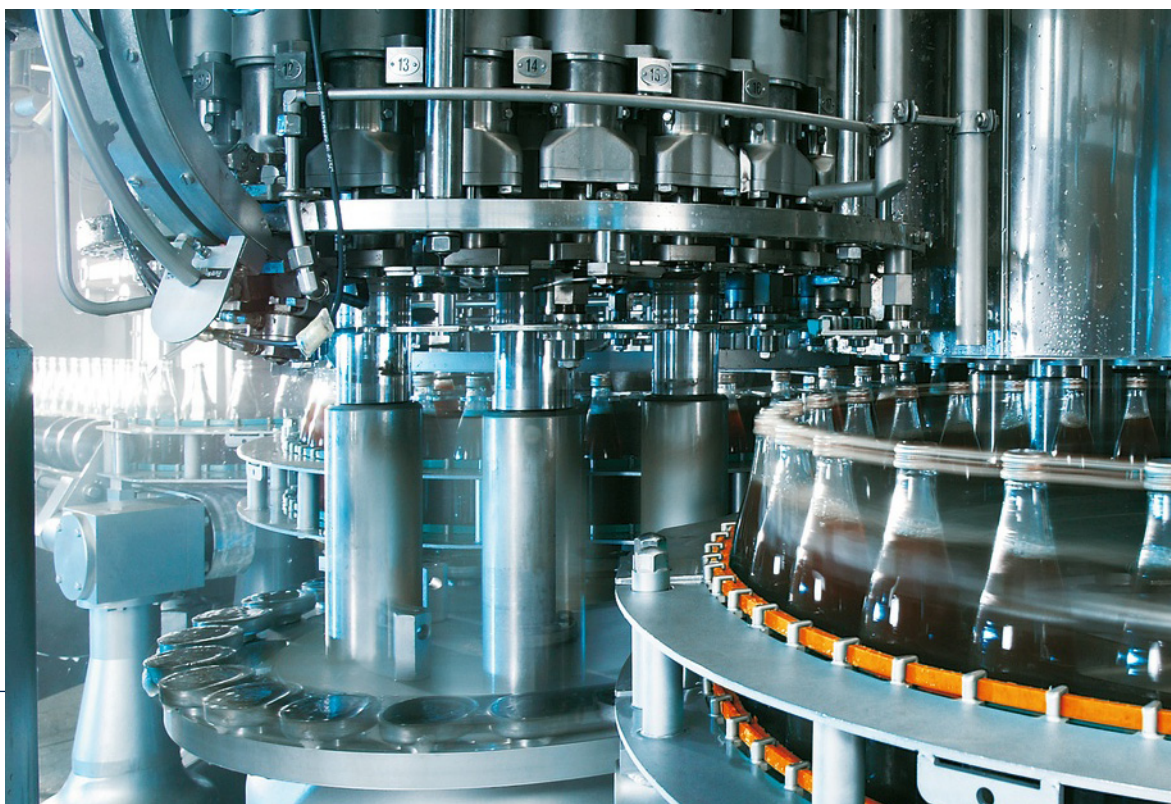


Chlorine dioxide vs. peracetic acid in breweries



Stable, effective and low-cost

In beverage production, cleanliness and hygiene take top priority. This applies equally to all processes in breweries. This is the only way to manufacture quality beer with a good biological shelf life. Rising consumer expectations and growing competition are forcing breweries to find economical production solutions for their high-quality products. In particular, CIP (Cleaning In Place) consumes more energy, time and chemicals than other areas of production. The following article shows how disinfection and cleaning processes can be optimised by using chlorine dioxide instead of peracetic acid. This switch also significantly reduces operating costs. A return on investment is possible in a few months depending on the size of the brewery.

In many breweries, peracetic acid (PAA) is used for disinfection in the bottling area or for CIP applications. As a disinfectant, it has almost universal efficacy and several advantages over chlorine. PAA has become established as a 'chlorine substitute' in the dairy industry as well as the beverage industry. However, the expensive disinfectant has to be used in relatively high concentrations (up to 450 ppm). Its excellent effectiveness is offset by a number of drawbacks. For example, because of its low stability as an oxidising agent, peracetic acid has very limited suitability for stacking. There are restrictions on the storage of large quantities of peracetic acid due to the hazard potential of concentrated substances. It has limited material compatibility with elastomers and directly measuring the concentration is relatively time-consuming. PAA is not compliant with drinking water regulations, so it always has to be completely rinsed out. Its pungent smell is also unpleasant for operating personnel.

Disinfection with chlorine dioxide

In drinking water treatment, chlorination has been largely replaced by chlorine dioxide (ClO₂) for water disinfection. One key advantage of ClO₂ compared with chlorination is that its effectiveness is not dependent on the pH of the water. Unlike chlorine, it does not produce chlorinated by-products. In addition, even low concentrations of ClO₂ remove biofilms from pipes and tanks. Removing biofilms, breeding grounds for disease-causing microorganisms, reliably prevents permanent contamination and attack by microorganisms. The high half life of chlorine dioxide produces a sustained-release effect lasting several days in the treated water.

In breweries, chlorine dioxide has been established for many years as an effective disinfectant. Chlorine dioxide systems Bello Zon® are ideal for use in breweries. They use the chlorite/acid process, which generates a chlorine-free chlorine dioxide solution. The innovative reactor design achieves an outstanding efficiency of up to 99 percent.

The disinfectant, produced on site, is used in very low concentrations for the effective disinfection of packaging, bottle caps and bottles on the rinser, and filler surfaces. Other areas of use include the bottle washing machine (cold water zone) and CIP. For these applications, a chlorine-free chlorine dioxide solution is fed to the applications with chlorine dioxide generation and metering systems on the basis of throughflow or measured values. One of the most important advantages of ClO₂ compared with other disinfectants is that the drinking water regulations TrinkwV 2001 permit quantities of 0.2 ppm, so it not necessary to completely rinse out the disinfectant.

Typical test parameters for a bottle rinser

The disinfection effect of peracetic acid and chlorine dioxide was investigated in various test series¹⁾. It was tested on a bottle rinser at temperatures of 20°C, 30°C and 40°C. Disinfection took place for 2 to 4 seconds in each case and then the bottles were allowed to drip for 1 to 3 seconds. The bottles were then rinsed with sterile water for 1 to 2 seconds and allowed to drip for 1 to 3 seconds. The killing efficacy in terms of beverage-specific yeasts, mainly in the context of a brewery, was investigated. The test microorganisms were *Saccharomyces cerevisiae* (used in winemaking, brewing and baking), *Zygosaccharomyces bailii* and *Pichia anomala* (used to prevent mould).

At 20°C, while peracetic acid in concentrations of up to 400 ppm only achieved a maximum mean logarithmic kill of *Saccharomyces cerevisiae* of 1.5, just 1 ppm of chlorine dioxide achieved a mean logarithmic kill of around 6.5. In the test with *Zygosaccharomyces bailii*, the mean logarithmic kill with 1 ppm ClO₂ of around 6 was approximately twice as high as the kill rate achieved with 400 ppm of PAA at 20°C.

In all tests with yeasts, an inactivation rate of at least 4.2 mean logarithmic kill was measured with 1 ppm ClO₂ at a temperature of 20°C. The inactivation rate of microorganisms that cause harm to beer, such as *Lactobacillus brevis* and *Pediococcus damnosus*, was around 7.5 mean logarithmic kill at 1 ppm ClO₂.

1) Getränke! issue 1-2014, pp. 8-9, Sachon Verlag, presentation by Dr. Diana Wolf

Material compatibility

A question that arises continually in CIP is „Are the substances we are using compatible with the materials they come into contact with, or will they corrode the steel pipes?“ This is mainly discussed in the context of using a disinfectant, the generation of which also produces chloride.

During chlorine dioxide generation with a Bello Zon system, for example, the ratio of chlorine dioxide to chloride is no higher than 1:2.5. Using the Heidelberg-based manufacturer's process, a maximum of 2.5 ppm of chloride is therefore added to the water for every 1 ppm of ClO₂. This is considerably lower than the limit values demanded by system manufacturers.

The last stage of disinfection is usually not stacked. The chloride concentration cannot increase because fresh water is used for the next CIP cycle.

As long as the water is used to rinse out the product before the next CIP process, this does not present a problem. The concentration is only increased to 0.4 ppm ClO₂. The use of very low chlorine dioxide concentrations for disinfection eliminates corrosion of the surfaces of piping, machinery and system parts because only very low concentrations of chloride are produced. Corrosion is reliably prevented.“

The potential savings of using chlorine dioxide

To compare the costs of disinfection with peracetic acid and those with chlorine dioxide, the amounts of both disinfectants consumed in the CIP process in different breweries were examined. The consumption values came from breweries with an annual output of over 100,000 hl of beer.

ROI in less than one year

Diagrams 1 and 2 show the calculated consumption values and necessary costs for the metering systems for peracetic acid, the costs of piping and investments for chlorine dioxide systems. The investment and consumption costs for breweries with a production capacity of 100,000 to 10 million hectolitres per year clearly show that disinfection with chlorine dioxide is much cheaper than disinfection with peracetic acid. For breweries with a capacity of 100,000 hectolitres of beer or more, the savings amount to over €10,000 per annum.

The larger the brewery capacity, the more rapid the return on investment (ROI). In breweries with a 50,000 hl capacity a ROI is achieved after about 1.4 years, in breweries with a capacity of 100,000 hl or more after less than one year, and in breweries with a 300,000 hl capacity or more, after less than six months. By using chlorine dioxide (ClO₂), generated with a system serving multiple applications, such as a rinser and cap disinfection, ROI can be improved further.

Additional savings can be achieved through the optimisation of CIP parameters, for example a reduction in rinsing water, because ClO₂ is approved under drinking water regulations and therefore does not have to be completely rinsed out.

Summary

In breweries, expensive chemicals such as peracetic acid, sodium hypochlorite and hydrogen peroxide are often used in very high concentrations for disinfection purposes. By using chlorine dioxide generated on site, both the application concentration and application temperature can be considerably reduced. This results in significantly lower operating costs, as well as the use of cheaper chemicals.

Thanks to the very high savings in operating costs, breweries with an annual capacity of 50,000 hectolitres or more can achieve ROI in less than two years even if disinfection is only switched from PAA to ClO₂ in the bottling section.

The correct integration of the technology into machine concepts ensures microbiologically hygienic bottling. The use of lower concentrations of a disinfectant which complies with drinking water regulations also saves water.

Benefits of a Chlorine Dioxide System Bello Zon®

- Reduced costs thanks to minimal use of chemicals
- Cost-effective way to provide several points of injection
- Quick ramp-up time after downtime thanks to long-term stability of chlorine dioxide solution
- Maximum output due to closed gas transport system
- Outstanding operating safety and reliability, thanks to intrinsically safe process control
- Ultra-simple process integration
- The disinfectant complies with drinking water regulations, so does not need to be fully rinsed out

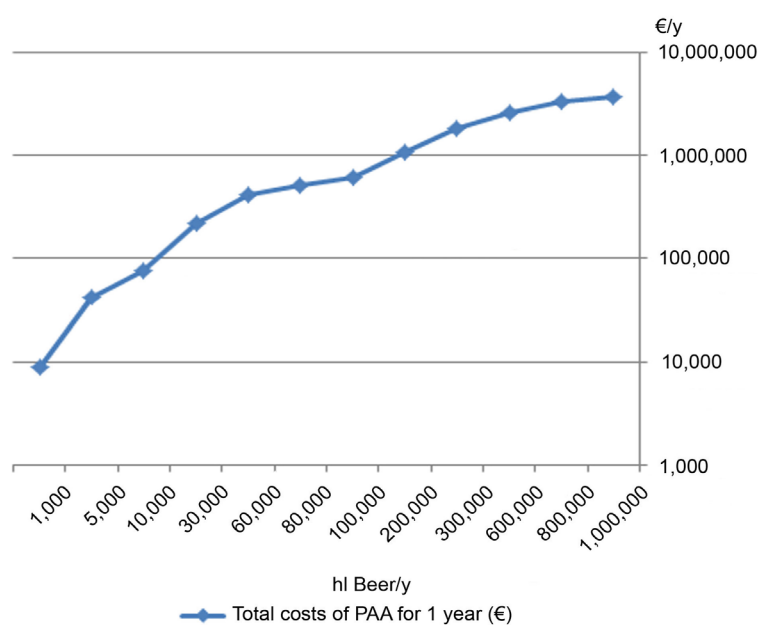


Diagram 1: ROI after one year in bottling

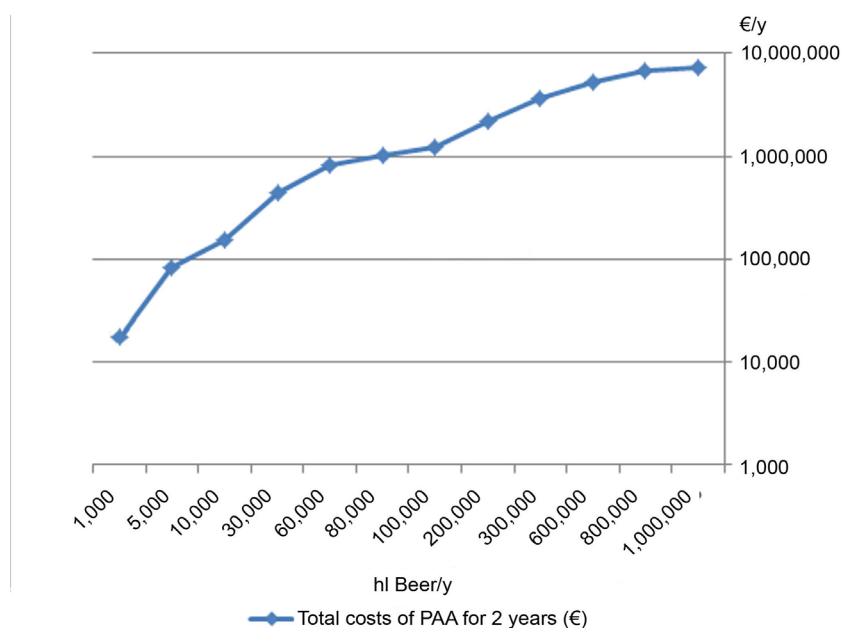


Diagram 2: ROI after two years in bottling