

Acetaldehyde – A Common Air Pollutant

Background

Acetaldehyde (CH_3CHO), also known as acetic aldehyde, ethanal, and ethyl aldehyde, is ubiquitous in the indoor and outdoor air. It is a colorless liquid that is highly flammable, easily oxidized by air to form unstable peroxides, and has a pungent and irritating odor. Acetaldehyde in outdoor air is primarily generated from incomplete combustion of organic sources like vehicle fuel. It is also a byproduct of the oxidation of VOCs in the atmosphere.

Indoor sources are numerous and include furnishings and finishes, flooring, wood products, paints and coatings, furniture, adhesives, and some insulation products. In complete combustion processes from fireplaces and environmental tobacco also contribute to indoor levels. Acetaldehyde can be created when fragrance related volatile organic compounds (VOCs) react with ozone. Outdoor levels are typically less than $10 \mu\text{g}/\text{m}^3$, and indoor levels are 2-4 times higher. Our research data shows that acetaldehyde is the most frequently found VOC emission from paints and coatings, furniture, and adhesives and sealants.

Health Concerns

Acetaldehyde can be detected in the blood and breath to determine whether exposure has occurred. Exposure to acetaldehyde can occur via inhalation, ingestion, skin and/or eye contact. Acute exposure results in eye, upper respiratory, and skin irritation. Elevated levels can lead to nausea, vomiting, headache, and unconsciousness. Skin contact from clothing wet with acetaldehyde causes burns or severe irritation. Acetaldehyde has been shown in animals to cross the placenta to the fetus and suggests it to be a potential developmental toxin. An increased incidence of nasal tumors in rats and laryngeal tumors in hamsters has been observed following inhalation exposure to acetaldehyde, however, human data regarding the carcinogenic effects of acetaldehyde are still inconclusive.

Acceptable Exposure Levels

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

Table 1: Acetaldehyde Exposure and Emission Standards

Organization or Standard	Application	Exposure Limit	Additional Information
California Office of Environmental Health Hazard Assessment (OEHHA)	General air/ Indoor air	$140 \mu\text{g}/\text{m}^3$	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. Acetaldehyde acute REL: $470 \mu\text{g}/\text{m}^3$, 8-hour REL: $300 \mu\text{g}/\text{m}^3$, and chronic REL: $140 \mu\text{g}/\text{m}^3$.
California Proposition 65 (Prop 65)	General air/ Indoor air	$90 \mu\text{g}/\text{day}$ (inhalation)	Prop 65 No Significant Risk Level (NSRL) is the level developed by OEHHA to which if exposed to every day for 70 years will result in one excess case of cancer in 100,000 people. The NSRL for acetaldehyde is $90 \mu\text{g}/\text{day}$.
International Agency for Research on Cancer (IARC)	General air/ Indoor air	B2: Probable human carcinogen	Acetaldehyde is considered a probable human carcinogen (Group B2) based on inadequate human cancer studies and animal studies that have shown nasal tumors in rats and laryngeal tumors in hamsters.

The United States Environmental Protection Agency (U.S. EPA)	General air/ Indoor air	9 $\mu\text{g}/\text{m}^3$	The U.S. EPA maintains the Integrated Risk Information System (IRIS), a database on information on non-cancer and cancer health effects that may result from exposure to various substances in the environment, based on toxicological reviews. Acetaldehyde has the inhalation reference concentration (RfC) of 9 $\mu\text{g}/\text{m}^3$ based on degeneration of olfactory epithelium in rats. The odor threshold of acetaldehyde is 0.05 parts per million (ppm) (0.09 mg/m^3).
Green Building Council Leadership in Environment and Energy Design (LEED)	Indoor air	140 $\mu\text{g}/\text{m}^3$	The LEED rating system specifies a maximum acceptable concentration of acetaldehyde for the clearance testing of air levels before a building or school is occupied.
CA 01350 Specification	Product emissions	70 $\mu\text{g}/\text{m}^3$	CDPH SM 01350 requires that emission levels for acetaldehyde from building products and materials be equal to or less than 70 $\mu\text{g}/\text{m}^3$ within 14 days after installation. Certification programs like CHPS and GREENGUARD gold have adopted this requirement.
National Institute of Occupational Safety and Health (NIOSH)	Occupational	Potential occupational carcinogen	NIOSH considers acetaldehyde to be potential occupational carcinogen and testing has yet to be completed to determine a recommended exposure limit (REL).
Occupational Safety and Health Administration (OSHA)	Occupational	360,000 $\mu\text{g}/\text{m}^3$ (360 mg/m^3) (200 ppm)	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 eight-hour TWA, which is an average value of exposure over an eight-hour work shift. The OSHA TWA PEL for acetaldehyde is 200 ppm based on an 8-hour day, 40-hour workweek, however there is a consideration of reducing it to 100 ppm with a STEL of 150 ppm.
California The Division of Occupational Safety and Health (Cal/OSHA)	Occupational	45,000 $\mu\text{g}/\text{m}^3$ (45 mg/m^3) (25 ppm)	Ceiling permissible exposure limit (PEL) for acetaldehyde is 25 ppm (45 mg/m^3).
American Conference of Governmental Industrial Hygienists (ACGIH)	Occupational	45,000 $\mu\text{g}/\text{m}^3$ (45 mg/m^3) (25 ppm)	Threshold Limit Values (TLVs) 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. The acetaldehyde ceiling TLV-8-hr time weighted average is 25 ppm.



References

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