Sources of Exposure

General Populations

- Exposure may occur by inhalation, ingestion, or dermal absorption. The most likely mode of exposure is by inhalation of indoor air.
- Styrene is also present in combustion products such as cigarette smoke and automobile exhaust.
- Styrene copolymers are also frequently used in liquid toner for photocopiers and printers.
- Small amounts of styrene are naturally present in foods such as legumes, beef, clams, eggs, nectarines, and spices. Small amounts can also be present in packaged foods by migration from polystyrene food containers and packaging materials.

Occupational Populations

- The highest potential exposure occurs in the reinforced plastics industry.
- Workers involved in styrene polymerization, rubber manufacturing, and use of styrene-polyester resin may also be exposed.
- Workers at photocopy centers or facilities may also be exposed to styrene.

Toxicokinetics and Normal Human Levels

Toxicokinetics

- Styrene is well absorbed by the inhalation and oral routes and poorly absorbed through the skin.
- Once absorbed, styrene is widely distributed throughout the body, with the highest levels detected in fat.
- There are several metabolic pathways for styrene; the primary pathway is oxidation of the side chain by cytochrome P450 to form styrene 7,8-oxide. The styrene oxide is further metabolized to ultimately form mandelic acid, phenylglyoxylic acid and hippuric acid or can be conjugated with glutathione to form phenylhydroxylethylmercapturic acids.
- Styrene is rapidly eliminated primarily in the urine as mandelic acid and phenylglyoxylic acid.

Reported Human Levels

- Urinary levels of styrene were 0.7-4.1 ppb in workers exposed to 3.8-14 ppm of styrene; average blood styrene levels in adults without occupational exposure to styrene were 0.22 ppb.

Biomarkers/Environmental Levels

Biomarkers

- Urinary levels of mandelic acid and/or phenylglyoxylic acid can be used to quantify exposure. However, these metabolites are not specific to styrene.
- Qualitative biomarkers included styrene levels in exhaled air and blood styrene levels.

Environmental Levels

Air

- Median concentrations in urban and rural/suburban air samples are 0.07–4.6 ppb and 0.06–0.08 ppb.
- Median concentration in indoor air samples are 0.07–11.5 ppb.

Sediment and Soil

- Styrene is rarely detected in soil samples.

Water

- Styrene is rarely detected in drinking water samples.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2010. Toxicological Profile for Styrene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™ for Styrene

C_8H_8

CAS# 100-42-5

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U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
www.atsdr.cdc.gov

Contact Information:
Division of Toxicology
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Applied Toxicology Branch

1600 Clifton Road NE, F-62
Atlanta, GA 30333
1-800-CDC-INFO

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Chemical and Physical Information

Styrene is a liquid

- Styrene is a colorless liquid that evaporates easily.
- Styrene is a high production chemical primarily used in the production of polystyrene plastics and resins, copolymers such as styrene-acrylonitrile and acrylonitrile-butadiene-styrene, and styrene-butadiene rubber, or formulated with unsaturated polyester resins for use as fiberglass reinforcement materials.
- Consumer products containing styrene include packaging materials, insulation, fiberglass, plastic pipes, automobile parts, shoes, drinking cups and other food-use items, and carpet backing.

Routes of Exposure

- Inhalation – Predominant route of exposure for general population is inhalation of contaminated indoor air. Predominant route of exposure for workers.
- Oral – Minor route of exposure via ingestion of food.
- Dermal – Skin contact may occur during manufacture or use of styrene and styrene products.

Styrene in the Environment

- Styrene enters the air, water, and soil as a result of its manufacture and use.
- Styrene photodegrades in the atmosphere with a half-life of 7–16 hours.
- A large fraction of the styrene released into water will volatilize into the atmosphere.
- Styrene is moderately mobile in soil and is rapidly degraded under aerobic conditions.
- Bioconcentration does not appear to be significant for styrene.

Relevance to Public Health (Health Effects)

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation

- An MRL of 5 ppm has been derived for acute-duration inhalation exposure (≤ 14 days).
- No intermediate-duration inhalation MRL was derived for styrene.
- An MRL of 0.2 ppm has been derived for chronic-duration inhalation exposure (≥ 1 year).

Oral

- An MRL of 0.1 mg/kg/day has been derived for acute-duration oral exposure (≤ 14 days).
- No intermediate- or chronic-duration oral MRLs were derived for styrene.

Health Effects

- The most sensitive target of toxicity is the nervous system. Effects observed in workers include decreased color discrimination, vestibular effects, hearing impairment, symptoms of neurotoxicity (particularly “feeling drunk” and tiredness), delays in reaction time, impaired performance on tests measuring attention and memory, impaired nerve conduction velocity, and EEG alterations.
- Nasal olfactory epithelial damage and liver necrosis have been observed in animals. However, humans are likely to be less sensitive to these effects due to species difference in styrene metabolism.
- DHHS has classified styrene as reasonably anticipated to be a human carcinogen. IARC has assigned styrene to Group 2B, possibly carcinogenic to humans.

Children’s Health

- Children are expected to be affected by styrene poisoning in the same manner as adults.
- Human studies are not adequate to evaluate the developmental toxicity of styrene. In general, animal studies have not found developmental effects following inhalation or oral exposure.