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Microbrewery Tests Less Hazardous Cleaning and Sanitizing Technology

Merrimack Ales in Lowell Tests Electrochemical Activation Technology for Clean in Place Process

Merrimack Ales in Lowell, received a grant to test how well electrochemical activation (ECA) technology works for cleaning and sanitizing equipment used during the beer brewing process. If effective, the technology could eliminate, or greatly reduce, caustic sodium hydroxide and acids used for cleaning and the follow on products used for sanitization.

In 2015, Merrimack Ales officially began brewing beer for local distribution. In establishing the cleaning and sanitizing process to be used at the facility, owner Adam Pearson researched the standard of practice for microbreweries. The cleaning and sanitizing of the various vats used in the brewing process employs caustic/alkaline cleaners and acids. Looking for other ways to do business, Pearson applied for a small business grant from the Toxics Use Reduction Institute (TURI) at UMass Lowell. The grant allowed him to invite in a vendor to test a different way of cleaning and sanitizing his process vats – using ECA.

The ECA technology generates two solutions, the first is a detergent called catholyte, which is a weak sodium hydroxide solution of approximately 400 ppm and with a pH of greater than 11.4.

The second is a disinfectant called anolyte, which is a hypochlorous acid and sodium hypochlorite mixture with a pH of 6.8. The anolyte has 190 ppm of free available chlorine.

These solutions are generated on site and then used to clean and sanitize the tanks used in the brewing process – mash tun, brew kettles, fermenters, and bright beer tanks. The catholyte and anolyte are generated by running electrical current through a weak brine mixture.

ATP meter readings taken during ECA testing in fermenter

This technology has been implemented successfully at industrial sized breweries, but only in the bottling operations and had not yet been tested in the brewing tanks and fermenters. The testing was performed over five days at the Merrimack Ales facility in Lowell and was considered successful by the brewery.

It was concluded that the catholyte solution could partially replace the current caustic detergent in use, and the anolyte could completely replace the products used for sanitization. The unit currently available through this vendor, however, is cost prohibitive for a small business the size of the microbrewery. Therefore, the brewery plans to work with TURI to complete additional testing (for both process modifications and alternative chemicals) and cost analyses.

Process and Performance

The ECA vendor arrived with a demonstration unit with a product capacity that fit the needs of this location's operation. The device was set up and calibrated. This entailed hooking up to the municipal water supply and adding salt until the correct brine solution was obtained. The device was then started and began to generate the catholyte and anolyte which were collected in 150-gallon totes; enough was generated overnight to carry out the trials. In a larger scale unit, this process would be automated and the solution generated would be stored until use.

Over the next several days, the vendor conducted four trials of the cleaning and sanitizing process. ATP meter readings were taken between each step in the process to understand the level of organic matter on the tank walls. The ATP test is a process of measuring actively growing microorganisms through detection of adenosine triphosphate, or ATP. The readings were taken in the same location and by the same person to provide consistency. The ATP meter was employed only for proof of concept of the new process. Additional testing will need to occur to ensure proper cleaning and sanitizing.

The two types of tanks used in the trials were the brew kettle (where the cooking takes place), and the fermenter (where the beer sits for a longer period of time to ferment the yeast). The residue on the brew kettle tends to be very thick and hard to remove, making it the most challenging part of the trial. The first step in the brewing process is mixing the ingredients in the mash tun, but as the residue left behind in the brew kettle provided a worst case scenario, the brew kettle and fermenters were the main focus.

After four trial runs – two in the brew kettle and two in the fermenters – the following conclusions were drawn:

- Both types of tanks were successfully cleaned with a mix of 30% catholyte and a dose of PBW (Five Star Powder Brewery Wash - the cleaner used in the currently implemented cleaning process) at half of the usual amount.
- Both tanks – the brew kettle and fermenters – were successfully sanitized with a 20% cold anolyte solution, based on the ATP readings.
- The acid wash currently used in the brew kettle was used after the above process, and there was no further beneficial effect on the cleaning operations.
- Some mechanical issues with the pilot equipment yielded some less than successful results; it is anticipated that replacing the faulty equipment would prevent these issues.

Toxics Use Reduction

Merrimack Ales is not required to report its chemical use under the Toxics Use Reduction Act (TURA) because it has less than 10 full time employees. However, some of the chemicals used are still hazardous and are discussed here to clarify what larger facilities may need to consider for TURA reporting. Reducing or eliminating these chemicals and high temperatures for hot water rinses, an additional benefit, would result in a safer and healthier workplace.

The current cleaner used at Merrimack Ales is PBW, which contains silicates, phosphates and surfactants. The hazardous ingredient listed on the MSDS is sodium metasilicate at 30%; though this ingredient is not listed on the TURA list of reportable chemicals, the product does have a pH of 11-12 and is an irritant to eyes, skin and mucous membranes.

The acid used in cleaning is 6% phosphoric acid and 38% nitric acid. Phosphoric and nitric acid are both listed on the TURA list of reportable chemicals. In addition, when nitric acid is neutralized, reportable nitrate compounds are coincidentally manufactured.

The sanitizer used at the facility is called Star San and consists of phosphoric acid (50%) and dodecylbenzene sulfonic acid (15%), both of which are TURA listed, and isopropyl alcohol (10%) which is not listed.

It should be noted, that if Merrimack Ales were to switch to the proposed ECA cleaning and sanitizing regimen they would be manufacturing sodium hypochlorite and sodium hydroxide on-site. The following reduction in purchased chemicals used would be achieved:

Material	Units	Old Process	ECA Process	Reduction
Cleaner (PBW)	lb/week	10.77	5.387	50% reduction
Acid (Nitric/ Phosphoric) Cleaner	Gal/week	4.14	0.78	Eliminated except for special quarterly process
Sanitizer	Gal/week	0.673	0.048	Eliminated except for special quarterly process

Financial Analysis

To determine the cost effectiveness of a conversion to the ECA technology, weekly and monthly operating costs for the old and new processes were calculated. The summary of those calculations are below.

Old Cleaning/Sanitizing Process & Operating Costs			
Tank	*Steps*	*Materials Used*	*Weekly Cost for chemicals, water and energy*
Mash Tun	Rinse	Cold Water	$25.13
	Wash	PBW	
	Rinse	Hot Water	
	Acid	Nitric/Phosphoric	
	Final Rinse	Cold Water	
Brew Kettle	Rinse	Cold Water	$25.86
	Acid	Nitric/Phosphoric	
	Rinse	Cold Water	
	Wash	PBW	
	Rinse	Hot Water	
	Sanitize	StarSan/Saniclean	
Fermenters	Rinse	Hot Water	$50.26
	Wash	PBW	
	Rinse	Hot Water	
	Acid	Nitric/Phosphoric	
	Final Rinse	Cold Water	
Fermenters & Bright Beer*	Rinse	Hot Water	$7.51
	Wash	PBW	
	Acid	Nitric/Phosphoric	
	Sanitize	StarSan/Saniclean	
Bright Beer	Rinse	Cold Water	$11.47
	Acid	Nitric/Phosphoric	
	Sanitize	StarSan/Saniclean	
		Total Weekly Cost:	$120.22
		Total Monthly Cost:	$510.95

*This line item is for a special cleaning regimen for these tanks that takes place every three months.

Merrimack Ales

Merrimack Ales is located at 92 Bolt St. in Lowell MA. The new microbrewery is owned and operated by Adam Pearson of Westford. One other full time employee works in the facility which has been in full operation for under a year. Within the 6,000 square foot facility, Merrimack Ales brews a range of beers currently distributed within the Merrimack Valley.

"We are very interested in making our processes safer for us and for the environment. TURI is a great resource for us to learn about technologies we didn't know about and the opportunity to pursue this safer alternative is fantastic."

Adam Pearson,
Owner of Merrimack Ales
Lowell, MA

Proposed ECA Process & Operating Costs			
Tank	*Steps*	*Materials Used*	*Weekly Cost for chemicals, water and energy*
Mash Tun	Rinse	Water	$12.53
	Wash	50% reduced PBW + 30% catholyte	
	Sanitize	20% anolyte	
	Final Rinse	Water	
Brew Kettle	Rinse	Water	$11.80
	Wash	50% reduced PBW + 30% catholyte	
	Sanitize	20% anolyte	
	Rinse	Water	
Fermenters	Rinse	Cold Water	$28.56
	Rinse	Hot Water	
	Wash	50% reduced PBW + 30% catholyte	
	Sanitize	20% anolyte	
	Final Rinse	Cold Water	
Fermenters & Bright Beer*	Rinse	Hot Water	$7.51
	Wash	PBW	
	Acid	Nitric/Phosphoric	
	Sanitize	StarSan/Saniclean	
Bright Beer	Rinse	Cold Water	$2.19
	Sanitize	20% anolyte	
	Rinse	Cold Water	
		Total Weekly Cost:	$62.59
		Total Monthly Cost:	$266.03

*This line item is for a special cleaning regimen for these tanks that takes place every three months, which would remain.

The financial benefit of using the ECA technology as proposed totals a savings in operational costs of $245 per month, or $2,940 per year. This includes chemical costs as well as energy and water use which are factored into the tables above. It does not however, factor in the initial capital cost of the equipment. To make this technology affordable to a very small business, an affordable unit will need to be accessible.

Results Encouraging, More Testing Underway

The results of this testing of ECA technology in the processing tanks at a microbrewery are encouraging. However, before investing in the technology, TURI and Merrimack Ales plan to undertake further study. Plans are underway to:

- Verify the standards of the current cleaning and sanitizing steps by performing bacteria plate count sampling between each step in the existing process to establish baseline bacteria levels;
- Test a 50% reduction in PBW alone (without the ECA catholyte) to determine the effectiveness of that change in the cleaning process and verifying with plate count sampling;
- Switch the order of the steps by starting with an acid wash followed by a non-caustic cleaner as employed by some breweries and verifying with plate count sampling; and
- Invite another ECA vendor with a small unit on the market to the site to learn about competing processes and costs.