

Toluene – A Common Air Pollutant

Background

Toluene, also known as methylbenzene or phenylmethane, is one of the most frequently found VOCs in our indoor air. It can be found in our schools, offices, homes, automobiles and other enclosed environments. Although small levels can be found in the outdoor air as an industrial chemical or in vehicular exhaust, indoor air levels are typically 10 - 100 times higher. A common industrial solvent, toluene frequency in the indoor air began to increase as benzene, a human carcinogen, started to decrease. Toluene becomes a vapor with a sweet smell when exposed to air at room temperature.

Toluene is used in many applications as a solvent, and air emissions have been associated with numerous products including paints and coatings, cleaning agents, adhesives and sealants, interior furnishings, combustion sources and personal care products, such as nail polish and synthetic fragrances. Our research has found that toluene is released from electronic cigarettes and vaping, 3D printing processes, and it is a common emission from more than 58% of furniture products tested. Typical indoor air levels range from 10-150 $\mu\text{g}/\text{m}^3$.

Health Concerns

People can be exposed to toluene by inhalation, ingestion, or skin contact. U.S. residents, on average, have 0.135 mg/L of toluene in whole blood. Exposure to toluene primarily affects the central nervous system (CNS) resulting in fatigue, dizziness, headaches, and nausea. It can also affect the eyes, skin, and respiratory system resulting in irritation and respiratory distress. The International Agency for Research on Cancer (IARC) lists toluene as a group 3 chemical, meaning that it is not classifiable as to its human carcinogenicity. It is however considered a reproductive toxin by the state of California and may result in birth defects, mental disabilities, and hindrance in growth. Expecting mothers, if exposed, can pass toluene to their babies through the placenta, resulting in neonatal toxicity.

Acceptable Exposure Levels

Although there are established occupational (workplace) exposure limits for toluene exposure, there are no regulated standards for acceptable airborne levels in more traditional environments such as schools or homes. Below is a list of some U.S. organizations with toluene exposure limits (Table 1).

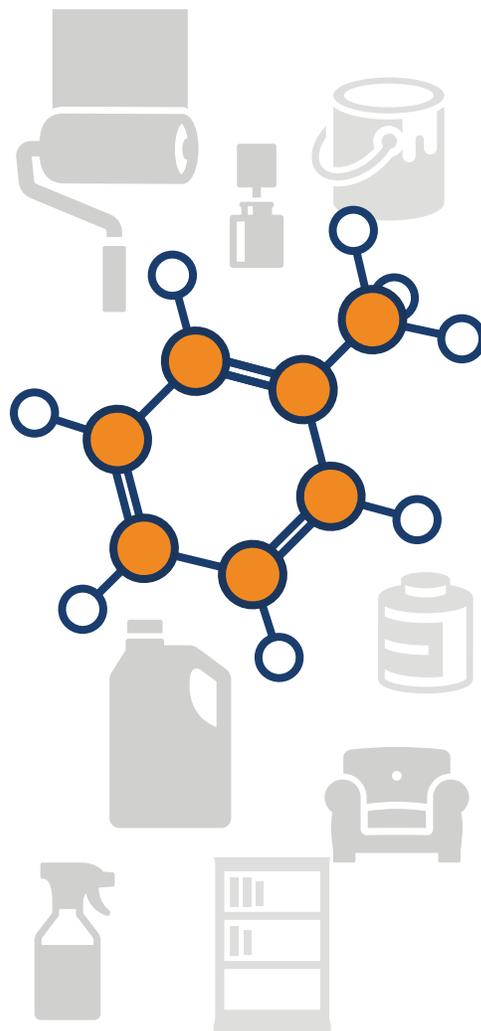


Table 1: Toluene Exposure Limits

Organization or Standard	Application	Exposure Limit	Additional Information
California Office of Environmental Health Hazard Assessment (OEHHA)	General air/ Indoor air	420 $\mu\text{g}/\text{m}^3$	Reference exposure levels (RELs) address non-cancer health effects of volatile organic compounds (VOCs) and provide concentrations below which these health effects have been observed in studies. Acute REL of toluene: 5,000 $\mu\text{g}/\text{m}^3$, 8-hour inhalation REL: 830 $\mu\text{g}/\text{m}^3$, chronic inhalation REL: 420 $\mu\text{g}/\text{m}^3$.
California Proposition 65 (Prop 65)	General air/ Indoor air	13,000 $\mu\text{g}/\text{day}$ (inhalation)	Prop 65 Maximum Allowable Dose Level (MADL) is the level developed by OEHHA for reproductive toxicity. The MADL for toluene is 13,000 $\mu\text{g}/\text{day}$ for inhalation.

Table 1 Continued: Toluene Exposure Limits

Organization or Standard	Application	Exposure Limit	Additional Information
The United States Environmental Protection Agency (U.S. EPA)	General air/ Indoor air	5,000 µg/m ³	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. Reference concentration (RfC) for toluene is 5,000 µg/m ³ . The Reference Dose (RfD) for toluene is 0.08 mg/kg/day.
Green Building Council Leadership in Environment and Energy Design (LEED)	Indoor air	300 µg/m ³	The LEED rating system specifies a maximum concentration of toluene in indoor air of 300 µg/m ³ . This level applies to clearance testing of air levels before a building or school is occupied, adopted from Cal EPA OEHHA CRELs.
CA 01350 Specification	Product emissions	150 µg/m ³	California Specification 01350 (CDPH SM) requires that emission contributions for toluene from building materials be equal to or less than 150 µg/m ³ within 14 days after installation. Certification programs like LEED, CHPS and GREENGUARD gold have adopted this requirement.
National Institute of Occupational Safety and Health (NIOSH)	Occupational/ Indoor air	375,000 µg/m ³	Recommended exposure limits (RELs) are time-weighted average (TWA) concentrations for up to a 10-hour workday during a 40-hour work week. NIOSH recommends TWA of 375,000 µg/m ³ . STEL (15-minute time-weighted average not to be exceeded is 565,000 µg/m ³).
Occupational Safety and Health Administration (OSHA)	Occupational/ Indoor air	754,000 µg/m ³	Permissible exposure limits (PELs) are how OSHA defines the maximum concentration of chemicals to which a worker may be exposed. PEL for an eight-hour TWA, which is an average value of exposure over an eight-hour work shift, is 754,000 µg/m ³ , ceiling limit is 1131,000 µg/m ³ .
American Conference of Governmental Industrial Hygienists (ACGIH)	Occupational/ Indoor air	75,000 µg/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. Recommended indoor air levels are typically 1/10 th or 1/100 th of the TLV.



References

1. Toluene | Toxic Substances | Toxic Substance Portal | ATSDR. Accessed May 19, 2021. <https://wwwn.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=29>
2. Toluene - Overview | Occupational Safety and Health Administration. Accessed May 19, 2021. <https://www.osha.gov/toluene>
3. U.S. EPA. toluene.pdf. Published July 2012. Accessed May 19, 2021. <https://www.epa.gov/sites/production/files/2016-09/documents/toluene.pdf>
4. CDC - NIOSH Pocket Guide to Chemical Hazards - Toluene. Accessed May 19, 2021. <https://www.cdc.gov/niosh/npg/npgd0619.html>
5. TOLUENE | CAMEO Chemicals | NOAA. Accessed May 19, 2021. <https://cameochemicals.noaa.gov/chemical/4654>
6. Chau K. Toluene. Proposition 65 Warnings Website. Published November 19, 2020. Accessed May 20, 2021. <https://www.p65warnings.ca.gov/fact-sheets/toluene>