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Briefing Paper

Styrene and Styrenic Compounds: What's the Difference?

Background

Many different chemical compounds and resins are made with or contain the building-block chemical styrene. All have different chemical and physical properties. Consumers should not make the assumption that because a compound or resin has "styrene" in its name or as part of its name that it is similar to the chemical styrene. Nor should they assume that because a compound or resin does not have "styrene" in its name that it is not made using styrene. This paper describes briefly the chemical and physical properties of styrene, common compounds and resins with styrene in the name and made from styrene, and the properties of each.

What is Styrene?

The basic chemical styrene monomer is a clear, colorless, oily liquid that is a building block used to make thousands of everyday products for home, school, work and play, ranging from food containers and packaging materials to cars, boats, computers, video games and myriad others. While styrene occurs naturally, it is produced in industrial quantities from petroleum and natural gas byproducts. Styrene helps create remarkably strong, flexible, and light-weight products, representing a vital part of the economy and quality of life.

Styrene has an aromatic, almost floral odor[1] at low concentrations, but is quite pungent at high concentrations. The list of alternative names for styrene includes vinyl benzene, phenethylene, cinnamene, Diarex HF 77, styrolene, styrol and styropol. Styrene is named after the styrax trees[2] from whose sap a related resin (benzoin) can be extracted. Styrene also occurs naturally in a variety of foods[3] including fruits, vegetables, nuts, beverages and meats; cinnamon is particularly rich in styrene. Its molecular formula is C8H8, meaning that it consists entirely of the elements carbon and hydrogen. Styrene evaporates quickly.

What is Not Styrene?

The following compounds are not styrene and do not have properties similar to the chemical styrene, but **all are made from styrene** and, in some chases, other compounds.

Polystyrene is a polymer (compound made up of many like molecules) made from styrene monomer; it is one of the most versatile, widely used plastics in the world.

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[1] U.S. Environmental Protection Agency Consumer Factsheet on Styrene.
[2] Wikipedia entry on styrene.
[3] "The Determination of Styrene in Selected Foods" by David H. Steele, Ph.D., et al., Journal of Agricultural and Food Chemistry, 19994, 42, p. 1661-1665.

By itself, styrene will react to air (oxygen) over a period of time to form polystyrene, which is a solid. However, commercial polystyrene is made by adding a catalyst to styrene, which causes it to react and form a solid. Polystyrene is produced in two principal forms -- (1) solid polystyrene and (2) expanded polystyrene foam. Expanded polystyrene foam, which can be produced in both open-cell and closed-cell forms, is made by dissolving a blowing agent (substance capable of producing a cellular structure in a plastic) into molten polystyrene, which then is formed into a desired shape. Like styrene, polystyrene is made up entirely of the basic elements carbon and hydrogen.

Pure solid polystyrene is colorless and hard, with limited flexibility. It can be transparent or made to take on various colors. It is used, for example, in disposable cutlery, plastic models, CD and DVD cases, laboratory containers and many other objects where a rigid, economical plastic is desired.

Expanded polystyrene foam's insulating properties make it important as a construction material. Other key products made from foamed (expanded) polystyrene include packing materials (packing peanuts, for example) and foodservice. For more information about polystyrene, visit the American Chemistry Council's Plastics Foodservice Packaging Group, www.americanchemistry.com.

Styrofoam® is a trademark for polystyrene thermal insulation manufactured by The Dow Chemical Company. There is not a coffee cup or food container in the world made of Styrofoam, although it is made from polystyrene and the word Styrofoam often is used mistakenly as a generic term for expanded polystyrene foam. In 1941, researchers at a Dow lab "rediscovered" a way to make foamed polystyrene, a method first discovered by Swedish inventor C.G. Munters. Dow acquired the exclusive rights to use Munter's patents and found ways to make large quantities of extruded polystyrene in a closed-cell form that resisted moisture. Because of its "unsinkability," it was adopted in 1941 by the U.S. Coast Guard for use in a six-person life raft, and continues to be widely used for flotation, as well as insulation. For more information, visit www.dow.com.

Styrene butadiene rubber[4] (SBR) is a type of rubber, three fourths of which are used in the automotive industry, primarily for tire treads. SBR originally was developed as a substitute for natural rubber, which has a number of supply and technical disadvantages. These drawbacks include being harder to process and less resistant to abrasion than SBR. SBR gives tires better road-hugging ability, especially on wet pavement, for a safer ride, and SBR-based tires also increase vehicle mileage. SBR also is used in shoe heels and soles and gaskets. For more information visit the International Institute of Synthetic Rubber Producers, www.iisrp.com.

Styrene butadiene (SB) latex allows the manufacture of high-gloss, water-resistant coated papers for printing, writing and paperboard packaging. Also, more than 90 percent of all the broadloom carpets produced in the United States are held together by SB latex binder. For more information visit the SB Latex Council, www.regnet.com/sblc/

Acrylonitrile butadiene styrene (ABS) resins are used mostly in automobiles, electrical and electronic applications, consumer goods, and buildings and construction. Everyday items like bicycle helmets,

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[4] Most of the descriptions for this compound and the following styrenic materials are drawn from "The Economic Benefits of Styrenics to the U.S. Economy," prepared for the Styrene Information and Research Center by Global Insight, Lexington, Mass., April 2004. This publication is available from the Styrene Information and Research Center.

luggage, telephones and housings for computers and kitchen appliances are made from ABS. These resins have superior properties, which makes them cost-effective in comparison with harder-to fabricate alternatives. ABS resins are tough, formable, have substantial heat resistance, and can be produced with gloss finishes.

Styrene acrylonitrile (SAN) resins are used mostly in consumer goods and appliances. SAN resins' glass-like clarity and the fact that products made from it are dishwasher safe make them the resins of choice for many everyday products. These qualities include impact strength, dimensional stability, heat resistance, and the ability to be washed at high temperature.

Unsaturated polyester resins (UPRs) usually are reinforced with glass fibers to produce composite plastics with improved strength. Reinforced UPRs – commonly called fiberglass – account for about 75 percent of all commercial UPRs. They have a host of uses, including in construction, transportation and fiberglass boat manufacturing. Without it, recreational boats would be made out of wood, aluminum and possibly steel, all of which perform differently and have different cosmetic properties than UPR-based boats, as well as a wide variety of other disadvantages. Un-reinforced UPRs (the remaining 25 percent) are used to make synthetic marble and polymer concrete. For more information, visit the American Composites Manufacturers Association, www.acmanet.org, or its International Cast Polymer Alliance, www.icpa-hq.org, or the National Marine Manufacturers Association, www.nmma.org.

Styrene maleic anhydride (SMA) is a plastic that is made with styrene and maleic anhydride monomers. This small-volume plastic is transparent, has high heat resistance and good dimensional stability, making it suitable for applications including engineered plastics and sizings for paper, binders and coatings.

Styrene oxide[5] is a chemical derived from styrene and a chemical that metabolizes from styrene in biological systems. It is used as a chemical intermediate in the production of styrene glycol and its derivatives, cosmetics, coatings, and agricultural and biological chemicals. Small quantities are used to improve the stability of hydraulic fluids, chlorinated cleaning compositions and other industrial fluids. It is not a large-volume chemical and public exposure is minimal, with the U.S. Department of Health and Human Services' Library of Medicine Hazardous Substance Data Bank (HSDB) identifying only one U.S. producer. (Editor's note: Commercial production of this chemical could not be independently confirmed and may have ceased since the HSDB reference was created.)

Styrene oligomers (sometimes referred to as styrene dimers and trimers) are created normally in small quantities during polystyrene manufacturing. Polystyrene is made by reacting many styrene molecules together to form polymers in long chains (typically several hundred styrene units per chain). The chains are not all the same length. In some cases there will be only two styrene units in a chain (dimer) or three (trimer). In general, they are present in very small amounts in polystyrene.

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[5] Information in this description is derived from the U.S. Department of Health and Human Services' National Library of Medicine Hazardous Substance Data Bank on styrene-7,8-oxide, CASRN: 96-09-3, http://toxmap.nlm.nih.gov/toxmap/main/chemicals.jsp (click on styrene oxide).