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Main Applications of Chlorine Dioxide

The uses of chlorine dioxide exploit the advantages over chlorine. The main applications are detailed below, along with any additional information.

Drinking Water

Chlorine Dioxide has been used as a drinking water disinfectant for many years. First use in the US was reported to be in 1944 at Niagara Falls, New York. International acceptance and use for drinking water is growing either as a primary or secondary water disinfectant. The main advantages of chlorine dioxide over chlorine as a drinking water disinfectant are as follows:

The advantages of chlorine dioxide for drinking water are:

- It is a more effective biocide than chlorine over a wide pH range
- It is less corrosive than chlorine and therefore more compatible with materials of construction
- It eliminates taste (iron and manganese issues) and odour problems from drinking water
- It does not react with organic matter to form trihalomethanes (THMs) such as chloroform

Main areas using chlorine dioxide for disinfection are the USA (760 systems in use 1998), Italy (over 30% of water works 1998), Germany (over 10% of water works) and Belgium has been using chlorine dioxide as primary disinfectant since 1956. Growth is anticipated in most areas with sophisticated disinfection systems.

China and India are both seeing rapid growth in use of chlorine dioxide for local/rural disinfection of drinking water. Over 900 regional generators for chlorine dioxide are now present in China and the testing aspect is beginning to grow. Currently CDC is leading the process but seek to devolve testing to the regions. WHO standards are used for drinking water, giving a level of 0.7 mg/l chlorite as an acceptable concentration.

The acceptable value of chlorine dioxide in drinking water is variable due to the rapid decomposition into other species in the sample. A taste threshold exists at 0.4 mg/l ClO2. The high cost of ClO2also drives the desire to operate at a minimum residual.

The US figure is based specifically around chlorite with a 0.8 mg/l recommended residual with a maximum of 1 mg/l. There is a current program of work to reduce the level of chlorite in drinking water further to 0.05 mg/l.

The current regulatory position for drinking water reflects this aspect and the relationship with chlorite. Belgium defines a limit of 5 mg/l chlorite and no limit for chlorine dioxide, Germany defines a limit of 0.4 mg/l chlorine dioxide, UK defines a limit of 0.5 mg/l of the sum of chlorine dioxide + chlorite + chlorate, Spain defines a limit of 30 mg/l chlorite, Sweden defines a limit of 0.7 mg/l chlorine dioxide.

Chlorite itself is a useful disinfection agent but has suspected carcinogenic effects. Chlorate, once present in the drinking water system, is persistent and again has carcinogenic implications.

The important aspect here is the relevance of chlorite and chlorate as measurements in the effective use of chlorine dioxide for disinfection. When using chlorine as a primary disinfectant the measurement of free chlorine, chlorine dioxide, chlorite and chlorate becomes significant if chlorine dioxide is used as a secondary disinfectant.

As the performance of chlorine dioxide in breaking down and removing biofilm is so superior and the membrane processes used to produce clean water increase in installation number, the rise of chlorine dioxide in this key growth market could become significant.

Paper and Pulp Bleaching

One of the first industrial applications for chlorine dioxide was in the bleaching of both virgin pulp and recycled paper. Use of chlorine is not desirable due to formation of dioxins. The levels of chlorine dioxide required are very high (10 – 12%) with a long contact time. This is not an application we can easily access.

Textile Bleaching

Similar to paper and pulp bleaching, high concentrations (% levels) are required to achieve successful bleaching.

Washing Fruit and Vegetables

The superior performance of chlorine dioxide in killing virus and pathogens such as E Coli are exploited in the preparation of fresh fruit and vegetables. The levels required are not high (as with chlorine) allowing concentrations similar to drinking water to be used for the process. Often a higher concentration of 1.0 to 2.5 mg/l is used to enable biofilm on process equipment to be simultaneously removed.

Washing Meat and Poultry

Similar to fruit and vegetables, a residual is required of around 2.5 mg/l. The disinfected water is used both as a spray and in chiller baths.

Disinfecting Food Processing Equipment

The superior biofilm and antipathogen properties make chlorine dioxide an ideal surface cleanser for flumes, pipework, mixers etc. Levels of chlorine dioxide are typically around 2.5 mg/l. Temperature of the sample can be reasonably high in this process to ensure that fats and grease are removed at the same time.

Cooling Tower Disinfection

Classed as an oxidizing biocide but superior to chlorine due to the biofilm action (particularly important for legionella prevention) and lower corrosion implications. Despite the higher cost compared to chlorine the performance improvements are frequently deemed worthwhile, especially around sensitive cooling installations. Chlorine dioxide is the oxidizing biocide of choice around cooling towers with significant ammonia contamination. Typical residuals of chlorine dioxide around cooling towers are around 0.2 – 0.5 mg/l. Testing is usually carried out on the sump but occasionally the hot return is used giving temperatures up to 50°C.

Odour Control

Chlorine dioxide is effective against mercaptans and sulphur compounds, aliphatic amines, ketones and aldehydes. Relative concentrations of chlorine dioxide required are four to five times as high as the mercaptan concentration and ten times for amine destruction. Typical concentrations are around 20 – 50 mg/l.

Swimming Pools and Spas

The original use of chlorine dioxide in Belgium was for spa disinfection. Again the superior performance in removal of biofilm, effective iron and manganese control and lower reactivity with ammonia make chlorine dioxide a superior if more expensive choice of biocide. The benefits of legionella control are being exploited to justify the higher cost. Levels of chlorine dioxide are typically around 0.5 mg/l and sample temperatures are at typical pool levels.

Wastewater Treatment

The major growth in disinfection use is the wastewater market due to the requirements of the EU Drinking Water Directive and Bathing Water Directive. This segment accounts for around 12% of the EU disinfection market overall and is growing as new accession countries raise standards to meet the EU criteria.

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Hot Water Circuit Disinfection

The presence of dead-legs and long runs of pipework coupled with warm water gives cause for concern regarding presence of legionella in many large (municipal) buildings. Chlorine dioxide is a preferential disinfectant in many areas such as hospitals, leisure centres and similar. Residuals are low and sample temperature is often above 60°C to comply with L8 regulations (UK and Ireland mainly).

Application	Chlorine Dioxide	Chlorine	Chlorite	Chlorate
Drinking Water	Yes	Yes	Yes	Yes
Paper and Pulp Bleaching	Yes	No	No	No
Textile Bleaching	Yes	No	No	No
Fruit and Vegetable Washing	Yes	Yes	Yes	Yes
Meat and Poulty Washing	Yes	Yes	Yes	Yes
Food Eqpt Disinfection	Yes	Yes	No	No
Cooling Tower Disinfection	Yes	Yes	No	No
Odour Control	Yes	No	No	No
Swimming Pools and Spas	Yes	Yes	No	No
Wastewater Treatment	Yes	Yes	No	No
Hot Water Circuit Treatment	Yes	Yes	No	No