styrene is around 700 ppm, according to the National Institute for Occupational Safety & Health (NIOSH), USA [15]. Styrene may enter the body of a human by breathing, ingesting food, and skin contact. Styrene takes a few days to degrade into other compounds and pass through urine after entering the human body. Styrene impacts the stomach and eyes when it is introduced to people. Long-term impacts include central nervous system dysfunction, depression, hearing loss, and peripheral neuropathy. If exposed to styrene gas for extended periods, they risk leukemia and headaches. Styrene exposure at work has been the subject of studies, although those results have not been definitive. The United States Environmental Protection Agency has proved styrene to have low to moderate toxicity by inhalation and oral exposure in experiments, including acute exposure of rats and mice. In animal studies, styrene exposure by inhalation has been linked to effects on the neurological system, liver, kidneys, and nose discomfort. Animals exposed to chromium orally affect their liver, blood, kidneys, and stomach.

Exposure to styrene gas

Chronic low-level exposure to styrene may cause cancer. The United States Environmental Protection Agency (EPA) states that short-term exposure to low levels of styrene in humans can have gastrointestinal symptoms as well as mucous membrane and ocular irritation. On the other hand, prolonged exposure impacts the central nervous system, resulting in headaches, weakness, exhaustion, hearing loss, nerve damage, and depression. Exposure to it can result in shortness of breath, respiratory issues, eye irritation, indigestion, and nausea, momentary loss of consciousness, unsteady walking, and giddiness. When styrene vapor is inhaled in large amounts, it irritates the skin, eyes, and lungs and makes breathing difficult. However, these disorders may worsen in Chronic Obstructive Pulmonary Disease (COPD) patients and respiratory illnesses, including asthma. Exposure to styrene gas primarily affects mucosal membranes. Compared to other organic compounds, styrene takes longer to enter the blood from the lungs. According to studies, 86% of styrene that enters the body is eliminated through urine.

The styrene leaked in what way?

Humans can have gastrointestinal symptoms, mucous membrane irritation, and ocular discomfort after short-term exposure to low amounts of styrene. Styrene cannot seep into the air unless high-temperature, such as a fire or an explosion. From an LG Chem Polymers storage tank, styrene gas spilled. The plant opened its doors in 1961. In the beginning, Hindustan Polymers produced polystyrene. In 1978, it amalgamated with McDowell & Co of the UB Group, and in 1997, South Korean company LG Chem acquired and renamed it LG Polymers. Expandable polystyrene, general-purpose polystyrene, high-impact polystyrene, and engineering plastics compounds are all produced at the business. It is situated 15 kilometers outside Visakhapatnam city at RRV Puram in Gopalapatnam. A corporate representative stated that a tank with a capacity of 2,400 tones was holding 1,800 tones of styrene. The gas escaped from this tank when authorities were getting ready to reopen the plant that had been shut down for 44 days owing to the lockout. Before it could be contained, around half of the gas spilled. There are significant environmental and occupational exposures to Benzene since it has been measured in all areas of the environment and is often released in several industrial and transportation contexts. The most frequent exposure route is inhalation, although Benzene can contaminate food and water, quickly permeate the skin, and cause cutaneous and gastrointestinal exposures. This incident in Visakhapatnam is connected to elevated levels of Benzene and had a positive outcome.

Styrene monomer applications

One of the most significant monomers for industrial polymers and co-polymers, which are employed in many applications, is styrene. Plastics, latex paints and coatings, synthetic rubbers, and polyesters are the main uses for styrene monomer [16]. The most common use of resins containing styrene monomer is in foams used as fillers and bolsters. Additionally, pipes, fittings, tanks, lighting fixtures, and corrosion-resistant items have applications in the construction industry. Artificial marble, flooring, throwaway dinnerware, and furniture made of plastic are examples of household items. Applications for transportation materials include car body putty, reinforced plastics, and tires. The vast majority of styrene is transformed into polystyrene resins, which may be easily molded and compatible with various colorants, modifiers, and fillers. The second-largest families of Styrene-Acrylonitrile (SAN) resins, co-

polymers, and adducts are used in various moldings for appliances, automobiles, buildings, pipelines, and electronics [17].

Causes of styrene

Styrene causes include a recent gas leak in Vishakhapatnam, Andhra Pradesh. In the wee hours of July 5th, 2020, a leak occurred at a privately held plastic manufacturing facility operated by LG polymers Pvt. Ltd. Styrene or vinyl benzene was used to confirm the gas. It is employed in the manufacture of resins and polymers made of polystyrene. These materials are used in food packaging, rubber, plastic, etc. PVC gas is another name for it. It can enter a person's body by inhaling, eating, or skin-to-skin contact. Styrene takes a few days to degrade into other compounds and pass through urine after entering the human body. Styrene impacts the stomach and eyes when it is introduced to people. Long-term impacts include central nervous system dysfunction, depression, hearing loss, and peripheral neuropathy.

Styrene carcinogenicity: According to the National Toxicology Programs (NTP) to the human studies, which are based on the 2,009 exposure of employees to these gases, there is only minimal evidence that styrene monomer causes cancer in people [18]. The likelihood of developing esophageal and pancreatic cancer among these exposed monomers is also elevated; as is mortality from cancer of the lymphohematopoietic system and genetic damage in lymphocytes due to DNA adduct levels [19]. Styrene exposure and cancer in humans are linked, however, by the discovery of DNA adducts and chromosomal abnormalities in lymphocytes from the exposed individuals.

Applications of polystyrene

In addition to being used for packing, polystyrene is used to make furniture, refrigerators, and other toys. Furthermore, the co-polymers of ABS and SAN are primarily utilized in transportation, watercraft, and the medical industry. The principal application for polystyrene foam is an insulating material for heat-sensitive goods.

Benzene

Colorless and combustible, Benzene has a lovely smell. When exposed to air, it swiftly evaporates. It serves primarily as a raw material for producing other chemicals, including plastics, rubber, dyes, medicines, lubricants, and insecticides. Additionally, it was frequently employed as an industrial solvent. Along with gasoline, cigarettes, and crude oil, Benzene is a naturally occurring component of all three.

Exposure locations

This viewpoint mentions a few locations, including the rubber industry, oil refineries, chemical factories, and gasoline-related businesses.

Health effects

This substance has the potential to be hazardous. These impacts are listed below if exposure to it can have immediate and long-term adverse health effects.

Short-term consequences

Dizziness, headaches, tremors, disorientation, and unconsciousness are short-term side effects. The neurological system can be impacted by benzene inhalation at significant concentrations. High doses of Benzene can make you throw up, make your stomach hurt, make you sleepy, and make your heart beat quickly. However,

eating or breathing very high levels of Benzene can be fatal. Benzene usually irritates the skin, eyes, and throat when exposed to it. Redness on the skin might happen after exposure to Benzene.

Long-term consequences

The soft inside of bones, called the bone marrow, is where new blood cells are primarily harmed by exposure to Benzene. One possible outcome is anemia (which can cause a person to feel weak and tired.) Low platelet count 2. (Which can lead to excess bruising and bleeding). 3. A low white blood cell count, potentially fatal, might make the body less able to fight infections.

Carcinogenicity of benzene

International Agency for Research on Cancer (IARC): Benzene is carcinogenic. It belongs to the WHO. Based on adequate evidence that Benzene causes Acute Myeloid Leukemia (AML), Acute Lymphocytic Leukemia (ALL), Chronic Lymphocytic Leukemia (CLL), and multiple myeloma, the IARC has classified Benzene as carcinogenic to humans.

The National Toxicology Program (NTP) has also designated Benzene as a substance known to cause human cancer.

The Integrated Risk Information System (IRIS), a database with information on the effects of exposure to numerous environmental contaminants on human health, is maintained by the US Environmental Protection Agency (EPA). The EPA lists Benzene as a recognized human carcinogen [20].

Conclusion

The authors concluded by stating that all of these natural gas exposures have a negative impact on human health and, in some situations, result in fatalities. These chemical compounds were released into indoor air due to cigarette smoking and emissions from various home items. They are highly significant chemicals utilized in manufacturing a wide range of polymers, copolymers, and glass-reinforced plastics. There is also a chance of being exposed to small amounts of food. Many people were sick, and some died due to the toxic gas leak that occurred in Bhopal and Vizag. It might spread across the natural world and contaminate the air, water, animals, and even people. Therefore, we should take care of our future and defend ourselves against such risks of tragedies.

References

- Blake PG, Ijadi-Maghsoodi S. Kinetics and mechanisms of the thermal decomposition of methyl isocyanate. *Int J Chem Kinetics*. 1982;14(8):945-52.
- Lewis RJ, Irving N, editors. *Sax's dangerous properties of industrial materials*. 5th Ed. New York: Van Nostrand Reinhold. 1979:24.
- Mishra UK, Nag D. A clinical study of toxic gas poisoning in Bhopal, India. *Indian J Exp Biol*. 1988;26(3):201-4.
- Ennever FK, Rosenkranz HS. Evaluating the potential for genotoxic carcinogenicity of methyl isocyanate. *Toxicol Appl Pharmacol*. 1987;91(3):502-05.
- Agency for toxic substances and disease registry. ATSDR. 2003.
- IARC monographs on the evaluation of carcinogenic risks to humans, supplement 6, genetic and related effects: An updating of selected IARC monographs from volumes 1-42. International Agency for Research on Cancer, Lyon. 1987.
- US-EPA. Health and environmental effects profile for methyl isocyanate. US Environmental Protection Agency. 1986.
- Pandey A. Vizag gas leak: CCTV footage shows how toxic vapour engulfed village as many collapsed on ground. 2020.
- National institute for occupational safety and health.
- James DH, Castor MW. Styrene. *Ullmann's Encyclopedia of Industrial Chemistry* (7th Ed). Wiley. 2007:1.
- Vaishali RA. Visakhapatnam gas leak kills 32 animals, 199 treated, says Animal Husbandry department. *The New Express*. 2020.
- Janardha Rao G. LG polymers gas leak: Panic subsides after the nightmare on Visakhapatnam streets. *The New Indian Express*. 2020.
- Hazardous substances fact sheet. New Jersey Department of Health. 2016:1-3.
- Lee EH. Iron oxide catalysts for dehydrogenation of ethylbenzene in the presence of steam. *Catal Rev Sci Eng*. 2006;8(1):285-305.
- Khuong, Kelli S, Jones, Walter H, Pryor, William A, et al. The mechanism of the self-initiated thermal polymerization of styrene. Theoretical solution of a classic problem. *J Am Chem Soc*. 2005;127(4):1265-77.
- Collins DE, Richey FA. Synthetic organic chemicals. In: Kent JA, editor. *Riegel's Handbook of Industrial Chemistry*, 9th Ed. New York, Van Nostrand Reinhold. 1992:800-62.
- Marczynski B, Razynek P, Eliehauson HJ, Korn M, Baur X. Detection of 8-hydroxydeoxyguanosine, a marker of oxidative DNA damage, in white blood cells of workers. Occupationally exposed to styrene. *Arch Toxicol*. 1997;71(8):496-500.
- Styrene. CAS No. 100-42-5. Reasonably anticipated to be human carcinogen. 12th Report on Carcinogens, National Toxicology Program. 2011.
- Teixeira JP, Gaspar J, Coelho P, Costa C, Pinho-Silva S, Costa S, et al. Cytogenetic and DNA damage on workers exposed to styrene. *Mutagenesis*. 2010;25(6):617-21.
- Benzene and cancer risk.