Product Stewardship Summary

Styrene

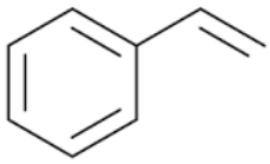
General Statement

Styrene is a colorless to yellowish 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, beef, beans and strawberries. Exposure to levels of styrene typically found in the environment is not expected to be harmful to human health or the environment.

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. Exposure controls in the workplace serve to prevent adverse health effects to workers. Consumers are unlikely to come into contact with harmful levels of styrene, as styrene monomer is found only in trace quantities in consumer products.

Chemical Identity

Name: Styrene
Brand Names: Multiple products in the Aroset™, Pliogrip™, Northwest Coatings™, Derakane™, Pureseal™, and other lines
Chemical name (IUPAC): Styrene
CAS number: 100-42-5
EC number: 202-851-5
Molecular formula: C8 H8
Structure:



Uses and Applications

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™ always solving

Ashland's unsaturated polyester resins prepared from styrene are used to make, among other things, boats,

counter tops, shower stalls, automobile parts, construction materials, storage tanks and piping.

Physical/Chemical Properties

Phys/Chem Safety Assessment

Property	Value
Form	Colorless to yellowish liquid
Physical state	Liquid
Color	Colorless to yellowish
Odor	Sweet. Odor threshold 0.04-0.32 ppm
Density	0.9060 g/cm^3 @ 20°C
Melting / boiling point	-31°C / 145°C at 1013 hPa
Flammability	H226: Flammable liquid and vapour
Explosive properties	Not explosive
Self-ignition temperature	490°C @ 1013 hPa
Vapor pressure	6.4 mm Hg @ 25°C
Mol weight	104.15 g/mol
Water solubility	310 mg/L@25°C
Flash point	31°C @ 1013 hPa
Octanol-water partition coefficient (Logk_{ow})	2.96 @ 25°C

Exposure, Hazard and Safety Assessment

The following section describes possible exposures scenarios and hazards associated with styrene. The exposure assessment describes both the amount of and the frequency with which a chemical substance reaches a person, a population of people, or the environment. Hazard refers to the inherent properties of a substance that make it capable of causing harm to human health or the environment. The safety assessment reports the possibility of a harmful event arising from exposure to a chemical or physical agent under specific conditions. Just because a substance may possess potentially harmful properties does not mean that it automatically poses a risk. It is not possible to make that determination without understanding the exposure.

Human Health Effects

Human Exposure Assessment

The principal route of styrene exposure for the general population 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.

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.

Consumer: Consumer exposure is most likely limited to extremely low levels of residual monomer present within the polymers used in consumer products.

Worker: The principal route of styrene exposure for the workers is via air. 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. Workers may come in skin contact with styrene during handling, storing and processing of styrene and styrene containing polymers.

Human Hazard Assessment

Exposure of humans to styrene via oral route or inhalation for a short duration results in low to moderate toxicity. Skin contact with the liquid causes irritation and eye contact with liquid or vapor could result in serious eye irritation. 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. Repeated exposure to 20 – 50 ppm styrene in the air has also been suggested to cause effects on hearing abilities. IARC and US NTP suggested the possibility of cancer causing effects of styrene in humans. Styrene is suspected of causing damage to unborn child. Styrene could be fatal if swallowed or accidentally enter airways.

Effect Assessment	Result
Acute Toxicity Oral / inhalation / dermal	Low acute toxicity via oral route. No acute toxicity if applied on skin. Moderate acute toxicity via inhalation.
Irritation / corrosion Skin / eye / respiratory test	Skin contact causes irritation. Eye contact with liquid or vapor could result in serious eye irritation. Inhalation of vapors may cause repiratory irritation.
Sensitization	Does not cause allergic reactions up on contact with skin.
Toxicity after repeated exposure Oral / inhalation / dermal	Causes damage to auditory system (hearing capacity) through prolonged or repeated exposure if inhaled.
Genotoxicity / Mutagenicity	Does not effect genetic system
Carcinogenicity	Not considered as carcinogen according to CLP/GHS. Classified by IARC as Group 2B – possibly carcinogenic to humans. Classified by US NTP as reasonably anticipated to be a human carcinogen. Listed as carcinogen in California under Proposition 65
Reproductive/Developmental Toxicity	Not toxic to reproduction. Suspected of damaging the unborn child (according to CLP)
Aspiration hazard	May be fatal if swallowed and enters airways.

Human Health Safety Assessment

Consumer: Consumers are unlikely to come into contact with harmful levels of styrene, as styrene monomer is found only in trace quantities in consumer products.

Worker: In industrial settings, styrene is handled primarily by sufficient ventilation, proper handling and storage techniques which limit exposure. Furthur styrene is handled primarily in closed and continuous processes which limit the exposure to maximum extent. Based on good manufacturing processes and industrial hygiene the

occupational health risk associated with styrene is low.

Environmental Effects

Environmental Exposures

Environmental exposure to styrene is minimal, as styrene quickly reacts or degrades. Minimal exposure to environment may happen because of the occasional relases from the industrial processes. Only large releases are anticipated to have the potential for environmental damage

Environmental Hazard Assessment:

The majority of styrene released into the environment is expected to reach the atmosphere due to its high potential for volatilisation. After evaporation or exposure to the air, the product will be rapidly degraded by photochemical processes. Styrene is readily biodegradable. Styrene does not accumulate appreciably in aquatic organisms. Styrene is not toxic to aquatic life.

Effect Assessment	Result
Aquatic toxicity	Toxic to aquatic organisms.

Fate and behavior	Result
Biodegradation	Readily biodegradable.
Bioaccumulation potential	Substance does not bioaccumulative (BCF < 100)
PBT / vPvB conclusion	This substance is not considered to be persistent, bioaccumulating and toxic (PBT) or very persistent and very bioaccumulating (vPvB).

Environmental Safety Assessment

Although styrene is toxic to aquatic life on the short time exposure, the chances of environemtal release are minimal. The minimally released styrene is rapidly degraded in air or by the micro oraganism. Overall the styrene is not considered to be persistent, bioaccumulating or toxic in the environment.

Risk Management Recommendations

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 in polymers also have been used to reduce styrene exposure in the workplace.

National 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.

Exposure to styrene in the workplace is covered by established exposure limits. A partial list of references follows:

US OSHA PEL: 100 ppm (8h TWA)
ACGIH TLV: 20 ppm (8h TWA)

EU and member states: 100 ppm (UK), 50 ppm (France, Belgium, Ireland), 20 ppm (Germany, Austria, Finland, Italy, Spain) (8h TWA)
China: 50 mg/m^3 (8h TWA)

Regulatory Agency Review

Styrene is listed in:

- Taiwan Chemical Substance Inventory (TCSI)
- Australia Inventory of Chemical Substances (AICS)
- Canadian Domestic Substances List (DSL)
- Inventory of Existing Chemical Substances in China (IECSC)
- ECHA List of Publishable Substances Registered
- European Inventory of Existing Commercial Chemical Substances (EINECS)
- ENCS - Existing and New Chemical Substances Inventory (Japan)
- Korean Existing Chemicals Inventory (KECI)
- Inventory of Chemical Substances (New Zealand)
- Philippines Inventory of Chemicals and Chemical Substances (PICCS)
- New notified substances and declared preparations (Switzerland)
- United States TSCA Inventory
- IARC as a Group 2B carcinogen
- US National Toxicology Program as a reasonably anticipated human carcinogen
- California Proposition 65 as carcinogen

Regulatory Information / Classification and Labeling

Under the Globally Harmonized System for classification and labeling (GHS), substances are classified according to their physical, health, and environmental hazards. The hazards are communicated via specific labels and the (Extended) SDS. GHS attempts to standardize hazard communication so that the intended audience (workers, consumers, transport workers, and emergency responders) can better understand the hazards of the chemicals in use.

GHS Classification:

Flammable liquids - Category 3
Acute toxicity (Oral) - Category 5
Acute toxicity (Inhalation) - Category 4
Skin corrosion/irritation - Category 2
Serious eye damage/eye irritation - Category 2A
Specific target organ toxicity - single exposure - Category 3
Specific target organ toxicity - repeated exposure - Category 1
Aspiration hazard - Category 1
Acute aquatic toxicity - Category 2

Hazard Statements:

H226: Flammable liquid and vapour.
H303: May be harmful if swallowed.
H304: May be fatal if swallowed and enters airways.
H315: Causes skin irritation.
H319: Causes serious eye irritation.
H332: Harmful if inhaled.
H335: May cause respiratory irritation.
H372: Causes damage to organs through prolonged or repeated exposure if inhaled.
H401: Toxic to aquatic life.

Signal Word:

Danger

Precautionary Statements:

P210: Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P233: Keep container tightly closed.
P240: Ground and bond container and receiving equipment.
P241: Use explosion-proof electrical/ ventilating/ lighting equipment.
P242: Use non-sparking tools.
P243: Take action to prevent static discharges.
P260: Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P264: Wash skin thoroughly after handling.
P270: Do not eat, drink or smoke when using this product.
P271: Use only outdoors or in a well-ventilated area.
P273: Avoid release to the environment.
P280: Wear protective gloves/ eye protection/ face protection.

Hazard Pictograms:

Conclusion

Styrene is a vital component of modern plastics, rubbers, composites, and many everyday materials. With proper engineering controls and protective equipment, workers can safely use styrene to produce a variety of consumer products. Consumers, in turn, are not expected to be exposed to dangerous levels of styrene.

Contact Information with Company

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Additional Information

For more information on GHS, visit http://www.osha.gov/dsg/hazcom/ghsguideoct05.pdf or http://live.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html.
Ashland product stewardship summaries are located at http://www.ashland.com/sustainability/product/product-stewardship

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REACH registration is specific to Importers/Manufacturers that place the chemical on the EU market, and is specific to registered uses. Inclusion on the list of REACH Registered Substances does not automatically imply registration by Ashland.

Inclusion on the New Zealand Inventory of Chemicals applies only to the pure substance listed. The importer of record must determine whether or not their substances are in compliance.