MBAA TQ vol. 40, no. 2 • 2003 • pp. 111–113

Chlorine Dioxide for the Brewing Industry

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Presented at the Master Brewers Association of the Americas Convention Sanitation Seminar, Austin, TX, October 2002.

ABSTRACT

Chlorine dioxide is a safe and effective sanitizer for use in a variety of brewing and packaging applications. Chlorine dioxide can be applied to water systems, processing equipment, and environmental surfaces to reduce or eliminate brewery spoilage organisms. Significant improvements have been made to ensure the safe and consistent generation and storage of chlorine dioxide and to ensure accurate dispensing to the point of use.

Keywords: antimicrobial, chlorine dioxide, sanitizing

SÍNTESIS

El dióxido de cloro es un medio de sanitación seguro y efectivo, utilizable en una variedad de aplicaciones cerveceras como también en el envasado. El dióxido de cloro puede ser utilizado en sistemas de agua, equipo de proceso y superficies del entorno para reducir o eliminar organismos dañinos a la cerveza. Se han hecho mejoras significativas para asegurar que su generación sea seguro y consistente y para asegurar su dosificación precisa en su punto de utilización.

Palabras claves: antimicrobio, dióxido de cloro, sanitición

Introduction

Chlorine dioxide in water solution provides effective sanitizing for the brewing industry. Chlorine dioxide can be applied in several different areas of the brewery, including cleaning-in-place (CIP) sanitizing of tanks and lines, water treatment, and environmental sanitizing. Chlorine dioxide can also be used for beer packaging, including bottle and cap rinse and sanitizing rinse of fillers and other production equipment.

This paper will review the following features of chlorine dioxide technology:

- Description and properties
- Advantages
- Brewery applications
- On-site production
- Properties and safety information
- Case studies of chlorine dioxide applications in breweries

Description and Properties of Chlorine Dioxide

The molecular structure of chlorine dioxide is ClO_2. Chlorine dioxide occurs naturally as a gas. For most brewery sanitizing applications, chlorine dioxide gas is dissolved in water and used as an aqueous solution.

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Publication no. T-2003-0505-01

Aqueous chlorine dioxide solutions have a yellow to yellow-green color. The color generally corresponds to the concentration. Solutions in the range of 1–5 parts per million (ppm) are a very faint yellow. Concentrated solutions in the range of 500–1,000 ppm are bright yellow to yellow-green.

Chlorine dioxide must be produced on site. The precursor chemical sodium chlorite (available as a 10–25% solution) is either mixed with other precursor chemicals in a chemical generator or reacted electrochemically to produce chlorine dioxide.

In the United States, the maximum allowable chlorine dioxide concentration in potable water is 1.0 ppm of residual. Typically, a chlorine dioxide concentration of 2–5 ppm is used for hard surface sanitizing.

Advantages

Antimicrobial Activity

Chlorine dioxide is a strong oxidizing agent. It is effective against a variety of beer spoilage organisms, including bacteria, yeast, and mold. Effective control of spoilage bacteria, such as *Lactobacillus* sp. and *Pediococcus* sp., on hard surfaces can generally be accomplished with a chlorine dioxide concentration of 1–5 ppm. Slightly higher concentrations may be required for high levels of yeast.

No Off-Flavors or Taint of Beer

Chlorine dioxide does not impart any chlorine (medicinal) taste to beer. It can be applied to surfaces in close proximity to beer production and will not cause off-flavors.

Reduced Corrosion

Since chlorine dioxide is used at lower levels than hypochlorite, it is less corrosive to production equipment.

Brewery Applications

Chlorine dioxide has effectively been applied in many brewery areas, including

- CIP sanitizing of tanks and lines
- Floor and environmental sanitizing

- Exterior sanitizing of beer fillers
- Empty bottle rinsing
- Crown rinsing
- Pasteurizer rinse zone treatment
- Conveyor belt sanitizing
- Incoming water treatment

On-Site Production

Chlorine dioxide must be produced on site. Electrochemical generators are used in many breweries to generate chlorine dioxide (Fig. 1). Sodium chlorite salt is passed through a generator, and the chlorine dioxide concentrate is manufactured and stored. The concentrate is then either pumped into a "day tank" at a 1- to 2-ppm concentration for direct sanitizing application or is volumetrically proportioned into the water stream.

Properties and Safety Information

Chlorine dioxide gas is about twice as dense as air, with a pungent odor typical of chlorine. Since it is a gas dissolved in water, its solubility in water is inversely related to temperature. The concentrate (500–1,000 ppm) is stable in water if the water temperature is less than 84°F. Some off-gassing will occur at higher storage temperatures.

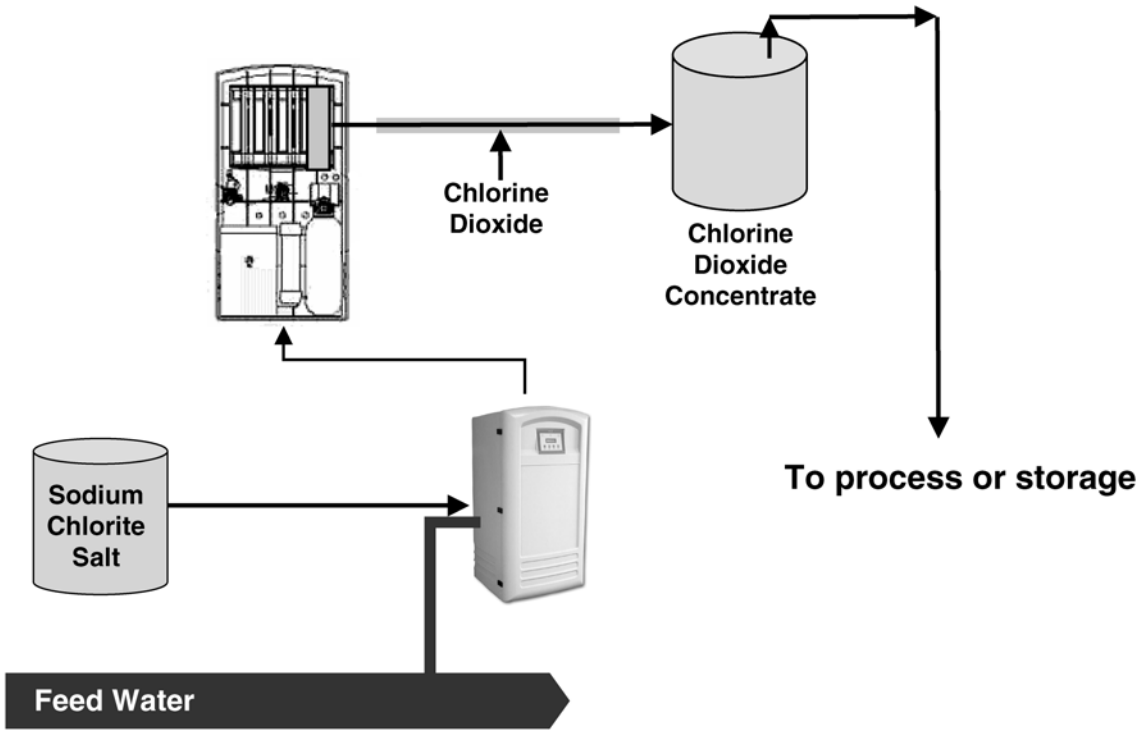

Figure 1. Electrochemical chlorine dioxide generation process.

Figure 2. Chlorine dioxide monitor (left) and chlorine dioxide alarm (right).

Generation of chlorine dioxide concentrate can be safely accomplished by chemical mixing or by electrochemical generation with approved generators. The concentrate is safely stored in closed containers and metered to the appropriate application.

The short-term exposure level for chlorine dioxide in the air is 0.3 ppm. The 8-h time weighted average for chlorine dioxide is 0.1 ppm. Sensors can be mounted in the area where chlorine dioxide is generated to monitor airborne levels and to provide an alarm if levels are exceeded (Fig. 2).

Case Studies of Chlorine Dioxide Applications

Treatment of Brewing Water

Problem. Brewing water may require chemical treatment to reduce or eliminate microorganisms. Chlorine treatment of brewing water, however, can contribute to off-odors and off-taste. When water is treated with chlorine, a carbon filter is usually installed to remove the chlorine. The carbon filter can then become a breeding ground for microorganisms.

Solution. Dosing about 0.2 ppm of chlorine dioxide into brewing water significantly reduces microorganism fouling, while causing no off-flavors or off-odors in the beer.

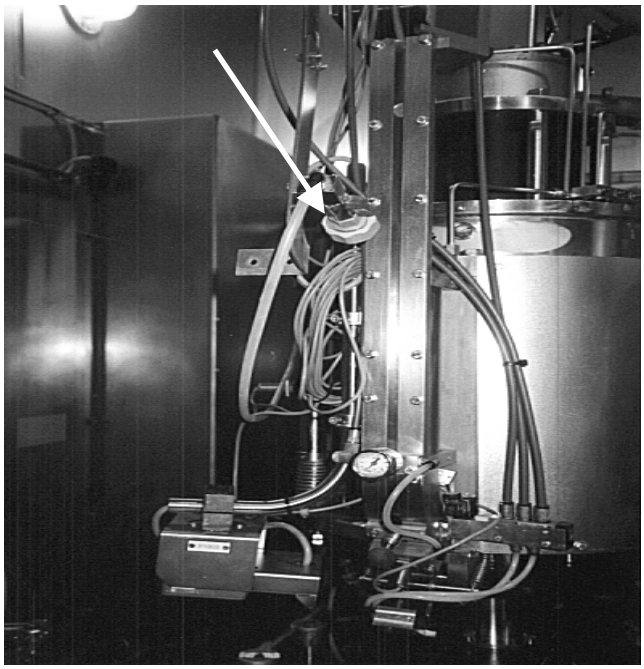

Figure 3. Chlorine dioxide spray application to crowns. Arrow indicates chlorine dioxide spray to cap feeder.

Crown and Bottle Rinsing

Problem. A small brewery producing unpasteurized beer had problems with microorganism contamination from empty bottles and crowns. Chlorine or iodine spray led to off-odors.

Solution. Application of 0.5-ppm chlorine dioxide spray onto crowns (Fig. 3) and into empty bottles eliminated microorganism contamination prior to reaching the filler.

Conveyor Treatment

Problem. Conveyors downstream of the can seamer were not treated with conveyor lubricant but with water only, by way of standard lubricant spray nozzles. Microorganism growth was prevalent on the conveyors, leading to buildup of slime and odors. The microorganism odor would transfer to the cans during production. Conveyors were difficult to clean, and significant manual labor and downtime were required to completely clean the belts and supports.

Solution. Dose 1 ppm of chlorine dioxide into the water supply header to the can conveyors, so that 1 ppm of chlorine dioxide is continually supplied to the conveyors. Microorganism counts were significantly reduced, and slime buildup and odors were eliminated. The conveyors looked cleaner and downtime for manual cleaning was significantly reduced.

Periodic Sanitizing of Filler Exteriors

Problem. Production of nonpasteurized beer required filler shutdown to manually clean and sanitize the filler exterior, crowner, infeed and exit conveyors, and other sensitive production equipment in the filler room. If chlorine or iodine sanitizer were used, excessive surface rinsing was required to eliminate all odors and prevent staining and corrosion.

Solution. Apply 1- to 2-ppm chlorine dioxide solution to the filler every 2 h. Fixed spray balls and spray nozzles apply sanitizing solution to all critical areas of the filler. Push-button activation saves time and ensures that the sanitizing cycle is performed consistently. Automatic rinsing saved time and water and ensured complete rinsing. Microorganism counts were significantly reduced and production efficiency increased.

Conclusion

Chlorine dioxide technology provides a cost-effective mechanism for brewery sanitation. Chlorine dioxide can be safely generated and provides broad-spectrum control of spoilage microorganisms. Chlorine dioxide can be applied to many different areas in both the brewing and production areas.

ACKNOWLEDGMENTS

The author thanks Halox Technologies Inc. for reference information on chlorine dioxide generation and case studies on successful brewery applications.