Product Summary
Styrene Monomer
Total Petrochemicals & Refining USA, Inc.
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Product Overview

Styrene is a building block, or monomer, for the manufacture of a broad range of materials used in thousands of plastics products throughout the world.

The most recognizable styrene-based material is probably polystyrene, often encountered as expanded polystyrene foam (EPS). Other styrene-based materials include impact polystyrene (polystyrene-polybutadiene-copolymer), acrylonitrile-butadiene styrene (ABS), styrene-acrylonitrile (SAN), styrene- butadiene rubber (SBR), and unsaturated polyester resin (UPR), which is better known as fiberglass.

Chemical Identity

Name: Styrene
Also known as: Ehenylbenzene; Phenylethylene; Vinylbenzene
CAS\textsuperscript{1} Registry Number: 100-42-5

Uses

Styrene-based materials add convenience, value, and quality to daily life. Some examples of these uses include:

- Packaging including food
- Toys/Recreational Equipment
- Consumer Electronics
- Construction
- Transportation
- Medical Supplies

Benefits of styrene-based materials

Styrene-based materials offer unique characteristics of toughness, high performance, versatile design and simplicity of production. They provide excellent hygiene, sanitation and safety benefits. Styrene-based products offer superior insulation qualities for use in building construction and lightweight components resulting in energy use reduction. They have the ability to be recycled where collection systems are available. In many cases, styrene helps create products for which there are few, if any, substitutes.

Physical/chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>0.91</td>
</tr>
<tr>
<td>Appearance</td>
<td>clear liquid</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>145°C (293°F)</td>
</tr>
<tr>
<td>Flash Point</td>
<td>31°C (88°F)</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>4.3 mm Hg at 20°C</td>
</tr>
</tbody>
</table>

\textsuperscript{1} CAS Registry Number is a Registered Trademark of the American Chemical Society.
Solubility in water: 310 mg/L at 25°C.
Molecular weight: 104 Daltons (g/mol)
Molecular Formula: C₈H₈
Odor Threshold: 0.01 - 0.1 ppm

Physical Hazards

Styrene is classified as a flammable liquid by the Occupational Safety and Health Administration (OSHA) and the United States Department of Transportation (USDOT).

Hazardous Polymerization

Under certain conditions, styrene can spontaneously polymerize, producing heat and high pressures, which may lead to an explosion.

To prevent auto-polymerization routinely monitor for percent polymer and inhibitor. Add inhibitor as needed. The most commonly used inhibitor is tertiary-butylcatechol (TBC) in the 10-15 ppm concentration range. Higher concentrations may be needed. Inhibitor needs greater than 15 ppm dissolved oxygen (O₂) to prevent polymerization. Do NOT blanket with nitrogen without providing means for keeping and checking a minimum of 15 ppm of oxygen (O₂) dissolved in liquid phase. Inhibitor depletion and risk of polymerization will increase if product is stored under high temperatures, in the presence of moisture, rust, or other impurities, or for extended periods.

Store below 84°F (29°C) in a dry, well-ventilated area. Storage temperature should be continuously monitored. If the temperature rises 1°C/day, it may be an early indication of spontaneous polymerization and the temperature should be monitored closely. Re-circulation of the material may stop or decrease the rate of temperature rise. A 2-3°C/day temperature increase is a typical indication of the onset of a runaway polymerization.

Conditions to avoid

- Elevated temperatures
- Contact with copper, copper alloys, peroxides and rust
- Static Electricity


Health Effects

High levels of exposure to styrene monomer can cause adverse health effects. Regulations require occupational exposures to remain within safe limits by use of appropriate industrial hygiene practices and emission controls.

Short-term exposure to levels of styrene above 100 parts per million can potentially cause central nervous system effects, including headaches, fatigue, weakness, eye irritation and symptoms similar to those of alcohol, such as dizziness and slight nausea². Short term exposure to styrene vapors may cause respiratory irritation and eye irritation. These symptoms are typically temporary and recovery usually occurs within 48 hours. Styrene exposure below permissible levels typically does not cause these effects.

Repeated exposure to skin may cause dryness, redness, or cracking.

Based on animal studies, short term and intermediate duration exposure to styrene may cause liver damage. However, there is little evidence of liver damage in humans exposed to styrene.

If swallowed, styrene is a potential aspiration hazard (inhaling liquid into the lungs). Vomiting increases risk of inflammation of the lung caused by aspirating the substance (chemical pneumonia) or fluid accumulation in the air spaces of the lungs (pulmonary edema) caused by aspiration. This is a serious medical condition which requires immediate and proper medical attention.

The nervous system is affected by long term exposure to styrene. Studies have shown that long-term exposure at levels above 30 parts per million has been identified as possibly contributing to hearing loss. Additionally, chronic exposure to styrene may result in minor impairment of color vision discrimination.

Styrene monomer has not been classified as a reproductive or developmental toxicant.

Different governmental and non-governmental agencies rate the cancer causing potential (carcinogenicity) of chemicals. Some results for Styrene Monomer include:

<table>
<thead>
<tr>
<th>Agency</th>
<th>Carcinogenicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Agency for Research on Cancer (IARC)</td>
<td>Possibly carcinogenic to humans</td>
</tr>
<tr>
<td>National Toxicology Program (NTP)</td>
<td>Reasonably anticipated to be a human carcinogen</td>
</tr>
<tr>
<td>American Conference for Governmental Industrial Hygienists (ACGIH)</td>
<td>Not considered to be carcinogenic</td>
</tr>
<tr>
<td>Occupational Safety and Health Administration (OSHA)</td>
<td>Not listed</td>
</tr>
</tbody>
</table>

In 2011, the NTP listed styrene in the 12th Report on Carcinogens (RoC) as “Reasonably Anticipated to be a Human Carcinogen”. The RoC does not state or conclude that the use of styrene-based products poses a safety risk to consumers who use the products, employees at companies that manufacture or use styrene-based products such as polystyrene, or individuals living in communities where such companies operate.

Several extensive, peer-reviewed studies of styrene workers show that long-term (at least several years) styrene exposure does not cause cancer or other serious health effects. These studies, conducted over the past two decades, have examined the health of more than 60,000 workers involved in styrene use or production in the United States, Canada, Japan and multiple European countries.³

Based on the large and still growing body of scientific evidence pointing away from a concern for styrene’s potential carcinogenicity, the European Union concluded in its Registration, Evaluation, Authorisation and Restriction (REAC)h risk assessment report on styrene” that “there is no clear and consistent evidence for a causal link between specific cancer mortality and exposure to styrene,” and that “no further risk management activity under (the REAC)h program) is required.”

A review conducted by an expert panel led by Dr. Paolo Boffetta of Mount Sinai School of Medicine and formerly of the International Agency for Research on Cancer is especially noteworthy. The review panel’s results, published in


2009 in the Journal of Occupational and Environmental Medicine, concluded that the available data “does not support a causal relationship between styrene exposure and any type of human cancer.” Other similar findings have also been also published, including research done by the University of Alabama’s School of Public Health.

Potential for Exposure

Environmental Exposure

Styrene readily biodegrades and does not present a hazard to organisms in the environment. Measured environmental concentrations of styrene in the air, water and soil are too low to cause effects on mammals, non-mammals or microorganisms. Styrene is moderately toxic to aquatic organisms, but the compound’s properties keep exposure levels below that required for toxicity.

Industrial Worker Exposure

Styrene monomer is a recognized hazardous substance with exposure limits. Ventilation and engineering controls must be used in areas where styrene monomer is present in order to keep exposure levels below established standards. Workers should wear respiratory protection, splash goggles or safety glasses, flame retardant clothing covering the entire body, and chemical resistant gloves and boots. If inhalation above industry standards is possible, an appropriate respirator must be worn.

The monomer has a distinct odor at a very low threshold of about 0.1 ppm. This allows it to be readily detected in the workplace at concentrations well below exposure limits.

Consumer/General Public Exposure

Foods such as coffee, strawberries and cinnamon naturally contain styrene. Small amounts of styrene are also produced naturally by plants, bacteria, and fungi. Styrene is also present in combustion products such as cigarette smoke and automobile exhaust.

Consumers use polymers containing styrene and are exposed to very small amounts of residual monomer. Safe food contact use is regulated by the US Federal Food and Drug Administration (FDA).

A study of children’s indoor exposure to styrene in a conservative, screening-level risk assessment has concluded that styrene monomer exposures to children are very low and are well below levels of public health concern.

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Product Stewardship Contact Information

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Additional Information

Total Petrochemicals & Refining USA, Inc. Material Safety Data Sheet for Styrene Monomer
http://www.totalpetrochemicalsusa.com

Styrene Producers Association/CEFIC:  http://www.styrenemonomer.org/index.html

Agency for Toxic Substances and Disease Registry (ATSDR) summary for styrene

Detailed summaries of available toxicity studies for styrene can be found at the Styrene Information Research Center (SIRC) website: http://www.styrene.org/science/health/overview.html

A resource of information on styrene for consumers, employees and communities:
http://youknowstyrene.org/

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