

Occupational Health Guideline for Styrene

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $C_6H_5CH=CH_2$
- Synonyms: Phenylethylene; vinylbenzene; cinnamene; styrene monomer
- Appearance and odor: Colorless liquid with a sweet aromatic odor at low concentrations. Sharp, penetrating, and disagreeable odor at higher concentrations.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for styrene is 100 parts of styrene per million parts of air (ppm) averaged over an eight-hour work shift, with a ceiling level of 200 ppm and an acceptable peak of 600 ppm for 5 minutes in any three-hour period. The American Conference of Governmental Industrial Hygienists has issued a Notice of Intended Changes of its recommended Threshold Limit Value for styrene from 100 ppm to 50 ppm.

HEALTH HAZARD INFORMATION

- **Routes of exposure**
Styrene can affect the body if it is inhaled, is swallowed, or comes in contact with the eyes or skin.
- **Effects of overexposure**
 1. **Short-term Exposure:** Styrene may irritate the eyes, nose, throat, and skin. High concentrations may cause a person to become sleepy or to become unconscious.
 2. **Long-term Exposure:** Repeated skin contact with styrene may produce a skin rash.
 3. **Reporting Signs and Symptoms:** A physician should be

contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to styrene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to styrene at potentially hazardous levels:

1. **Initial Medical Screening:** Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from styrene exposure.

- Central nervous system disorders: Since exposure to styrene vapor or liquid on the skin has been observed to result in central nervous system depression and occasional abnormalities in the electroencephalogram, persons with pre-existing disorders may be unusually susceptible to these effects.

- Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of styrene might cause exacerbation of symptoms due to its irritant properties or psychic reflex bronchospasm.

- Skin disease: Styrene is a defatting agent and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

- Kidney disease: Although styrene is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with possible impairment of renal function.

- Liver disease: Although styrene is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

2. **Periodic Medical Examination:** Any employee developing the above-listed conditions should be referred for further medical examination.

- **Summary of toxicology**

Exposure to concentrations of styrene above 200 ppm

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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Public Health Service Centers for Disease Control
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causes irritation of the eyes and upper respiratory tract. There is cracking and inflammation of the skin due to defatting. Higher exposures depress the central nervous system. Electroencephalographic changes have been reported. Styrene is excreted fairly rapidly in the urine, largely as hippuric acid.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 104
2. Boiling point (760 mm Hg): 145 C (293 F)
3. Specific gravity (water = 1): 0.90
4. Vapor density (air = 1 at boiling point of styrene): 3.6
5. Melting point: -30.6 C (-23 F)
6. Vapor pressure at 20 C (68 F): 4.5 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.03
8. Evaporation rate (butyl acetate = 1): 0.49

• Reactivity

1. Conditions contributing to instability: Styrene is stabilized by a polymerization inhibitor (often tert-butylcatechol). If this is not present in adequate concentrations, styrene can polymerize and explode its container. The polymerization is also speeded up by temperatures above 66 C (150 F).

2. Incompatibilities: Avoid contact with oxidizing agents and catalysts for vinyl polymerization, such as peroxides, strong acids, and aluminum chloride.

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving styrene. Styrene fumes are very acrid.

4. Special precautions: Styrene will corrode copper and copper alloys and dissolve rubber.

• Flammability

1. Flash point: 32 C (90 F) (closed cup)
2. Autoignition temperature: 490 C (914 F)
3. Flammable limits in air, % by volume: Lower: 1.1; Upper: 6.1
4. Extinguishant: Dry chemical, foam, or carbon dioxide

• Warning properties

1. Odor Threshold: May reports that the odor threshold of styrene is 0.08 ppm.

2. Eye Irritation Level: The AIHA *Hygienic Guide* reports that "styrene vapor at concentrations of 200 to 400 ppm was found to have transient irritant effects on the eyes."

4. Evaluation of Warning Properties: Since the odor threshold of styrene is below the permissible exposure limit, it is treated as a material with adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• Eight-Hour Exposure Evaluation

Measurements to determine employee exposure are best

taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of styrene. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Peak Above Ceiling Evaluation

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of styrene. Each measurement should consist of a 30-minute sample or a series of consecutive samples totalling 30 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

Sampling and analyses may be performed by collection of styrene vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure styrene may be used. An analytical method for styrene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National

Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid styrene.
- Clothing wet with liquid styrene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of styrene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the styrene, the person performing the operation should be informed of styrene's hazardous properties.
- Non-impervious clothing which becomes contaminated with liquid styrene should be removed promptly and not reworn until the styrene is removed from the clothing.
- Any clothing which becomes wet with liquid styrene should be removed immediately and not reworn until the styrene is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid styrene may contact the eyes.

SANITATION

- Skin that becomes contaminated with liquid styrene should be promptly washed or showered with soap or mild detergent and water to remove any styrene.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to styrene may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during spray-manufacture of glass fiber, reinforced styrene-polyester articles	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use during spray application of styrene polyester surface coatings	Process enclosure; local exhaust ventilation; personal protective equipment
Use during hand lay-up of glass fibers,	Local exhaust ventilation; general

Operation

reinforced styrene-polyester articles

Use during molding of articles or potting electrical components with polystyrene

Use during manufacture of tires and other rubber goods using styrene-butadiene elastomers (SBR)

Use in manufacture of concretes

Use during bag lay-up manufacture of glass fiber, reinforced styrene-polyester articles; during use of surface coatings containing styrene-butadiene copolymer resins

Liberation during die molding of articles made from styrene-polyester resins; during brush application of surface coatings

Use in process operations for production of polystyrene, acrylonitrile-butadiene styrene (ABS), styrene-acrylonitrile (SAN), and styrene-butadiene copolymers

Use in manufacture of surface coatings; use in miscellaneous processes as an elastomer, intermediate, or starting material; use during manufacture of ion-exchange resins (styrene-divinylbenzene copolymer)

Controls

dilution ventilation; personal protective equipment

Local exhaust ventilation; general dilution ventilation; personal protective equipment

General dilution ventilation

General dilution ventilation; personal protective equipment

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EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If styrene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If styrene gets on the skin, promptly flush the contaminated skin with water. If styrene soaks through the clothing, remove the clothing immediately and flush the skin with water. When there is skin irritation, get medical attention.

• Breathing

If a person breathes in large amounts of styrene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

If styrene has been swallowed, do not induce vomiting. Get medical attention immediately.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If styrene is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber. Combustion may be improved by mixing with a more flammable liquid.

• Waste disposal methods:

Styrene may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

2. By atomizing in a suitable combustion chamber. Combustion may be improved by mixing with a more flammable liquid.

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RESPIRATORY PROTECTION FOR STYRENE

Condition	Minimum Respiratory Protection* Required Above 100 ppm
Vapor Concentration	
400 ppm or less	Any chemical cartridge respirator with an organic vapor cartridge(s).** Any supplied-air respirator.** Any self-contained breathing apparatus.**
1000 ppm or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).
5000 ppm or less	A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 5000 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

**If eye irritation occurs, full-facepiece respiratory protective equipment should be used.