1,3-Butadiene

106-99-0

Hazard Summary

Motor vehicle exhaust is a constant source of 1,3-butadiene. Although 1,3-butadiene breaks down quickly in the atmosphere, it is usually found in ambient air at low levels in urban and suburban areas. Acute (short-term) exposure to 1,3-butadiene by inhalation in humans results in irritation of the eyes, nasal passages, throat, and lungs. Epidemiological studies have reported a possible association between 1,3-butadiene exposure and cardiovascular diseases. Epidemiological studies of workers in rubber plants have shown an association between 1,3-butadiene exposure and increased incidence of leukemia. Animal studies have reported tumors at various sites from 1,3-butadiene exposure. EPA has classified 1,3-butadiene as carcinogenic to humans by inhalation.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (5), which contains information on the health effects of 1,3-butadiene including the reference concentration and unit cancer risk for inhalation exposure, and the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for 1,3-Butadiene. (1)

Uses

- 1,3-Butadiene is used in the production of rubber and plastics. It is also used in copolymers including acrylics. (1)

Sources and Potential Exposure

- Sources of 1,3-butadiene released into the air include motor vehicle exhaust, manufacturing and processing facilities, forest fires or other combustion, and cigarette smoke. (1)
- 1,3-Butadiene was detected in ambient air of cities and suburban areas from 1970 to 1982 at an average level of 0.3 parts per billion (ppb). (1)
- Higher levels of 1,3-butadiene may be found in highly industrialized cities or near oil refineries, chemical manufacturing plants, and plastic and rubber factories. (1)
- 1,3-Butadiene has been found in drinking water and in plastic or rubber food containers, but not in food samples. (1)
- Occupational exposure to 1,3-butadiene may occur in the rubber, plastics, and resins industries. (1)

Assessing Personal Exposure

- There is no reliable medical test available at this time to assess personal exposure to 1,3-butadiene. (1)

Health Hazard Information

Acute Effects:

- Acute exposure to 1,3-butadiene by inhalation in humans results in irritation of the eyes, nasal passages, throat, and lungs. Neurological effects, such as blurred vision, fatigue, headache, and vertigo, have also been reported at very high exposure levels. (1,3)

- Dermal exposure of humans to 1,3-butadiene causes a sensation of cold, followed by a burning sensation, which may lead to frostbite. (1)
- Tests involving acute exposure of animals in rats and mice have shown 1,3-butadiene to have low acute toxicity. (1,4)

Chronic Effects (Noncancer):

- One epidemiological study reported that chronic (long-term) exposure to 1,3-butadiene via inhalation resulted in an increase in cardiovascular diseases, such as rheumatic and arteriosclerotic heart diseases, while other human studies have reported effects on the blood. (1)
- Animal studies have reported effects on the respiratory and cardiovascular systems, blood, and liver from chronic, inhalation exposure to 1,3-butadiene. (1)
- EPA has established a Reference Concentration (RfC) a chronic reference level of 0.002 milligrams per cubic meter (mg/m^3) for 1,3-butadiene based on reproductive effects in mice. The RfC is an exposure concentration at or below which adverse health effects are not likely to occur. It is not a direct estimator of risk, but rather a reference point to gauge the potential for effects. At lifetime exposures increasingly greater than the reference exposure level, the potential for adverse health effects increases. (5)

Reproductive/Developmental Effects:

- No information is available on reproductive or developmental effects of 1,3-butadiene in humans. (1)
- Animal studies using mice have reported developmental effects, such as skeletal abnormalities and decreased fetal weights, and reproductive effects, including an increased incidence of ovarian atrophy and testicular atrophy from inhalation exposure to 1,3-butadiene. (1)

Cancer Risk:

- A large epidemiological study of synthetic rubber industry workers demonstrated a consistent association between 1,3-butadiene exposure and occurrence of leukemia (10, 11).
- Several epidemiological studies of workers in styrene-butadiene rubber factories have shown an increased incidence of respiratory, bladder, stomach, and lymphato-hematopoietic cancers. However, these studies are not sufficient to determine a causal association between 1,3-butadiene exposure and cancer due to possible exposure to other chemicals and other confounding factors. (1,5,6)
- Animal studies have reported tumors at a variety of sites from inhalation exposure to 1,3-butadiene. (1,5,6)
- 1,3-Butadiene is metabolized into genotoxic metabolites by experimental animals and humans. (1)
- EPA has classified 1,3-butadiene as carcinogenic in human by inhalation.(5)
- EPA uses mathematical models, based on animal studies, to estimate the probability of a person developing cancer from continuously breathing air containing a specified concentration of a chemical. EPA has calculated an inhalation unit risk estimate of 3×10^{-5} $(\mu g/m^3)^{-1}$. (5)

Physical Properties

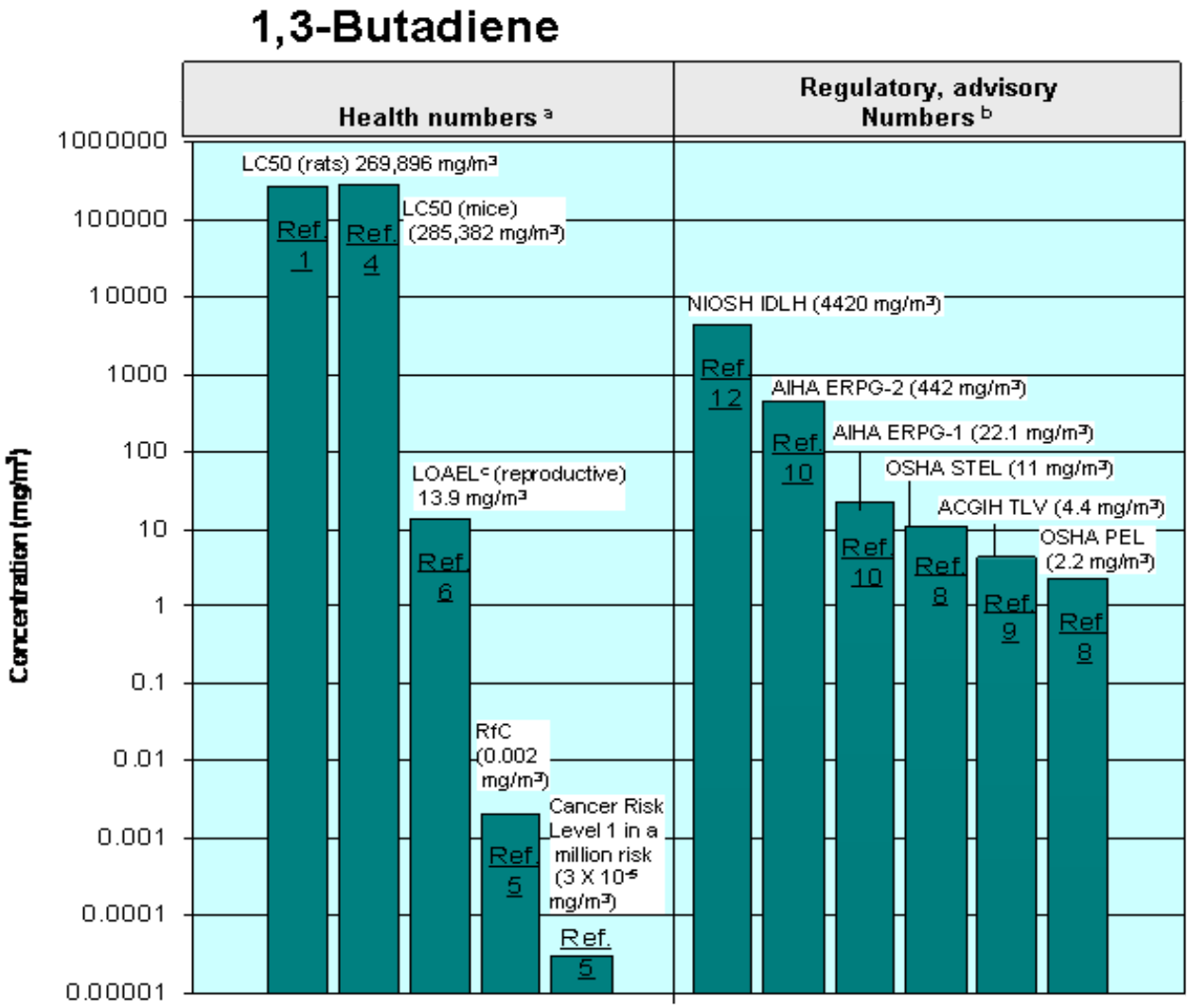
- 1,3-Butadiene is a colorless gas with a mild gasoline-like odor. (1)
- The odor threshold for 1,3-butadiene is 1.6 parts per million (ppm). (7)
- The chemical formula for 1,3-butadiene is C_4H_6, and the molecular weight is 54.09 g/mol. (1)
- The vapor pressure for 1,3-butadiene is 2100 mm Hg at 25 °C, and it has an octanol/water partition coefficient (log K_{ow}) of 1.99. (1)

Conversion Factors (only for the gaseous form):

To convert concentrations in air (at 25°C) from ppm to mg/m^3: mg/m^3 = (ppm) × (molecular weight of the

compound)/(24.45). For 1,3-butadiene: 1 ppm = 2.21 mg/m^3. To convert concentrations in air from µg/m^3 to mg/m^3: mg/m^3 = (µg/m^3) × (1 mg/1,000 µg).

Health Data from Inhalation Exposure



ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

AIHA ERPG--American Industrial Hygiene Association's emergency response planning guidelines. ERPG 1 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor; ERPG 2 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing or developing irreversible or other serious health effects that could impair their abilities to take protective action.

LC_{50} (Lethal Concentration$_{50}$)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

NIOSH IDLH-- National Institute of Occupational Safety and Health's immediately dangerous to life or health concentration; NIOSH recommended exposure limit to ensure that a worker can escape from an exposure condition that is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from the environment.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-

weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

OSHA STEL --OSHA's short-term exposure limit.

The health and regulatory values cited in this factsheet were obtained in March 2009.

[a] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

[b] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH, ACGIH, and AIHA numbers are advisory.

[c] The LOAEL is from the critical study used as the basis for the EPA RfC.

Summary created in April 1992, updated in January 2000 and March 2009.

References

1. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for 1,3-Butadiene. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1992.
2. E.J. Calabrese and E.M. Kenyon. Air Toxics and Risk Assessment. Lewis Publishers. 1991.
3. U.S. Department of Health and Human Services. Hazardous Substances Data Bank (HSDB, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
4. U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD. 1993.
5. U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) on 1,3-Butadiene. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 2009.
6. California Environmental Protection Agency (CalEPA). Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. Draft for Public Comment. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1997.
7. J.E. Amoore and E. Hautala. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatilities for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, 3(6):272-290. 1983.
8. Occupational Safety and Health Administration (OSHA). Occupational Safety and Health Standards, Toxic and Hazardous Substances. Code of Federal Regulations. 29 CFR 1910.1000. 1998.
9. American Conference of Governmental Industrial Hygienists (ACGIH). 1999 TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents. Biological Exposure Indices. Cincinnati, OH. 1999.
10. Delzell E, Sathiakumar N, Hovinga M, et al. A follow-up study of synthetic rubber workers. Toxicology 113:182-9. 1996.
11. Macaluso M, Larson R, Delzell E, et al. Leukemia and cumulative exposure to butadiene, styrene and benzene among workers in the synthetic rubber industry. Toxicology 113:190-202. 1996.
12. National Institute for Occupational Safety and Health (NIOSH). Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. Cincinnati, OH. 1997.
13. American Industrial Hygiene Association (AIHA). The AIHA 1998 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook. 1998.