Styrene

100-42-5

Hazard Summary

Styrene is primarily used in the production of polystyrene plastics and resins. Acute (short-term) exposure to styrene in humans results in mucous membrane and eye irritation, and gastrointestinal effects. Chronic (long-term) exposure to styrene in humans results in effects on the central nervous system (CNS), such as headache, fatigue, weakness, and depression, CSN dysfunction, hearing loss, and peripheral neuropathy. Human studies are inconclusive on the reproductive and developmental effects of styrene; several studies did not report an increase in developmental effects in women who worked in the plastics industry, while an increased frequency of spontaneous abortions and decreased frequency of births were reported in another study. Several epidemiologic studies suggest there may be an association between styrene exposure and an increased risk of leukemia and lymphoma. However, the evidence is inconclusive due to confounding factors. EPA has not given a formal carcinogen classification to styrene.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (5), which contains information on inhalation and oral chronic toxicity of styrene and the RfC and the RfD, and the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for Styrene. (1)

Uses

- Styrene is used predominately in the production of polystyrene plastics and resins. Styrene is also used as an intermediate in the synthesis of materials used for ion exchange resins and to produce copolymers. (1)

Sources and Potential Exposure

- Indoor air is the principal route of styrene exposure for the general population. Average indoor air levels of styrene are in the range of 1 to 9 $\mu g/m^3$, attributable to emissions from building materials, consumer products, and tobacco smoke. (1)
- Ambient air in urban locations contains styrene at average concentrations of 0.29 to 3.8 $\mu g/m^3$, while styrene in rural and suburban air has been measured at 0.28 to 0.34 $\mu g/m^3$. (1)
- Occupational exposure to styrene occurs in the reinforced plastics industry and polystyrene factories. (1)

Assessing Personal Exposure

- Laboratory tests can determine styrene by measuring the breakdown products in the urine. However, these tests are only useful for detecting very recent exposures. (1)

Health Hazard Information

Acute Effects:

- Acute exposure to styrene in humans results in respiratory effects, such as mucous membrane irritation, eye irritation, and gastrointestinal effects. (1,2)
- Tests involving acute exposure of rats and mice have shown styrene to have low to moderate toxicity by inhalation and oral exposure. (3)

Chronic Effects (Noncancer):

- Chronic exposure to styrene in humans results in effects on the CNS, with symptoms such as headache, fatigue, weakness, depression, CNS dysfunction (reaction time, memory, visuomotor speed and accuracy, intellectual function), and hearing loss, peripheral neuropathy, minor effects on some kidney enzyme functions and on the blood. (1-3)
- Animal studies have reported effects on the CNS, liver, kidney, and eye and nasal irritation from inhalation exposure to styrene. (1)
- Liver, blood, kidney, and stomach effects have been observed in animals following chronic oral exposure.(5)
- The Reference Concentration (RfC) for styrene is 1 milligram per cubic meter (mg/m^3) based on CNS effects in occupationally exposed workers. The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At exposures increasingly greater than theRfC, the potential for adverse health effects increases. Lifetime exposure above the RfC does not imply that an adverse health effect would necessarily occur. (5)
- EPA has medium confidence in the study on which the RfC was based because, although the study documents concentration-response relationships of CNS effects in a relatively small worker population, the results are consistent with a number of other studies showing central effects in chronically exposed worker populations; medium to high confidence in the database because the chronic laboratory animal studies addressing noncancer endpoints were not available, although a number of human exposure studies support the choice of critical effect; and, consequently, medium confidence in the RfC. (5)
- The Reference Dose (RfD) for styrene is 0.2 milligrams per kilogram body weight per day (mg/kg/d) based on red blood cell and liver effects in dogs. (5)
- EPA has medium confidence in the principal study on which the RfD was based because it was well done and the effect levels seem reasonable, but the small number of animals/sex/dose prevents a higher confidence; medium confidence in the database because it offers strong support, but lacks a bona fide full-term chronic study; and, consequently, medium confidence in the RfD. (5)

Reproductive/Developmental Effects:

- Human studies have not reported an increase in developmental effects in women who worked in the plastics industry, while an increased frequency of spontaneous abortions and a decreased frequency of births were reported in a study on the reproductive effects of styrene in humans. However, these studies are not conclusive, due to the lack of exposure data and confounding factors. (1,2)
- Animal studies have not reported developmental or reproductive effects from inhalation exposure to styrene. (1)
- Lung tumors have been observed in the offspring of orally exposed mice. (12)

Cancer Risk:

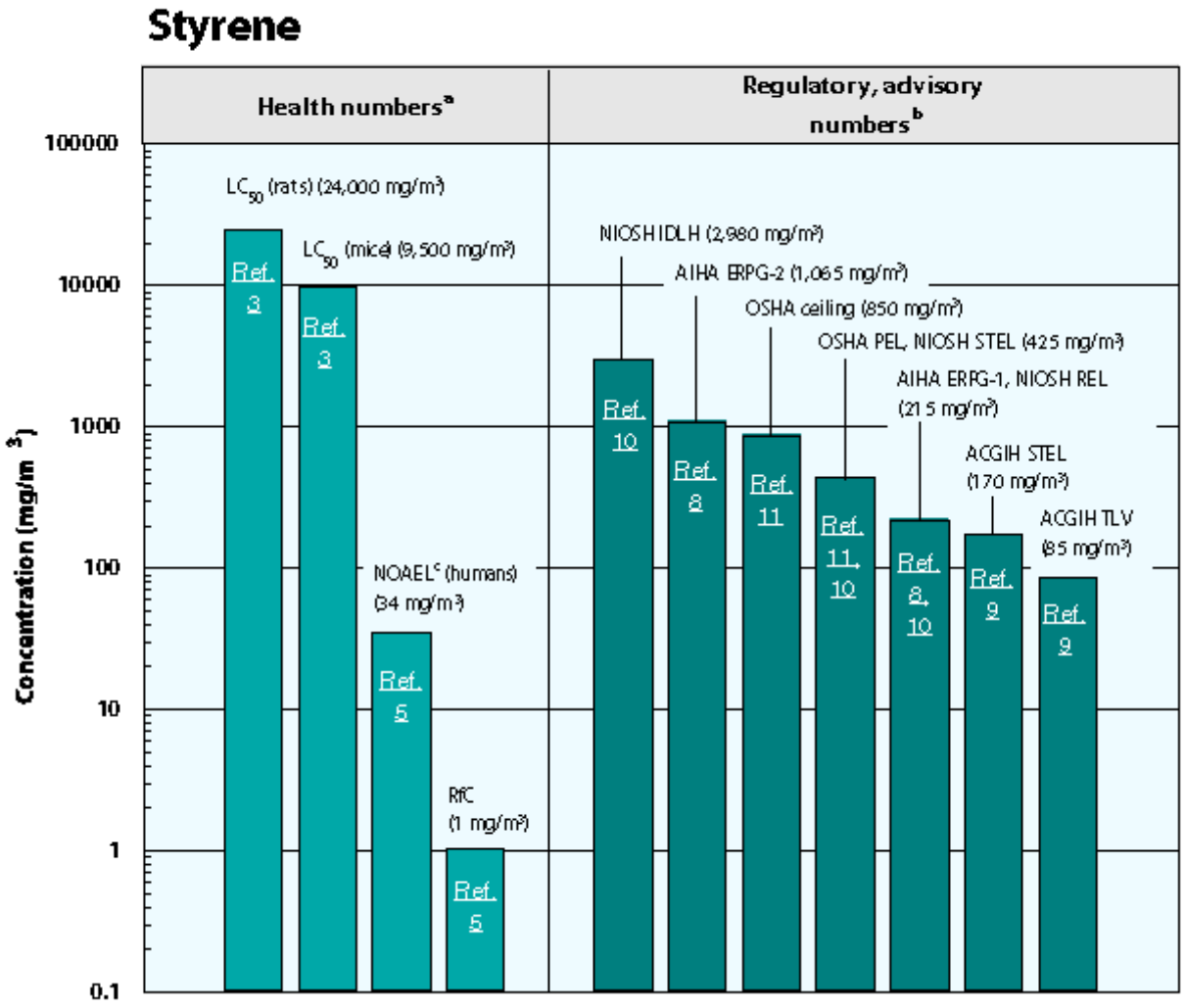
- Several epidemiologic studies suggest that there may be an association between styrene exposure and an increased risk of leukemia and lymphoma. However, the evidence is inconclusive due to multiple chemical exposures and inadequate information on the levels and duration of exposure. (1,2,7,12)
- Animal cancer studies have produced variable results and provide limited evidence for carcinogenicity.(7)
- IARC has classified styrene as a Group 2B, possibly carcinogenic to humans. (12)
- Styrene oxide is a reactive metabolite of styrene and shows positive carcinogenic results in oral exposure bioassays. Styrene oxide has been detected in workers exposed to styrene. IARC has classified this metabolite as a Group 2A, probable human carcinogen. (7,12)
- EPA does not have a carcinogen classification for styrene; the chemical currently is undergoing an EPA Integrated Risk Information System (IRIS) review to establish such a classification. (5)

Physical Properties

- Styrene is a colorless liquid that has a sweet smell. (1)
- The odor threshold for styrene is 0.32 parts per million (ppm). (6)
- The chemical formula for styrene is C_8H_8, and the molecular weight is 104.16 g/mol. (1)
- The vapor pressure for styrene is 5 mm Hg at 20 °C, and its octanol/water partition coefficient (log K_{ow}) is 2.95. (1)

Conversion Factors:
To convert concentrations in air (at 25 °C) from ppm to mg/m^3: mg/m^3 = (ppm) × (molecular weight of the compound)/(24.45). For styrene: 1 ppm = 4.26 mg/m^3.

Health Data from Inhalation Exposure



AIHA ERPG --American Industrial Hygiene Association's emergency response planning guidelines. ERPG 1 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor; ERPG 2 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing or developing irreversible or other serious health effects that could impair their abilities to take protective action.
ACGIH STEL --American Conference of Governmental and Industrial Hygienists' short-term exposure limit; a 15-minute TWA exposure which should not be exceeded at any time during a workday.
ACGIH TLV --ACGIH's threshold limit value expressed as a time-weighted average; the concentration of a substance

to which most workers can be exposed without adverse effects.
LC_{50} (Lethal Concentration $_{50}$)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.
NIOSH IDLH -- National Institute of Occupational Safety and Health's immediately dangerous to life or health concentration; NIOSH recommended exposure limit to ensure that a worker can escape from an exposure condition that is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from the environment.
NIOSH REL--NIOSH's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.
NIOSH STEL--NIOSH's recommended short-term exposure limit; a 15-minute TWA exposure which should not be exceeded at any time during a workday.
NOAEL--No-observed-adverse-effect level.
OSHA ceiling --Occupational Safety and Health Administration's permissible exposure limit ceiling value; the concentration of a substance that should not be exceeded at any time.
OSHA PEL--OSHA's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

The health and regulatory values cited in this factsheet were obtained in December 1999.
[a] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.
[b] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH, ACGIH, and AIHA numbers are advisory.
[c] This NOAEL is from the critical study used as the basis for the EPA RfC.

References

Summary created in April 1992, updated in January 2000

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