

EPB 416 - Chlorine Dioxide

What is chlorine dioxide?

The chemical chlorine dioxide has been used extensively as a drinking water disinfectant around the world. Chlorine dioxide is also used for industrial process water and air treatment, food production and waste disinfection. Chlorine dioxide is one of a number of disinfectants that are effective against *Giardia lamblia* and *Cryptosporidium parvum* parasites. Chlorine dioxide can be used as an oxidizing agent and as a disinfectant. Chlorine dioxide is a known disinfectant for bacteria and viruses. Using chlorine dioxide instead of chlorine can help reduce the formation of harmful halogenated disinfection byproducts like trihalomethanes and halogenated acetic acids. However, using chlorine dioxide for drinking water disinfection can form the by-products chlorite and chlorate, which must be monitored.

Do I need a permit to add chlorine dioxide to my water treatment plant?

Yes, a Permit for Construction of Waterworks must be obtained prior to adding chlorine dioxide to your water treatment processes. The application must include a design plan stamped by a professional engineer including minimum and maximum dosage rates and estimated chlorite and chlorate levels, a CT calculation, a startup plan describing the dosage changes of chlorine dioxide during commissioning, and all other related information as seen in section 1 of the WSA's document *EPB 501 – Waterworks Design Standard*.

What is the minimum level of chlorine dioxide that must be maintained in drinking water?

Unless otherwise set out in the permit, the minimum chlorine dioxide level in water entering the distribution system and in water throughout the distribution system shall be 0.1 mg/L.

Does chlorine dioxide have regulated disinfection by-products?

An issue for chlorine dioxide is the formation of the by-products chlorate and chlorite. Health Canada's maximum acceptable concentration (MAC) for chlorite in drinking water is 1 mg/L, and the MAC for chlorate is 1 mg/L.

What is the maximum feed dose and maximum residual level for chlorine dioxide?

Treatment plants using chlorine dioxide as primary disinfectant should not exceed a maximum feed dose of 1.2 mg/L without approval from the WSA. The Maximum Residual Disinfectant Level (MRDL) is 0.8 mg/l chlorine dioxide in water within the distribution system, which is not to be exceeded due to potential health concerns.

How will chlorine dioxide and byproducts be monitored in drinking water?

Monitoring for the minimum residual chlorine dioxide level of 0.1 mg/L shall be conducted on the same schedule as for chlorine residual; typically once per day at the water treatment plant, and at the same frequency and locations used for bacteriological sampling. During startup, additional monitoring for chlorine dioxide, chlorite and chlorate may be required.

For monitoring the MRDL of 0.8 mg/L, water systems are also required to take daily samples of the water entering the distribution system. For any daily sample that exceeds the MRDL of 0.8 mg/L, the system must take additional samples in the distribution system the following day at:

- a location representative of the first consumer in the distribution system;
- a location representative of average residence time; and
- a location as close to the end of the distribution system as possible (reflecting maximum residence time in the distribution system).

These additional samples must continue until all results are within MRDL. Exceeding the MRDL in any sample requires notification of the Environmental Protection Officer (EPO).

Chlorite and chlorate monitoring will be required monthly, and if any sample that exceeds the MAC of 1.0 mg/L, the system owner or operator must take additional samples in the distribution system the following day at:

- a location representative of the first consumer in the distribution system;
- a location representative of average residence time; and
- a location as close to the end of the distribution system as possible (reflecting maximum residence time in the distribution system).

These additional samples must continue until all results are below the MAC. Exceeding the MAC at any sample requires notification of the EPO.

Note that if the system includes chlorine dioxide and also maintains a free chlorine residual, then monitoring for free chlorine residual will also be included in the Permit to Operate a Waterworks. In these systems, chlorine dioxide and chlorite may react with free chlorine to form chlorate. Once chlorate is present in water, it is very persistent and very difficult to remove.

Unless otherwise approved by the WSA, facilities using chlorine dioxide shall have equipment and ability to perform in-plant tests for chlorine dioxide, chlorite and chlorate, or have the ability to have rapid test results meeting timelines of this factsheet. Records of all routine tests shall be maintained for review by the relevant EPO upon request.

Does the facility need to perform notices and updates?

The owner of a facility using chlorine dioxide shall notify any facility where kidney dialysis is practiced, of the use of chlorine dioxide as a water disinfectant. The owner of a facility using chlorine dioxide shall review and update their Quality Assurance/Quality Control (QA/QC) plan.

Are there Occupational Health and Safety issues with chlorine dioxide?

The Saskatchewan workplace contamination limit for chlorine dioxide in air is 0.28 mg/m³ (0.1ppm) for an 8-hour average and 0.83 mg/m³ (0.3 ppm) for a 15-minute average. The owner, designer and operator must ensure that all occupational health and safety requirements for the use of chlorine dioxide are met.

Can chlorine dioxide be stored before use?

Many existing chlorine dioxide facilities generate chemical on site just before use, but some technology includes storage of chlorine dioxide. Storage of chlorine dioxide solution over a period of time can cause degradation of the chemical and increases in unwanted compounds. For chlorine dioxide equipment that involves storage of the solution over a period of time, designers and operators are to ensure chemical degradation and by-product formation is accounted in the design of storage and supply equipment.

Are any small-scale trials required before we install chlorine dioxide at our facility?

Yes, at a minimum tabletop or pilot studies must be conducted to assist designers with evaluating levels of chlorine dioxide and by-products in the drinking water, and to form a chlorine dioxide demand table, and to address health-related or aesthetic issues. Include an evaluation of oxidizables like iron and manganese – some poor quality water with high iron and manganese may not be suitable for chlorine dioxide use. Some water will not be suitable because chlorine dioxide may not maintain an acceptable residual level in the entire distribution system. Results of tabletop or pilot studies can form part of the application for a Permit for Construction of Waterworks.

Is there any concern with switching instantly from chlorine to chlorine dioxide?

Switching instantly from chlorine to chlorine dioxide can result in distribution problems including water discoloration, and taste and odour issues. System designers need to consider gradually replacing the disinfectants over a period of several weeks (a description of this is to be part of the startup plan discussed above). System owners are to carefully monitor consumer complaints to determine if any complaints relate to the use of chlorine dioxide.

Is more information on chlorine dioxide available?

Additional information on design and safe use of chlorine dioxide is available from engineering consultants, equipment suppliers and chemical suppliers.

Additional information on the regulation of chlorine dioxide is available from a Water Security Agency EPO or Approvals Engineer. To speak to an EPO or an Approvals Engineer please call 306-787-6504.