

Sources of Exposure

Toxicokinetics and Biomonitoring Levels

Biomarkers/Environmental Levels

General Populations

- The main source of acrolein exposure for the general population stems from indoor air; smoking (cigarettes, e-cigarettes, marijuana), secondhand smoke, cooking with oils and fats, and building materials all contribute to acrolein levels in the air.
- Environmental tobacco smoke, including primary, secondhand, and thirdhand smoke, is a major source of exposure for many people in the general population.
- Acrolein can be found in the exhaust from gasoline or diesel vehicles. Living or working near dense traffic areas can increase your exposure.
- Ingestion of some foods and beverages and consumption of contaminated drinking water can be routes of exposure.
- People living near a landfill or water source being treated with acrolein to eliminate unwanted plants may be exposed.

Occupational Populations

- People who work in heavy traffic or parking garages may be exposed to acrolein by breathing vehicle exhaust.
- Firefighters are at high risk of exposure to acrolein when battling house fires, wildfires, and industrial fires.
- Workers involved in the production of acrylates, methionine, perfumes, plastics, refrigerants, rubber, or textile resins may potentially be exposed.
- People working in a restaurant kitchen or a bar/tavern that allows indoor smoking may have higher exposure levels to acrolein.

Toxicokinetics

- Studies in animals indicate that acrolein is absorbed in the respiratory tract, primarily the upper respiratory tract, following inhalation exposure.
- Human and animal studies demonstrate that acrolein is absorbed from the gastrointestinal tract following oral exposure.
- Animal studies indicate that distribution of acrolein after inhalation and oral exposure is limited due to the strong reactivity of acrolein with tissues at the exposure site.
- The main metabolic pathway is through acrolein conjugation with reduced glutathione (GSH) followed by enzyme-catalyzed conversion to mercapturic acid products for urinary excretion. The major urinary products of this pathway are 3-hydroxypropylmercapturic acid (3-HPMA) and carboxyethyl mercapturic acid (CEMA). Minor metabolic pathways are postulated to yield glyceraldehyde and malonic acid.
- Acrolein is not excreted unchanged. Acrolein metabolites are excreted primarily in the urine and exhaled air following oral or inhalation exposure; small quantities are excreted in feces.

NHANES Levels

- There are no data regarding levels of acrolein in the general population; however, higher urinary levels of 3-HPMA and CEMA were seen in tobacco smokers compared to non-tobacco users (NHANES 2005–2006).

Biomarkers

- Urinary excretion of the metabolite, 3-HPMA, has been proposed as a biomarker; however, this metabolite is not specific for acrolein exposure.

Environmental Levels

Air

- In 2022, the average concentrations of acrolein from 61 monitoring stations across the United States ranged from 0.062 to 0.591 ppbv (0.14–1.36 $\mu\text{g}/\text{m}^3$), with maximum values of 1.27 ppbv (2.91 $\mu\text{g}/\text{m}^3$).

Water

- From 2005 to 2019, acrolein was detected in 20% of 69 surface water samples at average concentrations of 0.97–4.44 $\mu\text{g}/\text{L}$.

Sediment and Soil

- In sediment samples, acrolein was found at a maximum of 1.9 $\mu\text{g}/\text{kg}$ in 8 of 105 sediment samples reported for 2005–2014. Acrolein was not detected in five soil samples reported in the Water Quality Portal database from 2005 to 2009.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2024. Toxicological Profile for Acrolein (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™ for Acrolein

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Chemical and Physical Information

Routes of Exposure

Relevance to Public Health (Health Effects)

Acrolein

- Acrolein is a colorless or yellowish liquid with a disagreeable odor.
- It is a reactive aldehyde primarily used as an intermediate in the chemical manufacturing of acrylic acid to make synthetic glycerol, acrolein polymers, polyurethane, and polyester resins.
- Acrolein is also used as an herbicide (trade name Magnacide H) to control algae and aquatic weeds, and as a biocide (trade name Magnacide B) to control mollusks in recirculating process water systems.
- Acrolein is used as an intermediate in the production of methionine, which is a protein supplement used in animal feed.
- Due to its foul odor, acrolein has also been used in military poison gas mixtures.

- Inhalation – Predominant route of exposure for general and occupational populations.
- Oral – Not a likely route of exposure for general and occupational populations.
- Dermal – Not a likely route of exposure for general and occupational populations.

Acrolein in the Environment

- Acrolein is released to the environment in emissions from manufacturing and use facilities, combustion processes (including automobile emissions and smoke from any type of fire), degradation of other pollutants, and direct release.
- Acrolein is a reactive compound and is unstable in the environment.
- Acrolein is expected to volatilize rapidly from surface water and soil.
- Acrolein is not persistent in the atmosphere and reacts with hydroxyl radicals, with a half-life of 15–20 hours.
- When applied to surface water as an herbicide, the half-life was reported to be <1–3 days.
- Acrolein can be removed from water and soil by volatilization, abiotic processes, and biodegradation processes.
- Acrolein is not expected to bioaccumulate.

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation

- A provisional acute-duration (≤ 14 days) inhalation MRL of 0.003 ppm was derived.
- A provisional intermediate-duration (15–364 days) inhalation MRL of 4×10^{-4} ppm was adopted.
- A provisional chronic-duration (≥ 365 days) inhalation MRL of 4×10^{-4} ppm was derived.

Oral

- No provisional acute-duration (≤ 14 days) or chronic-duration (≥ 365 days) oral MRLs were derived.
- A provisional intermediate-duration (15–364 days) oral MRL of 0.002 mg/kg/day was derived.

Health Effects

- Rapid onset of nose and throat irritation and a reduction in breathing rate (believed to be a protective measure triggered by nose irritation) were reported by volunteers acutely exposed to low levels of acrolein.

- Epidemiology studies have reported associations between acrolein exposure and reporting of respiratory irritation symptoms, prevalence of asthma, and decrements in pulmonary function.
- In animals, nasal and pulmonary irritation, altered respiratory function, and increased lung weight were reported after acute-, intermediate-, and chronic-duration inhalation exposure.
- Altered immune function has been seen in animals following inhalation or oral exposure.
- In animals, stomach lesions including ulcers, hemorrhage, hyperplasia of the forestomach, and/or erosion of the glandular mucosa were seen after intermediate-duration oral exposure.
- Increased incidence of nasal tumors was seen in animals after chronic inhalation.
- The Department of Health and Human Services (HHS) has not classified acrolein as to its carcinogenicity. The U.S. Environmental Protection Agency (EPA) concluded that the potential carcinogenicity of acrolein cannot be determined due to inadequate data. The International Agency for Research on Cancer (IARC) has classified acrolein as “probably carcinogenic to humans” (Group 2A) based on “sufficient” evidence of carcinogenicity in experimental animals and “strong” mechanistic evidence.

Children’s Health

- It is not known if children are more sensitive to acrolein exposure than adults.