TURI TOXICS USE REDUCTION INSTITUTE UMASS LOWELL

Making Massachusetts a safer place to live and work

Soup Manufacturer Refines its Cleaning Process

KETTLE CUISINE

Overview

Sodium hydroxide (NaOH) is commonly used in the food industry as an alkaline detergent in clean-in-place (CIP) processes. Kettle Cuisine, a large-batch maker of soup in Lynn, Massachusetts, uses over 10,000 pounds of NaOH per year in their cleaning operations. NaOH is on the list of toxic chemicals under the Toxics Use Reduction Act (TURA), which requires a facility using over a certain threshold to report on the use of the chemical and to consider options to reduce the use of the chemical. NaOH is a corrosive chemical; contact with eyes or skin can cause pain, redness, burns, and blistering. Facing these hazards, Kettle Cuisine chose to investigate how to optimize the use of NaOH and identify and evaluate the effectiveness of less toxic alternatives.

The Toxics Use Reduction Institute (TURI) at UMass Lowell facilitated a partnership between Kettle Cuisine and researchers in the Department of Biomedical and Nutritional Sciences at UMass Lowell to undertake this work. A TURI industry grant funded a student at UML to perform the research and testing.

Testing

The research team chose to test the cleaning performance of NaOH and the alternatives using macaroni and cheese as the model food. Macaroni and cheese is one of the highest volume production products at Kettle Cuisine. Dairy ingredients also leave the highest amount of scaling on equipment surfaces and provide the worst-case scenario for cleaning. Bench-scale testing was performed on stainless steel coupons that mimic the substrate of the soup-making vats in the facility. Researchers tested alkaline and acidic cleaners at different temperatures and concentrations, simulating the CIP process used at the facility.

Macaroni and cheese placed on stainless steel coupons, heated to 180°F for 3 hours

Researchers measured effectiveness using both gravimetric analysis and ATP monitoring. Using a before and after method, gravimetric analysis weighs any soil residue left on a coupon after cleaning. ATP monitoring is a test swab method that detects any residue of organic matter remaining on a coupon after being cleaned. Kettle Cuisine uses ATP monitoring as their standard quality control test.

Kettle Cuisine's original standard cleaning protocol was:

- Using a mixed solution of 0.3817% w/w HLC-5000 (NaOH, 50% max) and 0.0957% w/w H_2O_2 (<8%) to treat the kettle at 82°C for 1 hour
- Using 50% phosphoric acid to physically wash the kettle with a brush
- Rinsing the kettle with water
- Performing an ATP test to ensure cleanliness

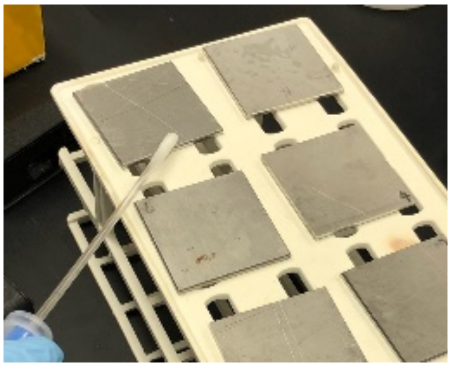
The NaOH concentration and temperature from the Kettle Cuisine's standard cleaning protocol as noted above was used as the control. The variables were:

- The NaOH concentrations tested were 100% of the concentration used by Kettle Cuisine (control), 75% and 65% (experimental).
- The temperatures of the NaOH tested were 82°C (control), 75°C and 65°C (experimental).

First, lab testing was conducted to understand the performance of the NaOH in the process. This test used diluted concentrations of NaOH and decreased the temperature. Results showed that decreasing the working concentration of NaOH to 75% and dropping the temperature from 82°C to 75°C was effective for cleaning. At this concentration and temperature, the ATP test showed the same cleanliness compared with the control group (Kettle Cuisine's standard cleaning protocol). The lower concentrations and temperatures were not effective.

Next, two alternative processes were tested:

- Alternative 1:
  - 3% hydrogen peroxide treatment at 65°C for 1 hour
  - 50% phosphoric acid brush washing
  - Water rinse
  - Gravimetric analysis and ATP test
- Alternative 2:
  - 0.1% phosphoric acid treatment at 65°C for 1 hour
  - 50% phosphoric acid brush washing
  - Water rinse
  - Gravimetric analysis and ATP test



ATP testing on coupons after cleaning and scrubbing with diluted phosphoric acid

Results showed that both alternatives had equivalent performance by passing the ATP test and had the same performance as the control group (Kettle Cuisine's standard cleaning protocol). Therefore hydrogen peroxide at varying concentrations could be a feasible alternative to sodium hydroxide for Kettle Cuisine.

As a third phase of the research, other alternatives were reviewed and considered for future testing. The alternatives that ranked best using TURI's environmental, health, and safety comparison tool (P2OASys) were:

- Electrochemical activation (ECA) technology
- NaDCC tablets (that produce hypochlorous acid upon dissolution)
- Surface Cleaner 930 (active ingredient oxirane, 2-methyl, and polymer with oxirane, monodecyl ether)
- Micro A07 (active ingredients citric acid and anionic surfactants)

TURI and UMass Lowell hope to test these alternatives at Kettle Cuisine or other food processors in the near future.

Discussion/Results

Lab tests showed that Kettle Cuisine's CIP process could be optimized to reduce chemical and energy use by adjusting the concentration and temperature of chemical cleaners. Results of lab cleaning trials showed that diluting Kettle Cuisine's current cleaning reagent to 75% and dropping the temperature to 75°C was effective in removing 100% of the soil. Varying concentrations of hydrogen peroxide were also effective.

As a follow-up to this work, Kettle Cuisine plans to test other less toxic alternatives in the field. The facility is currently under contract for regular purchases of NaOH, but plans to test several feasible, safer alternatives in the meantime. Other food processors can also apply this research to field test less toxic alternatives.

Data collected in these studies can help in the minimization of NaOH and support the switch to less toxic alternatives that will achieve 100% cleaning efficiency, achieving both food safety and toxics use reduction goals in the food industry.