Chlorine Dioxide CLO_2 Safety Information

Chlorine dioxide is not shipped in commerce or stored for any significant period of time because it is a highly reactive “free radical” molecule. Instead, chlorine dioxide is generated on-site in a safe working concentration level at the location and time of its use.

The Sabre generation process produces high purity chlorine dioxide through the controlled reaction of three common industrial materials. These materials are sodium hypochlorite (i.e. bleach) (12.5 percent), hydrochloric acid (15 percent), and sodium chlorite (25 percent). The three precursors are reacted in a “column” under a strong vacuum created by water flowing through an eductor. The chlorine dioxide formed within the column is subsequently educted into the flowing water stream, where it becomes a dissolved gas in the water at a safe working concentration level of approximately 0.3 percent (i.e. 3,000 ppm).

At this low concentration level, chlorine dioxide is extremely safe to handle and apply as either a liquid treatment agent or fumigant gas. For example, a 3,000 ppm solution of chlorine dioxide is a non-flammable liquid with a vapor pressure and boiling point essentially the same as water (i.e., 20 mm Hg at 68 degrees F (20°C) and 212 degrees F (100°C)). In addition, a 3,000 ppm solution of chlorine dioxide is minimally irritating to the eyes and non-irritating to the skin, so long as the pH of the solution is maintained in the neutral range. Although good hygiene practice always dictates the use of eye and skin protection when working with liquid chemicals, ordinary work clothes may otherwise be worn when generating and applying chlorine dioxide solutions in this concentration range.

Toxicology

The toxicology of chlorine dioxide has been studied extensively, particularly with regard to exposure through ingestion, because chlorine dioxide is widely used in disinfection and food sanitation applications. The USEPA has established a Reference Dose (RfD) of 3×10^{-2} mg/kg/day, based on findings of a two-generation reproduction drinking water study in the rats that identified a No Observed Adverse Effect Level of 3 mg/kg/day (35 ppm chlorite) and a Lowest Observed Adverse Effect Level of 6 mg/kg/day (70 ppm chlorite) (neurodevelopmental effects). The RfD has been used by USEPA to derive drinking water standards, including a Maximum Residual Disinfectant Level of 0.8 ppm for chlorine dioxide and a Maximum Contaminant Level of 1.0 ppm for chlorite ion, the principal breakdown product of chlorine dioxide. Drinking water is by far the largest source of human oral exposure to chlorine dioxide and chlorite.

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Carcinogenicity

There are no data available for chlorine dioxide carcinogenicity because it does not persist in the environment. However, the major decomposition product, chlorite ion, has been tested for carcinogenicity in animals. The data in rats and mice do not associate chlorite ion with cancer.

Inhalation

By inhalation, excessive exposure to chlorine dioxide has been shown to cause adverse health effects that are largely related to its irritant properties. The most likely health effects associated with excessive chlorine dioxide exposure include: irritation of the eyes, nose and throat; coughing; wheezing; shortness of breath; bronchitis; pulmonary edema; and headache. The American Conference of Governmental Industrial Hygienists (ACGIH) and the Occupational Safety and Health Administration (OSHA) have both established an eight-hour time-weighted average (TWA) exposure standard of 0.1 ppm_v. The 0.1 ppm ACGIH/OSHA standard represents the airborne concentration of chlorine dioxide to which it is believed that nearly all healthy adult workers may be repeatedly exposed, day after day, over a working lifetime, without experiencing any adverse health effects. The ACGIH has also established a short-term exposure standard (STEL) of 0.3 ppm_v for chlorine dioxide. Exposures at the STEL concentration should not be repeated more than four times a day and should be separated by intervals of at least 60 minutes.

USEPA Standards

In order to ensure protection of sensitive subgroups within the general population during gaseous chlorine dioxide applications, the USEPA has also developed a rolling 15-minute TWA environmental exposure standard of 0.025 ppm_v that is applicable at the “fenceline” of each facility undergoing treatment. Experience gained during previous large-scale chlorine dioxide fumigation projects demonstrates that compliance with this standard is readily achievable. chlorine dioxide can be effectively contained within a treatment zone or building during fumigation through either of two basic strategies. The building can be sealed as tightly as possible with tape, expandable foam, etc. and a negative pressure pulled sufficient to prevent chlorine dioxide from leaking out cracks, crevices, etc. or a “tent” can be constructed over the entire facility and a slight negative pressure pulled to seal the tent to the structure. The decision regarding which containment approach to take during a given fumigation is highly dependent upon characteristics of the building, economics and other attendant circumstances.