

Styrene - A Common Air Pollutant

Background

Styrene (C₈H₈, CAS number: 100-42-5), also known as vinyl benzene, is commonly found in newly constructed buildings with levels exceeding 200 µg/m³.

It is frequently emitted from consumer products manufactured with polystyrene plastics and is released from numerous building and construction materials.

Elevated levels can be associated with cigarette smoke, the operation of laser printers and photocopiers, as well as the emissions from 3D printers using thermoplastic filaments, and the use of plastic reinforced bathroom fixtures such as sinks and bathtubs. Typical air concentrations in residences and operating facilities are less than 50 µg/m³. It has a low odor threshold and is typically observed as a pungent, sweet smell.

Health Concerns

For typical indoor air exposure, styrene is a mucous membrane irritant affecting the eyes and respiratory system. This can result in cough, headache, fatigue and tearing of eyes. If odor is present, nausea and flu like symptoms can develop. Styrene inhalation over longer time periods (chronic exposure) may affect the central nervous system leading to headache, fatigue, and weakness. Styrene is not classified as to its carcinogenic potential; several studies show a potential link to leukemia and lymphoma, but data is inconclusive and it is considered a probable carcinogen by IARC.



Acceptable Exposure Levels

There are no regulated standards for acceptable indoor levels in nonindustrial environments such as homes, offices, and schools. Below is a list of some U.S. and global organizations with recommended exposure limits/odor thresholds for various applications (Table 1).

TABLE 1: STYRENE EXPOSURE AND EMISSION STANDARDS

Organization or Standard	Application	Exposure Limit	Additional Information
The United States Environmental Protection Agency (U.S. EPA)	Inhalation and oral exposure	RfC: 1000 µg/m ³ RfD: 0.2 mg/kg/day for nervous and respiratory systems	The U.S. EPA maintains the Integrated Risk Information System (IRIS), a database on information on noncancer and cancer health effects that may result from exposure to various substances in the environment, based on toxicological reviews. IRIS has a reference concentration for inhalation exposure (RfC) and a reference dose for oral exposure (RfD). RfD is an estimate of a daily exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime.
CDC's Agency for Toxic Substances and Disease Registry (ATSDR)	General air/ Indoor air	MRL Inhalation: 0.2 ppm or 850 µg/m ³ (chronic) MRL Oral: 0.1 mg/kg/day (acute)	The CDC's Agency for Toxic Substances and Disease Registry (ATSDR) has developed Minimal Risk Levels (MRLs) which estimate the daily level to which a subject may be exposed without the likelihood of adverse, non-cancer health effects. MRLs are derived for acute (1 - 14 days), intermediate (>14 - 364 days), and chronic (365 days and longer) exposure durations.
CA 01350 Specification	Product emissions	450 µg/m ³	CDPH SM 01350 sets allowable concentrations that emission levels from building products and materials must meet within 14 days after installation. Certification programs like CHPS, GREENGUARD gold, and BIFMA have adopted this requirement.
American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)	General air/ indoor air	900 µg/m ³	ASHRAE defines indoor air quality (IAQ) requirements for VOCs as general guidance for building design, diagnostics, and ventilation system design in ASHRAE 189.1.
U.S. Green Building Council Leadership in Environment and Energy Design (LEED)	Indoor air	900 µg/m ³	The LEED rating system specifies maximum acceptable concentrations for the clearance testing of air levels before a building or school is occupied.
California Office of Environmental Health Hazard Assessment (OEHHA)	General air/ Indoor air	REL = 900 µg/m ³ (chronic)	Reference exposure levels (RELs) address non-cancer health effects of volatile organic compounds (VOCs) and provide concentrations above which these health effects have been observed in studies.

Organization or Standard	Application	Exposure Limit	Additional Information
Ausschuss zur gesundheitlichen Bewertung von Bauprodukten (AgBB)	General air/ Indoor air	LCI = 250 µg/m ³	Ausschuss zur gesundheitlichen Bewertung von Bauprodukten (AgBB) sets Lowest Concentration of Interest (LCI) for VOC emissions from building products.
California The Division of Occupational Safety and Health (Cal/OSHA)	Occupational	PEL = 50 ppm (213.0 mg/m ³)	California has the most extensive list of occupational exposure limits of all states in the US reported as permissible exposure limit (PEL).
National Institute of Occupational Safety and Health (NIOSH)	Occupational	REL = 50 ppm (213.0 mg/m ³)	NIOSH recommended exposure limits (RELs) are intended to limit exposure to hazardous substances in workplace air to protect worker health.
American Conference of Governmental Industrial Hygienists (ACGIH)	Occupational	TLV = 10 ppm (42.6 mg/m ³)	Threshold Limit Values (TLV [®] s) are guidelines for the level of exposure that the typical worker can be exposed to without adverse health effects. They are not quantitative estimates of risk at different exposure levels or by different routes of exposure.
Occupational Safety and Health Administration (OSHA)	Occupational	TWA = 200 ppm (851.9 mg/m ³)	Permissible exposure limits (PELs) are how OSHA defines the maximum concentration of chemicals to which a worker may be exposed. PELs are defined in two ways: STEL (15-minute time-weighted average not to be exceeded) or an 8-hour total weight average (TWA), which is an average value of exposure over an eight-hour work shift.

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