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STYRENE Issue Brief

What's driving the production of styrene and related benzene emissions?

Mike Belliveau, Bend the Curve, May 2024

- Polystyrene (plastic and foam) is the largest single driver of benzene use and exposure
- Its production requires 3 cancer-causing chemicals: benzene, ethyl benzene & styrene
- More than half of all benzene produced by oil refineries is used to make styrene
- Polystyrene plastic and foam consume more than 60% of all styrene production
- Most uses of polystyrene plastic and foam are unnecessary, problematic, and replaceable by safer, more sustainable materials and other solutions, such as reuse

Production Process

Styrene is a petrochemical derived from unsustainable fossil resources. Of its fossil carbon, 75% comes from crude oil (to benzene) and 25% from natural gas (to ethylene):

Oil Extraction > Oil Refining > Benzene > Ethyl Benzene > **Styrene** > Plastics & Rubber
Gas Extraction > Processing > Ethane > Ethylene ⇑ (see next page)

Chemical Hazards (this is not an exhaustive list of chemicals or human health concerns)

- Benzene – known human carcinogen (leukemias and lymphomas), blood toxicant
- Ethyl benzene – possible human carcinogen; proven to cause cancer in lab animals
- Styrene – probably causes cancer in humans based on worker studies and lab testing
- Additives – toxic chemicals are added to styrene to prevent runaway reaction disasters

Market Drivers (see the next page for a more detailed description of styrene markets)

Polystyrene is the major driver of styrene production and associated benzene emissions. Half of all benzene is used to make styrene. More than 60% of all styrene is converted to polystyrene plastic or foam, which is a persistent pollutant that's rarely ever recycled.

Nearly two-thirds of the polystyrene plastic produced in the U.S. is consumed domestically by single-use **food packaging**, such as clear plastic clamshells and egg cartons, and disposable **food serviceware**, such as plastic forks, spoons, knives, cups, and bowls.[1]

Expanded polystyrene, often called styrofoam,[2] is widely used as **foam packaging** blocks and peanuts in shipping boxes for consumer electronics and small appliances, and for **food serviceware**, such as foam coffee cups, food trays, take-out containers, and coolers.

These markets are vulnerable to disruption from safer, more sustainable solutions, such as reusable cutlery and other food serviceware; molded fiber, corrugated cardboard, and paperboard for packaging in boxes; and aluminum, steel, and other safer plastics, for cases. In fact, polystyrene use has begun to decline[1] due to corporate and public policies.

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[1] American Chemistry Council, "Resin Review: The Annual Statistical Report of the North American Plastics Industry." 2023 Edition. Washington, DC: April 2023.

[2] Styrofoam™ is a registered trademark that Dupont acquired from Dow Chemical and refers exclusively to their own branded polystyrene foam insulation board and products, not expanded polystyrene in general.

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Styrene: Downstream Supply Chain and Major Markets

Market Share	Material Markets	Some Major End-Use Markets
36 %	General Purpose Polystyrene (GPPS)	Food packaging & food serviceware (cutlery, cups, etc.), other packaging
	High Impact Polystyrene (HIPS)	Computer housing, compact disc cases
26 %	Expanded Polystyrene (EPS)	Foam food serviceware (coffee cups, food trays, containers, etc.), foam packaging peanuts and blocks, coolers
	Extruded Polystyrene (XPS)	Foam insulation board, flotation
17 %	Styrene Butadiene Rubber (SBR)	Tires, conveyors belts, industrial hoses and cables, footwear, consumer goods
	Styrene Butadiene (SB) Latex	Coated paper pigment (for catalogs magazines, etc.) and for paperboard (for brand advertising); carpet back coating
	SBR Latex	Molded foams and adhesives
13 %	Acrylonitrile butadiene styrene (ABS)	Plastic parts for appliances, cars, toys, etc. and blends with other plastics
6 %	Unsaturated polyester resins (UPR)	Fiberglass reinforced plastic (FRP) for marine (boats), construction, cars, consumer goods, industrial products
< 2 %	Acrylonitrile styrene acrylate (ASA)	3D printing (especially for outdoor uses), auto parts (e.g. exterior panel coatings)
	Styrene-acrylonitrile copolymer (SAN)	Housewares, consumer goods, packaging, appliances (electronics), medical products, blends with ABS, polymeric polyols for polyurethanes
< 2 %	Styrene block copolymers (SBC)	Footwear, adhesives, sealants, bitumen modifier (paving & roofing), blending
	Other styrenic copolymers (several)	Ion exchange resins for water treatment, weather resistant plastics, other uses

Sources:

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Wikipedia contributors, "Acrylonitrile styrene acrylate," *Wikipedia, The Free Encyclopedia* (https://en.wikipedia.org/w/index.php?title=Acrylonitrile_styrene_acrylate&oldid=1196781507 : accessed April 25, 2024).

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