

Workplace Health and Safety Bulletin



Styrene at the Work Site

Properties of styrene

Styrene is an organic solvent widely used in the plastic industry. It is the raw material for polystyrene and co-polymers such as styrene-acrylonitrile and styrene-divinyl benzene, styrene-butadiene rubber, styrene-butadiene latexes and fibreglass resins. Styrene resins are used to make fibreglass hulls, insulation, car bodies, storage tanks, and tub and shower units. Resins produced from styrene are also the raw material for plastics and packing materials.

Styrene is a very flammable liquid that easily becomes a vapour at room temperature. As the temperature increases, styrene evaporates more quickly. It is heavier than air, so the vapour tends to stay close to the ground and can travel some distance before dispersing. If it contacts an ignition source, it will ignite (flash back). One can smell styrene at very low concentrations (0.02 to 1.9 parts per million). However, after prolonged exposure to the chemical, the ability to smell it diminishes.

Inhaling styrene vapours is the most common way that workers are exposed to the chemical. For example, when spraying or spreading styrene, workers can inhale the vapours released. Workers can accidentally swallow styrene if they eat, drink or smoke in work areas where styrene is used. Styrene can also be absorbed into the body when it comes in contact with the skin.

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Health effects

If styrene is inhaled or ingested, it is rapidly absorbed by and distributed throughout the body. Styrene causes a number of short- and long-term health effects.

Short-term health effects

The most common short-term health effect is irritation. Concentrations of styrene vapour as low as 50 parts per million can cause irritation to the nose, eyes and throat. However, people who are exposed to styrene repeatedly will develop some tolerance to this irritation effect. Direct contact with the skin may cause irritant dermatitis (dry, itchy skin and skin rashes). Liquid styrene splashed in the eyes causes moderate to severe eye irritation. If liquid styrene gets into the eyes and is not flushed out immediately, it can cause permanent damage. Exposure to high concentrations of styrene vapour may also irritate the eyes.

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Inhaling styrene vapour can cause headaches, dizziness, drowsiness, and at concentrations above 100 parts per million, difficulty concentrating. Inhaling styrene vapour in concentrations above 200 parts per million slows reaction times and causes effects similar to those of intoxication. These effects can occur at concentrations as low as 50 parts per million.

Long-term health effects

Long-term or chronic exposure to styrene can damage the kidneys, liver and central nervous system. Workers exposed to styrene over a long period of time report changes to hearing, balance, the ability to distinguish different colours and reaction time. There is some evidence that the effects to the central nervous system are at least partly reversible after exposure stops, but it is not known how long this process might take.

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If the body is exposed to other organic solvents, including ethanol, at the same time as styrene, the body metabolizes the styrene more slowly, increasing the toxic effects.

Cancer

The International Agency for Research on Cancer (IARC) has determined that styrene is carcinogenic to humans. Because laboratory studies show the chemical can cause cancer in rats and mice, the overall IARC classification for styrene is 2B, or “possibly carcinogenic to humans.” Styrene’s toxicity is attributed to the body’s production of styrene oxide — a mutagen and carcinogen — as styrene is metabolized.

Effects on hearing

There is some evidence to suggest that styrene is ototoxic (causes impairment and degeneration of the inner ear). This condition may be reversible or irreversible, and may manifest itself as hearing loss, tinnitus (ringing in the ear) or vertigo. Studies have shown that styrene is ototoxic to rats and that combined exposure to styrene and noise can cause more hearing damage than exposure to noise alone.

Health assessment

There is no legislated requirement for workers exposed to styrene to have a medical assessment. However, where there is doubt whether a worker should risk exposure to styrene, an occupational physician should be consulted. If a worker is required to wear a respirator to prevent exposure to styrene, a medical assessment is needed to determine the worker’s fitness to wear a respirator.

For more information:



http://employment.alberta.ca/documents/WHS/WHS-PUB_mg005.pdf

Medical Assessment of Fitness to Wear a Respirator (MG005)

Biological monitoring

Styrene can be found in an exposed person’s urine or blood. When styrene is metabolized in the body, it changes to styrene oxide. This is further metabolized to phenylglyoxylic acid and mandelic acid. Both of these substances can be detected in urine.

If a worker is required to wear a respirator to prevent exposure to styrene, a medical assessment is needed to determine the worker’s fitness to wear a respirator.


The American Conference of Governmental Industrial Hygienists (ACGIH) has published Biological Exposure Indices (BEI[®]) for styrene in both blood and urine. The BEI[®] provides a measure of a person's uptake of a chemical (the amount of the chemical that actually gets into the body).

The BEIs for styrene recommended by the ACGIH are:

Compound	When measured	BEI
Mandelic acid plus phenylglyoxylic acid in urine	End of shift	400 mg/g creatinine
Styrene in blood	End of shift	0.2 mg/L

Note: End of shift means as soon as possible after exposure stops.

For more information:

 *2009 Threshold Limit Values for Chemical Substance and Physical Agents and Biological Exposure Indices*, available for sale from ACGIH at www.acgih.org

Preventive measures

Preventing exposure to styrene is the best way to protect health. Ways to prevent exposure include:

- using less hazardous substances
- implementing engineering controls
- changing work practices (administrative controls)
- using personal protective equipment.

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Using less hazardous substances

Where styrene is used as an industrial solvent, less hazardous substitutes may be available. In the fibreglass industry, standard styrene resins may be replaced by waxed resins. The resins contain a wax, or wax-like, additive that rises to the surface while the fibreglass cures, creating a barrier that reduces emissions.

Engineering Controls

Engineering controls are mechanical processes used to eliminate exposure to a substance. These controls remove the substance from the air or provide a barrier between the worker and the substance. Examples of engineering controls that can be used to prevent exposure to styrene include:

- installing local ventilation hoods
- installing enclosures around work processes, or using closed processes
- using airless spray-application methods or low-pressure systems
- using spray booths
- changing work processes.

If engineering controls are working properly, they will eliminate or greatly reduce the potential hazard of styrene exposure. They need only be installed once and do not place a physical burden on workers. However, an initial investment is required, and the systems must be properly operated and maintained once installed.

Using engineering controls may be problematic in situations where styrene resins are hand applied or sprayed on. Styrene vapours are produced when the resins are applied, and are also given off in the curing stage. Spray application processes tend to generate two to three times more styrene vapour compared to hand application using rollers or brushes. Rollers that are fitted with guards to reduce the formation of droplets while styrene is applied will reduce styrene emissions. When possible, workers should use rollers with long handles to increase their distance from the areas of application.

Where local ventilation systems or spray booths are used, they must be designed properly.

- Ventilation systems or spray booths must not vent back into the work area. Exhausts must be vented to the outside, away from air intakes for the work area.
- Spray booths must supply a minimum air flow of 100 feet per minute (about 30 metres per minute) past the worker and sufficient make-up air must be provided. Note that the actual required air flow will depend on the size and design of the spray booth. A good reference for more information is “Industrial Ventilation: A Manual of Recommended Practice for Design” published by the American Conference of Governmental Industrial Hygienists or ACGIH.

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Where local ventilation systems or spray booths are used, they must be designed properly.

- Spray-booth equipment must be approved for use in flammable or explosive atmospheres.
- The design, operation and maintenance must comply with the requirements in the Alberta Fire Code.

Administrative controls

Work practices to reduce exposure to styrene include:

- educating workers about the hazards of styrene. (Workers must participate in training and monitoring programs in the workplace.)
- ensuring that engineering controls and other equipment used to reduce exposure are maintained and used properly
- using good hygiene practices. Workers must not eat, drink or smoke in work areas where styrene is used or stored. They should wash their hands and faces thoroughly before eating, drinking or smoking.
- ensuring that styrene is properly stored
- ensuring unprotected workers do not enter areas where resins containing styrene are applied
- ensuring spills are cleaned up quickly and properly
- keeping product containers tightly sealed when not in use.

Styrene presents not only a health hazard to workers, but also a fire hazard. Particular attention must be paid to fire safety and potential sources of ignition in areas where styrene is used or stored. Resins and liquid styrene should be stored in cool, dry, well-ventilated areas out of direct sunlight, and away from ignition sources and combustible materials.

For more information



http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf

Handling and Storage of Flammable Materials at the Work Site

Implementing work practices (administrative controls) to reduce exposure to styrene is often less expensive than implementing other control measures. However, workers must be properly trained and the practices used appropriately.

Workers must not eat, drink or smoke in work areas where styrene is used or stored.

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Using personal protective equipment

Where engineering or administrative controls cannot adequately reduce exposures, or where these controls are impractical, the employer must provide workers with appropriate personal protective equipment. If styrene may be inhaled, respiratory protective equipment will be needed. There are many types of respirators available. It is important to select the correct respirator(s) for the work.

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For more information



http://employment.alberta.ca/documents/WHS/WHS-PUB_ppe004.pdf

Guideline for the Development of a Code of Practice for Respiratory Protective Equipment (PPE004)



http://employment.alberta.ca/documents/WHS/WHS-PUB_ppe001.pdf

Respiratory Protective Equipment: An Employer's Guide (PPE001)

Styrene can be smelled at very low concentrations. Workers must be aware that if they smell styrene while they are wearing air-purifying respiratory protective equipment, they must change the respirator cartridges. However, this is not a reliable indicator of when a cartridge should be changed, as a person's ability to smell styrene generally lessens with exposure over time.

Since styrene is also absorbed into the body through the skin, workers using styrene or styrene resins must wear appropriate protective clothing. Solvent-resistant gloves and coveralls must cover the arms and legs, and vapour-tight eye protection must cover the eyes.

Regulatory requirements

Alberta occupational health and safety legislation includes general and specific requirements related to styrene. The legislation provides an Occupational Exposure Limit (OEL) for styrene, which applies to workers directly involved with tasks using styrene, and also to workers who may be exposed to the substance indirectly from these operations. It is important to note that OELs represent standards to protect healthy workers over an eight-hour workday, in a 40-hour week.

Legislation also requires employers to:

- develop safe-work procedures
- train workers about the health hazards associated with exposure to styrene and the safe-work procedures
- ensure the amount of ventilation required is properly assessed
- ensure the ventilation systems installed are properly designed and maintained
- train workers to properly operate installed ventilation systems
- provide appropriate protective equipment, including respirators, where concentrations of styrene cannot be kept below safe limits.


Storage of styrene in the workplace is regulated under the Alberta Fire Code, which is administered by Alberta Municipal Affairs.


For more information on this legislation:

 www.municipalaffairs.alberta.ca/cp_fire.cfm
Municipal Affairs Web Site

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<http://employment.alberta.ca/whs-ohs>

Call any Government of Alberta office toll-free
Dial 310-0000, then the area code and telephone number you want to reach

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