Product Stewardship Summary
Styrene

Styrene is a colorless liquid with a sweet odor used to make thousands of everyday products for home, school, work and play. Styrene is produced primarily from ethyl benzene, a chemical found in petroleum. It is also a naturally occurring substance found in foods such as cinnamon, coffee, and strawberries.

Exposure to levels of styrene typically found in the environment is not expected to be harmful to human health or the environment. Adequate exposure controls in the workplace can also prevent adverse health effects to workers.

Chemical identity:

NAME: Styrene
CAS#: 100-42-5
SYNONYMS: Cinnamene; Cinnamenol; Cinnamol; Diarex HF 77; Ethylene, Phenyl; Vinyl benzene; Ethenylbenzene; NCI-C02200; Phenethylene; Phenylethene; Styreen; Styren; Styrol; Styrole; Styrolene; Styrolo; Styropol; Styropor; UN 2055

Uses:
Styrene is used to manufacture polymers. The polymers are used in the production of plastics such as: polystyrene (PS), acrylonitrile butadiene styrene (ABS); rubber, such as: styrene-butadiene rubber (SBR), styrene-butadiene latex, styrene-isoprene-styrene (SIS), styrene-ethylene/butylene-styrene (S-EB-S), styrene-divinylbenzene(S-DVB), and unsaturated polyesters.

Styrene-containing polymers are used to manufacture a wide variety of everyday goods ranging from cups and utensils to furniture, bathroom and kitchen appliances, hospital and school supplies, sports and recreational equipment, consumer electronics, automotive parts and durable, light weight packages.

Ashland does not produce styrene but instead purchases styrene from both US and international manufacturers. Ashland's Performance Materials business uses styrene to manufacture unsaturated polyester resins. Ashland Distribution also distributes styrene and many styrene-containing polymers for use in various industrial applications. Ashland Performance Materials' unsaturated polyester resins are used to make, among other things, boats, counter tops, shower stalls, automobile parts, construction materials, storage tanks and piping.

Physical/chemical properties:
Styrene monomer:

- is a colorless to yellowish appearing liquid
- is flammable (Flashpoint < 95ºF).
- has a distinctive sweet aroma and oily appearance. The distinctive odor can be detected even when styrene is present at extremely low levels. The odor threshold for styrene ranges from 0.04 to 0.32 ppm
- can polymerize upon loss of inhibitor or exposure to excessive light or heat.
- has a vapor density of 3.6 (Air = 1) which means vapors are heavier than air and will migrate downward and accumulate in low lying areas.
- is soluble in a variety of solvents; however is only slightly soluble in water.

Health Effects:
Exposure of humans to styrene by contact with the liquid or by breathing styrene in the air may result in temporary irritation of the eye and skin. Breathing styrene may also result in temporary irritation of nose and throat. Irritation is typically seen when styrene levels in the air exceed 100 ppm. Central Nervous System (CNS) effects, such as dizziness, drowsiness, headaches and nausea, may also occur from exposures exceeding 100 ppm. Repeated exposure to 20 – 50 ppm styrene in the air has also been suggested to cause effects on hearing, color vision and reaction time.

No conclusive evidence indicates that exposure to styrene will cause cancer in human beings. However, laboratory mice exposed to styrene over their lifetime have developed lung tumors. Therefore, the International Agency for Research on Cancer (IARC) has classified styrene as a "possible" human carcinogen.

The following websites provide additional information on the potential health effects of styrene:

- Agency for Toxic Substances and Disease Registry http://www.atsdr.cdc.gov/tfacts53.html
- Styrene Information and Research Center http://www.styrene.org/information.html
- US EPA Integrated Research Information Center http://www.epa.gov/ncea/iris/subst/0104.htm
- International Agency for Research on Cancer (IARC) http://www.iarc.fr/

Environmental Effects

Environmental fate information

Styrene is biodegradable and does not persist in the environment. Styrene has a half-life of three or four hours, and rapidly breaks down (i.e., within 12 hours) to carbon dioxide and water under aerobic conditions in soil or water.

Aquatic and/or terrestrial toxicity:

Styrene was shown to be moderately toxic to minnows, water fleas and shrimp-like crustaceans. It was shown to be highly toxic to green algae, and slightly toxic to earthworms. Long-term exposure is not a concern based on these studies. Styrene's potential impact on aquatic and soil environments is significantly reduced by the rapid rate at which it evaporates and biodegrades in the environment.

Aquatic organisms which have been exposed to low levels of styrene in the water system may have an unpleasant taste if ingested, but overall toxicity is low to both the aquatic organism and the consumer.

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Exposure

The principal route of styrene exposure for the general population and workers is via air. Air contamination levels of styrene for the general public can be attributed to emissions from industrial activities, building materials, consumer products, vehicle exhaust, and tobacco smoke. Rural or suburban air generally contains lower concentrations of styrene than urban air. Indoor air often contains higher levels of styrene than outdoor air. Typical levels of styrene in outdoor air ranges from 0.06–4.6 parts per billion (ppb) and indoor air ranges from 0.023–11.5 ppb.

Air contamination levels in the workplace are due to handling, storing and processing of styrene and styrene containing polymers. The highest potential for exposure to styrene occurs in the reinforced-plastics industry. Workers involved in styrene polymerization, rubber manufacturing, and styrene-polyester resin facilities may also be exposed to styrene.

Exposure can also occur by eating foods containing styrene and by absorbing styrene through the skin. Low levels of styrene occur naturally in a variety of foods, such as fruits, vegetables, nuts, beverages, and meats. In addition, negligible amounts of styrene can be transferred to food from styrene-based packaging material.

Styrene is occasionally detected in groundwater, drinking water, or soil samples. Drinking water containing styrene or bathing in water containing styrene may result in low levels of exposure. Workers may come in skin contact with styrene during handling, storing and processing of styrene and styrene containing polymers

Risk Management Recommendations
Exposure to styrene in the workplace is covered by established exposure limits. The regulatory limit in the United States is established by Occupational Safety and Health Administration (OSHA) and is 100 ppm as a time weighted average (TWA) over an 8 hour workday. The North American Composite Manufacturers Association, an industry trade association whose members use unsaturated polyester resins and fiberglass to manufacture their products, has a voluntary agreement with OSHA that exposure to styrene in member company plants will not exceed 50 ppm TWA. The American Conference of Governmental Industrial Hygienists recommends occupational exposure limit of 20 ppm as a TWA.

Exposure to styrene is controlled by sufficient ventilation and proper handling and storage techniques. Examples include: ventilation system, proper protective equipment such as eye protection (i.e., splash proof goggles), normal work clothing which covers arms and legs, resistant gloves, and NIOSH approved respirators in situations where exposure exceeds allowable exposure limits and/or ventilation alone is not sufficient. In addition, low pressure spraying and reduced styrene level polymers also have been used to reduce styrene exposure in the workplace.

Federal, state and local governments regulate styrene emissions from facilities. The regulatory emission limits for each facility are established to protect the health and environment of the community surrounding the facility and are written into the facility's operating permit.

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