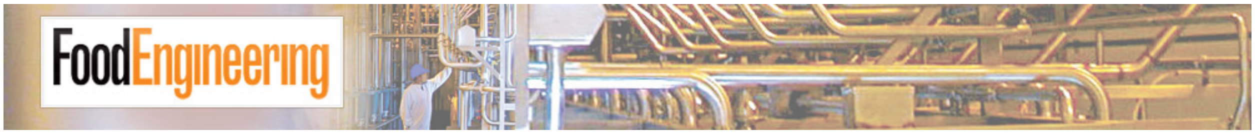

Engineering R&D: Do-it-yourself disinfectants

by Kevin T. Higgins, Senior Editor
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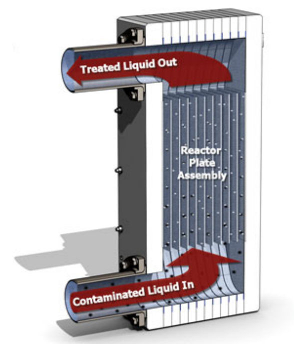
By manipulating electrical current and frequency, an electrochemical reactor provides an alternative to chlorine in disinfecting some of food processing's nastiest water streams.

For food exporters, the writing is on the wall in terms of future use of chlorine as a processing aid. Russian authorities recently banned the import of chlorine-rinsed poultry, adding urgency to the conversion to other oxidizers and antimicrobials in poultry chillers. One option being explored is an electrochemical process developed by BioIonix Inc.



An absence of moving parts and ceramic reactor plates minimize maintenance needs and reduce the likelihood of fouling with Bioionix's electrochemical disinfection technology. Source: Bioionix Inc.

Two Milwaukee area electrical engineers filed the first in a series of patent applications eight years ago for an "electroionic water disinfection apparatus" that would kill bacteria and other microorganisms by generating hydrogen peroxide, hydroxyl radicals and hypochlorous acid. Municipal wastewater was the inventors' original target, but in recent years the Madison-area firm's focus has switched to food production. A modular rack unit that expands to meet capacity demand by adding plates, much like a plate heat exchanger, was designed to meet 3A sanitary standards, and a letter of no objection was secured from USDA in October. A variety of applications are envisioned, but the most promising may be disinfecting red water from poultry chillers, in place of chlorinated water. The first commercial installation was completed in December at Gerber Poultry Inc., in Kidron, OH.

Helping guide the commercialization of BioIonix's technology is Ajit K. Chowdhury, a chemical engineer who has spent 35 years developing and implementing systems for water treatment. He joined BioIonix in 2007 as senior development manager and brings three decades of industry experience in technology development roles. Dr. Chowdhury earned his PhD at the University of Denver in Colorado.

FE: Other electrochemical processes are being applied to treat water in food plants. How does electro-ionization differ from the electrolyzed oxidative process?

Ajit K. Chowdhury, senior development manager, BioIonix Inc., McFarland, WI

Chowdhury: Electrolyzed oxidation is a direct current process that relies on a membrane in the middle, separating anode and cathode catalyzers to create hypochlorous acid on the positive side and sodium hydroxide on the negative. We use a hybrid, low-frequency alternating current and don't have a membrane, which is prone to fouling and can make the system difficult to operate and run. That allows us to work with dirty process water with organic load, such as red water from a poultry chiller.

FE: Early versions of the electroionic process generated hydrogen peroxide; now the system produces hydroxyl radicals and other oxidizers. What technical change did this require?

Chowdhury: High-frequency DC power was originally used when the processing system was geared toward wastewater and effluent treatment. You have to have some sort of converter to achieve certain goals, and low-frequency AC power now is used instead of high frequency to generate different oxidants.

The initial focus was on municipal wastewater systems and the treatment of biosolids. It's a huge market that looked promising, but municipal plants are very slow in adopting new technology and face lengthy approval processes. Private industry embraces new technology much more quickly, particularly if the technology solves a problem.

FE: Since joining the firm, on what issues have you focused?

Chowdhury: Making the system work consistently has been the biggest challenge. It took quite a bit of development effort and experimenting with different types of electrodes to ensure consistent performance. Stainless-steel electrodes, aluminum and other materials were tried in bench and pilot trials before consistency was resolved with ceramic plates.

PLC controls had to be engineered to control the process, optimize energy efficiencies and make adjustments as COD levels and other metrics changed. In the discharge unit, the oxidation-reduction potential is electronically monitored to ensure that sufficient power is being delivered to generate the disinfectants needed to oxidize the water.

FE: What disinfectants are created in the reactor?

Chowdhury: When contaminated water enters the reactor and contacts the high-performance electrodes placed in parallel, three powerful “super-oxidants” are created. The fastest acting are hydroxyl radicals, very short-lived super oxides that are more powerful than ozone. Those radicals mutate and break down the DNA of microbes and are second only to fluorine as an oxidant. In addition, any chloride in the water—and there always is some—creates oxychlorides, including hypochlorous acid, which also effectively kills microorganisms. Hypochlorite residuals also are created, providing a longer-term kill.

Unlike a chlorine generator, which requires the addition of lots of salt and only treats clean water, we treat contaminated process water and sometimes add a small amount of salt as a catalyst to improve conductivity.

FE: Are the parallel catalytic plates an example of technology transfer from other applications?

Chowdhury: The catalytic ceramic plates that create the electrochemical reaction are relatively new. The basic technology has been around for years, but the plates were not sustainable because of their limited run times.

Developments in materials of construction have changed that. Platinum metals now coat the plates and make them much more robust. And because we're changing polarity with alternating current, anything that tried to adhere to them would be flushed away with the water flow.

FE: What is the expected useful life of the plates?

Chowdhury: We haven't run the system long enough to determine the point of failure, but there are no moving parts; there is a 5/8th-inch gap between plates, and our experience led us to offer a three-year guarantee. The hope is that they will last much longer.

Maintenance is minimal. The entire module is part of the normal plant CIP process.

FE: Are there any worker-safety issues surrounding the catalyzer?

Chowdhury: There are no off gases, as can occur with an ozone generator.

FE: What impact do the oxidants have on the food they contact?

Chowdhury: No negative impacts have been detected in our lab and pilot trials.

The system in place at Gerber Poultry's Kidron, OH, facility is treating 650 gallons per minute (gpm) of red water from the poultry chiller. They had used chlorine, then tried chlorine dioxide, but obviously they were not happy with the results. We're still gathering data, and there are a lot of details to work on, but according to the folks at the plant, there has been no affect on food texture or taste.

FE: What affect do water temperature and other variables have on chemical generation?

Chowdhury: Reactions slow as temperature declines, but the system works well at freezing temperatures. Poultry red water tends to be just above freezing. If fluid temperature approached 0° F, additional power and catalytic surface could be added to get the job done.

FE: What testing has been done to quantify the system's effectiveness?

Chowdhury: Extensive lab and pilot tests have been performed in collaboration with Sara Lee Corp. and Alkar-Rapidpak Inc. in Lodi, WI. Sara Lee developed the test protocol, and tests were performed at 2 gpm flow rates in our lab and 10-20 gpm at Alkar's pilot plant.

Deibel Laboratories in Madison prepared Salmonella Enteritidis and Salmonella Typhimurium cultures for 30 gallons of spent turkey chiller water from Sara Lee. The water was held at 40˚F, then pumped through the reactor that circulated it every 15 minutes and provided a two-second residence time. A bacterial bolus of two million colony forming units per milliliter, including Salmonella, was added, and a control test with the reactor turned off was run. No change in aerobic plate count (APC) occurred. Next, we turned the reactor on and drew periodic samples until, after 210 minutes, Salmonella counts were below detection, a kill of more than 6 Logs. In another test, water was circulated through the reactor prior to the bacterial bolus's introduction, to build up residual disinfectants. In that case, a 6-Log reduction occurred in 180 minutes. In both trials, APC was below detection at the end of the six-hour test.