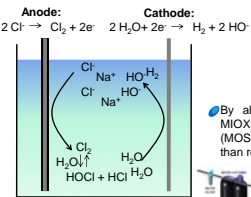




Use of On-Site Generated Disinfectants in Three Step Clean-In-Place Operations (Andrew K. Boal, Ph.D./MIOX Corporation)

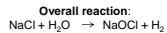
What is On-Site Generation?

On-Site Generation (OSG) works by passing an electric current through a sodium chloride brine solution, producing aqueous chlorine:



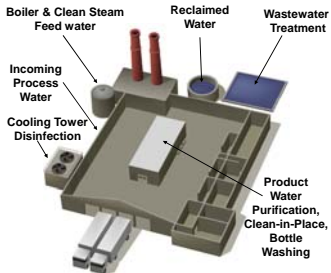
• The heart of OSG is the electrochemical cell. Here, the action of the sodium chloride brine produces chlorine at the anode and hydroxide at the cathode. These components combine to produce sodium hypochlorite with hydrogen gas as a byproduct.

• By altering cell design and operating parameters, MIOX can also produce a Mixed Oxidant Solution (MOS) that has a greater microbial inactivation efficacy than regular bleach.



• A working generator contains several components, including a water softener, brine tank, heaters and chillers, the electrochemical cell, an oxidant tank, and metering pumps which dose the oxidant into the process stream.

Applications in the Brewing Industry



On-Site Generation can be applied to all aspects of water treatment and process equipment cleaning in a brewery.

Using on-site generated chemicals for cleaning and disinfection can provide numerous economic and environmental benefits.

Mixed Oxidants and Clean-In-Place Operations

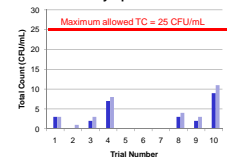
Of all the applications of MOS pilot tested at beverage manufacturing facilities, Clean-In-Place (CIP) operations appear to be the application where MOS has the greatest value proposition:

Pilot CIP Tests at Soft Drink Bottling Facilities

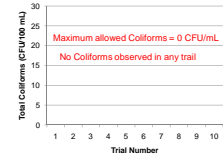


- MIOX has run CIP pilots at 5 soft drink manufacturing plants in both the United States and Mexico.
- Tests are being run with a skid-mounted MIOX MOS generator.
- Tests run to this point have focused on flavor changovers of carbonated beverages, and have studied chemical aspects of the process such as MOS concentration, MOS contact time, and water rinse times.
- Efficacy of MOS-based CIP is evaluated both by measuring microbial contamination as well as with Taste and Odor tests.
- Representative data from CIP cleaning of a finished syrup line at a soft drink manufacturing plant:

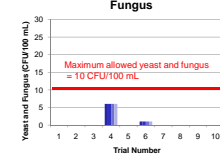
Finished Syrup Line- Total Count



Finished Syrup Line- Coliforms



Finished Syrup Line- Yeast and Fungus



- CIP operating parameters for this test: MOS concentration between 49 and 74 ppm FAC, MOS contact time between 10 and 15 min, final water rinse time of 12-25 min.
- To date, all CIP pilot studies have passed all microbiological as well as taste and odor tests.

Comparison of MOS-based and Traditional CIP Processes



- Four and Five step hot CIPs can take up to 90 minutes to complete, time is largely due to heating of the entire CIP line.



- Three step cold MOS-based CIP processes can take as little as 45 minutes to achieve a clean system, thus allowing for extra production time.
- Additionally, the cold three step MOS CIP provides other direct economic benefits in terms of less chemical and energy used as well as yields greener plant operations due to reduced water usage.

MOS CIP Applications in a Brewery

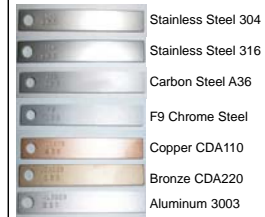


- MOS is expected to be highly effective at cleaning Bright Beer tanks and filling lines- the challenges here are the same as in soft-drink manufacturing.
- Cleaning fermentation tanks may present a greater challenge due to the presence of krausen. However, krausen is similar to biofilm, and MOS has been shown to be effective at biofilm removal.

Ongoing Research

Corrosion Studies

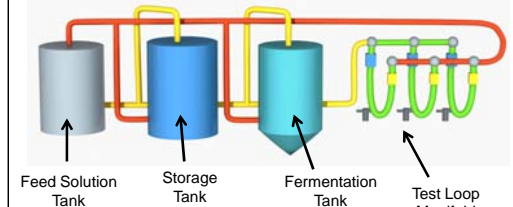
Corrosion of CIP and other bottling equipment is a concern of beverage manufacturers, and to ensure that MOS will not cause corrosion in excess of bleach-based cleaners currently used by bottling plants, we have developed an extensive corrosion research program.



- A selection of 7 metals common to brewing and bottling plants were selected for studies.
- These materials are being immersed in solutions of MOS and bleach having a FAC range between 10 and 1000 ppm.
- Coupons are removed from the solutions at various points over six week total immersion time, cleaned, and weighed.
- Weight changes are being used to calculate uniform corrosion rates.
- Pitting corrosion of stainless steel in dilute MOS and bleach solutions is also being investigated.

Laboratory Scale CIP

We are also building an in-laboratory CIP system that will allow a more extensive investigation of the capabilities of MOS for bacteria decontamination and biofilm removal and prevention in CIP lines covering a wide product market space.



- All aspects of the CIP process can be readily controlled in this system, including rinse duration, rinse solution temperature, and MOS concentration.
- Several food science professors have published studies using similar systems in selected industries (mainly dairy production), and the methods and protocols that they have developed can be applied to industries such as brewing.
- Initial laboratory testing will allow the Science and Applications team at MIOX dial in a process to be piloted in an operating plant, significantly decreasing the amount of time and effort that will be required to optimize the process when it is applied to actual operations.