

Sources of Exposure

Toxicokinetics and Normal Human Levels

Biomarkers/Environmental Levels

ToxGuide™

for

Chlorine Dioxide and Chlorite

ClO₂

CAS# 10049-04-4 (chlorine dioxide)
September 2004

U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
www.atsdr.cdc.gov

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General Populations

- The general population is most likely to be exposed to chlorine dioxide and its by-products (e.g., chlorite ion) through ingestion of treated water.
- Exposure through inhalation is not likely because chlorine dioxide and chlorite do not persist in the atmosphere

Occupational Populations

- The primary route for occupational exposure to chlorine dioxide and chlorite is inhalation in the immediate vicinity of their use.
- Exposure may occur at facilities that use these chemicals as bleaching agents (pulp and paper mills) or water disinfectants (water-treatment plant).

Toxicokinetics

- Due to its highly reactive nature, little absorption of chlorine dioxide across lung tissue is expected following inhalation exposure.
- Being both a strong oxidizer and water soluble, chlorine dioxide is not likely absorbed in the gastrointestinal tract to any great extent.
- Chlorine dioxide rapidly dissociates predominantly into chlorite (which is also highly reactive) and chloride ion.
- The chloride ion is slowly cleared from the blood and widely distributed throughout the body.
- The chloride ion is primarily eliminated in the urine

Normal Human Levels

- No data available.

Biomarkers

- Presently, no chemical-specific biomarkers of effect are known to exist for chlorine dioxide or chlorite.

Environmental Levels

Air

- Chlorine dioxide degrades rapidly in air and should only be detected near its source of production or use.

Sediment and Soil

- Concentrations of chlorine dioxide or chlorite are expected to be small or nil.

Water

- In a survey of chlorite levels in water samples from publicly-owned treatment works facilities that use chlorine dioxide, 16% had levels of 0–0.1 ppm, 16% had levels of 0.5–0.6, and 16% had levels >1 ppm.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological Profile for Chlorine Dioxide and Chlorite. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ClO₂

Chemical and Physical Information

Routes of Exposure

Relevance to Public Health (Health Effects)

Chlorine Dioxide is a Gas

- Chlorine dioxide is a yellowish to reddish-yellow gas that can decompose rapidly in air.
- Chlorite does not persist in the atmosphere either in ionic form or as chlorite salt.
- When it reacts with water, chlorine dioxide forms chlorite ion.
- Chlorine dioxide is used as bleach at paper pulp mills, in public water-treatment facilities to kill bacteria and microorganisms, and to decontaminate public buildings.

- Inhalation – Not a likely route of exposure for the general population. Predominant route of occupational exposure.
- Oral – Predominant route of exposure for general population.
- Dermal – Minor route of exposure for the general population.

Chlorine Dioxide in the Environment

- Chlorine dioxide is a strong oxidizer and will not persist in the open environment for long periods of time.
- In air, sunlight quickly breaks chlorine dioxide apart into chlorine gas and oxygen. In water, chlorine dioxide forms chlorite ions.
- Chlorite exists primarily in water and may move into groundwater.
- Chlorine dioxide and chlorite (ions and salts) will not bioaccumulate or biomagnify in plants, aquatic organisms, or animals.

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

Minimal Risk Levels (MRLs)

Inhalation

- No MRL was derived for acute-duration inhalation exposure to chlorine dioxide (≤ 14 days).
- An MRL of 0.001 ppm has been derived for intermediate-duration inhalation exposure to chlorine dioxide (15–364 days).
- No MRL was derived for chronic-duration inhalation exposure to chlorine dioxide (≥ 1 year).
- No inhalation MRLs were derived for chlorite.

Oral

- No oral MRLs were derived for chlorine dioxide.
- No MRL was derived for acute-duration oral exposure to chlorite (≤ 14 days).
- An MRL of 0.1 mg/kg/day was derived for intermediate-duration oral exposure to chlorite (15–364 days).
- No MRL was derived for chronic-duration oral exposure to chlorite (≥ 1 year).

Health Effects

- Human and animal studies indicate that chlorine dioxide acts primarily as a respiratory tract and ocular irritant.
- In animal studies, exposure to chlorine dioxide and chlorite during critical periods of neurodevelopment resulted in delayed brain growth, decreased locomotor and exploratory behavior, and altered auditory response.
- Ingestion of large amounts of chlorine dioxide or chlorite may result in irritation of the digestive tract and increased levels of methemoglobin in the blood.
- IARC and EPA have determined that chlorine dioxide and chlorite are not classifiable as to human carcinogenicity.

Children's Health

- Infants may exhibit a greater degree of methemoglobinemia than adults following oral exposure to chlorine dioxide or chlorite.