# Phosgene

# Hazard Summary

Phosgene is used as a chemical intermediate; in the past, it was used as a chemical warfare agent. Phosgene is extremely toxic by acute (short-term) inhalation exposure. Severe respiratory effects, including pulmonary edema, pulmonary emphysema, and death have been reported in humans. Severe ocular irritation and dermal burns may result following eye or skin exposure. Chronic (long-term) inhalation exposure to phosgene has been shown to result in some tolerance to the acute effects noted in humans, but may also cause irreversible pulmonary changes of emphysema and fibrosis. Limited human studies indicate no increase in the incidence of cancer among workers chronically exposed to phosgene. EPA has classified phosgene as a Group D compound, not classifiable as to human carcinogenicity.

Please Note: The main source of information for this fact sheet is EPA's Health Assessment Document for Phosgene. (1) Other secondary sources include the Hazardous Substances Data Bank (HSDB) (2), a database of summaries of peer-reviewed literature, and the Registry of Toxic Effects of Chemical Substances (RTECS) (4), a database of toxic effects that are not peer reviewed.

#### Uses

- Phosgene is a widely used chemical intermediate, primarily manufactured in the preparation of many organic chemicals. Phosgene is used for the synthesis of isocyanate-based polymers, carbonic acid esters, and acid chlorides. It is also used in the manufacture of dyestuffs, some insecticides, and pharmaceuticals and in metallurgy. (1,6)
- In the past, phosgene was used as a chemical warfare agent (in WWI and WWII). (1,3,5)

#### Sources and Potential Exposure

- Individuals are most likely to be exposed to phosgene in the workplace during its manufacture, handling, and use. (1)
- Exposure to phosgene may occur in the ambient air from direct industrial emissions of phosgene, thermal decomposition of chlorinated hydrocarbons, and photooxidation of chloroethylenes in the air. (1)

# Assessing Personal Exposure

• No information was located concerning the measurement of personal exposure to phosgene.

# Health Hazard Information

Acute Effects:

- Acute inhalation exposure to phosgene causes severe respiratory effects in humans, including pulmonary edema, pulmonary emphysema, and possibly death. Symptoms of acute exposure include choking, chest constriction, coughing, painful breathing, and bloody sputum. Death results from anoxemia, which causes paralysis of the respiratory center, asphyxiation, or heart failure. (1-3)
- Acute phosgene poisoning may also affect the brain, heart, and blood in humans. These effects are thought to be caused by a lack of oxygen and not by the direct action of phosgene. (1)
- Severe ocular irritation and dermal burns may occur following eye or skin exposure in humans. (2)

- Phosgene also damages the lungs and alters pulmonary immune system function in animals. (5) Tests
- involving acute exposure of rats, mice, rabbits, and guinea pigs have demonstrated phosgene to have high acute toxicity from inhalation exposure. (4)

Chronic Effects (Noncancer):

- Chronic inhalation exposure to low levels of phosgene has been shown to result in some tolerance to the acute effects noted in humans but may also cause irreversible pulmonary changes of emphysema and fibrosis. (6)
- An increased incidence of chronic pneumonitis and acute and fibrinous pneumonia has been observed in animals chronically exposed to phosgene. (6)
- EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for phosgene. (7)
- The California Environmental Protection Agency (CalEPA) has calculated a chronic inhalation reference exposure level of 0.0003 milligrams per cubic meter (mg/m<sup>3</sup>) for phosgene based on pulmonary toxicity in rats. The CalEPA reference exposure level is a 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 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 the reproductive or developmental effects of phosgene in humans or animals.

Cancer Risk:

- No adequate animal data exist on the carcinogenic effects of phosgene, and limited human studies indicate no increase in the incidence of cancer among workers chronically exposed to phosgene. (1)
- EPA has classified phosgene as a Group D compound, not classifiable as to human carcinogenicity, based on a lack of animal and human data. (1)

## **Physical Properties**

- The chemical formula for phosgene is COCI, and its molecular weight is 98.92 g/mol. (1,3)
- Phosgene occurs as a colorless gas that is sl<sup>2</sup>ightly soluble in water. (1,3)
- Phosgene has a suffocating odor reminiscent of moldy hay at low concentrations. The odor threshold for phosgene is 0.4 parts per million (ppm). (1,3)
- The vapor pressure for phosgene is 1,215 mm Hg at 20 °C. (3)

**Conversion Factors:** 

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 phosgene: 1 ppm = 4.05 mg/m<sup>3</sup>.

Health Data from Inhalation Exposure

#### Phosgene



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 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 )--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. LOAEL--Lowest observed adverse effect level.

NIOSH REL--National Institute of Occupational Safety and Health's recommended exposure limit; NIOSHrecommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.

NIOSH ceiling--NIOSH's recommended exposure limit ceiling; the concentration that should not be exceeded at any time.

NIOSH IDLH -- NIOSH'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 timeweighted 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. The health and regulatory values cited in this factsheet were obtained in December 1999.

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

<sup>°</sup> 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.

The LOAEL is from the critical study used as the basis for the CalEPA chronic inhalation reference exposure level.

Summary created in April 1992, updated in January 2000

## References

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- 5. 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.
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- 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. 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.
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- 11. American Industrial Hygiene Association (AIHA). The AIHA 1998 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook. 1998.