DeLaval Cleaning Solutions

OPTIMIZE CLEANING EFFICIENCY WHILE REDUCING WASTE WATER

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Abstract
One-Step Acid (OSA) is a new patented detergent manufactured by DeLaval Cleaning Solutions designed to improve CIP cleaning efficiency by combining the organic soil and mineral scale removal into one cleaning step. This low foam detergent lifts and removes organic soils, such as fats and proteins, while preventing and removing hard water scale. Commercial scale trials were conducted at a medium sized milk processing facility to document the efficacy and benefits of OSA. The convenience of single cycle cleaning decreased the amount of CIP cycle time required at this facility by 40%. Additionally, the plant saved over 1 million gallons of water per year, while at the same time reducing energy consumption and chemical discharge.

Introduction

Traditional cleaning of food processing plants through either clean in place (CIP) or manual (COP) programs involves the following basic steps:

- Pre-rinse for removal of gross soil particles
- Caustic wash, including chloralkaline detergents, for removal of proteins, fats and other organic soils
- Rinse
- Acid rinse, for removal of mineral deposits
- Sanitizing rinse for final preparation of the surface for food production

The length and frequency of each of these steps is dependent on the type of soil being cleaned, the size of the operation, the equipment being cleaned, and the chemicals used. For example, heat applied during food processing can bind proteins onto the surface, making their removal more difficult and requiring shorter production cycles to prevent high soil deposition.

In any food processing plant, but particularly those with product demand to run 24 hours per day, the down time spent cleaning and sanitizing surfaces has a direct impact on production time and thus on profitability of the operation. Food producers are constantly looking to improve the cleaning cycle and allow for either longer processing runs or shorter cleaning times. A product that seeks to accomplish this goal is One Step Acid, OSA, by DeLaval Cleaning Solutions.

As part of our vision of making sustainable food production possible, DeLaval Cleaning Solutions has designed a line of cycle time reduction cleaners. OSA is an integral part of this line. It contains a proprietary and patented blend of surfactants and acids designed to both clean and de-scale cold processed surfaces. OSA is intended to replace traditional chlorinated CIP cleaners and allow customers to combine the alkaline and acid cycles into one wash step. The impact of the product is not limited to the reduction in cleaning time. The elimination of cleaning steps also translates in reduced water use, and reduced chemical use, both of which have an important environmental impact. The objective of this study is to better demonstrate the efficacy, customer value and reduced environmental impact of OSA in a typical milk processing facility.

The purpose of the traditional alkaline wash cycle is to break up, lift and remove solids such as proteins and fats from a surface. Replacement of the alkaline wash with OSA is possible because of its unique blend of low – foaming surfactants and acids. The unique blend of acids in OSA, with the aid of the surfactants, allows for highly efficient solubilization of organic soils and consequent removal of mineral deposits. OSA contains both organic and inorganic acids. The blend of organic acids and mineral acids in the formulation provides strong acidity with improved penetration and solubilization of organic soils, which is not common for typical descaling acid products. Eliminating the chlorine wash cycle also helps minimize potential system corrosion issues. Additionally, the acids in OSA are able to remove calcium carbonate and other low solubility salts that are present in hard water and would precipitate during alkaline cleaning routines. These acids are also highly soluble in water, thus reducing the likeliness of any chemical deposits after the cleaning cycle.

The surfactant blend in OSA is optimized to lift and solubilize fatty and protein soils. A surfactant is an organic molecule with hydrophobic (water-repellent) and hydrophilic (water – loving) ends. It may also have a net charge (either positive or negative). Both of these characteristics allow the surfactants to attract and emulsify organic molecules, such as fats, present on surfaces **(Figure 1).** This physical trapping of the soil lifts it from the surface and keeps it suspended in a solution, allowing it to be washed away as the detergent is circulated through the pipes, without re-depositing on the surface. Additionally, breaking hard water deposits, by the acids in the formula, also increases accessibility to organic soil deposits. Properties for OSA are given in **Table 1** for the concentrate and several typical dilutions.

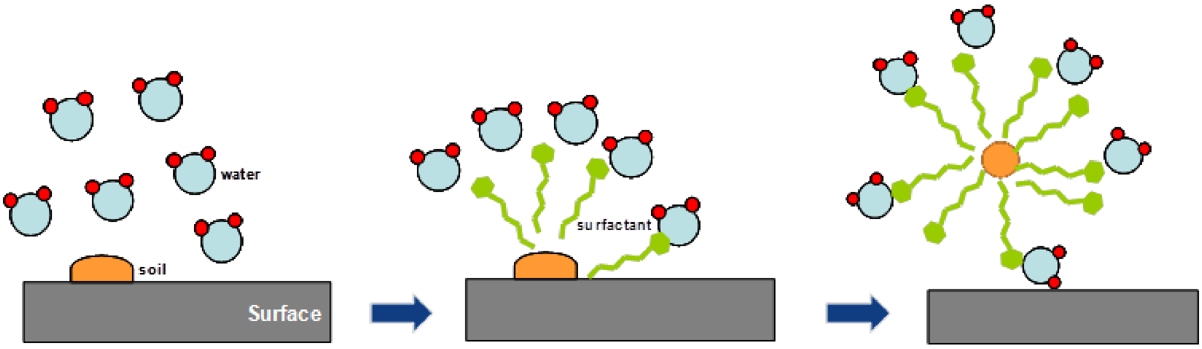


Figure 1. Surfactant mode of action. By having both polar and non-polar ends, surfactants are able to interact both with soils and water at the same time, thus effectively suspending the soils in water and allowing them to be washed out during cleaning.

Property*	Concentrate	0.5oz/gallon (0.4%)	2oz/gallon (1.5%)
pH	<1	4.95	4.01
Acidity	17.5 – 19.5%	0.08%	0.3%
Conductivity	130 ms	0.51ms	4.65ms

*measured in cow water

Table 1. Properties of OSA at different use concentrations.

Methods

The ability to combine the alkaline wash and acid rinse with OSA was evaluated at a milk processing facility in the Midwest. The facility receives milk from 7200 cows daily and processes approximately 3.5 million lb of raw milk per week for production of cream, condensed and skim milk.
The CIP programs for raw tankers, raw lines and silos and the cream separator were modified to replace the caustic wash and acid rinse with a single step using OSA. The following parameters were monitored over a 5 month period between the Fall of 2013 and the Spring 2014:

- Overall cleanliness via pre-op observations and microbiological examination. (Microbial counts not released. Proprietary information)
- Cycle time automatically recorded in CIP system.
- Water usage, as compared with the same time frame a year prior to the study.
- Reduction in cleaning temperature
- Energy usage, as compared with the same time frame a year prior to the study.

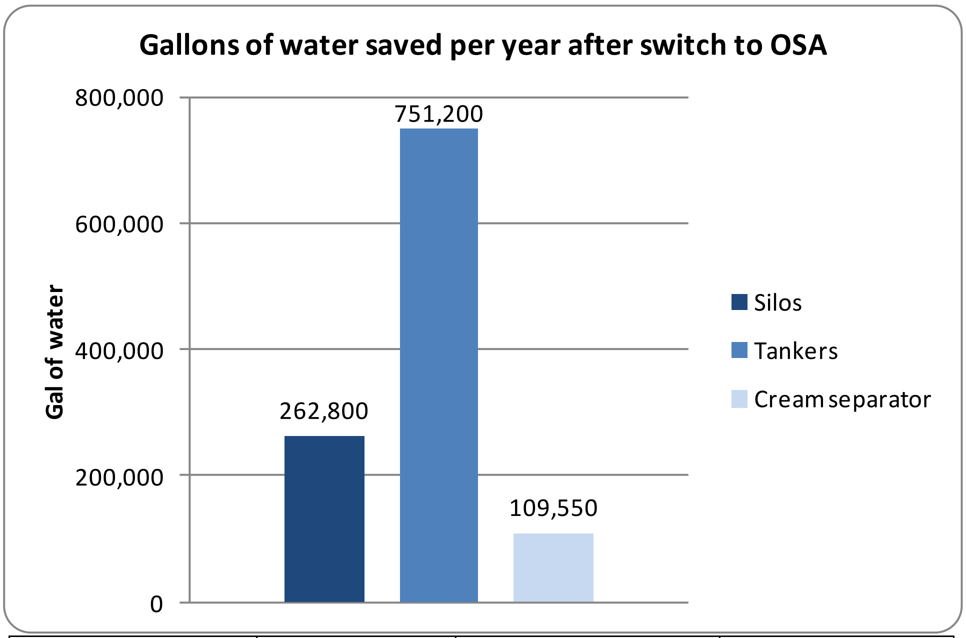
Results

The test facility is a commercial facility that runs 24 hr per day, 7 days per week, with approximately 85 CIP cycles per week for the equipment involved in this study. The total CIP time for each equipment is specified in **Table 2**. The trial resulted in the successful elimination of the caustic wash step without affecting the cleanliness of the surfaces. Cleaning time was reduced by approximately 1/3 to half for each cycle.

Equipment	Standard Chemical Dose	Standard CIP cycle time	OSA Dose	OSA CIP cycle time	Time Savings
Raw tankers	Caustic (1oz/gal) Acid (0.5 – 1 oz/gal)	45 min	0.5oz/gal	20 min	25 min
Raw lines and silos	Caustic (1oz/gal) Acid (0.5 – 1 oz/gal)	60 min	0.5oz/gal	40 min	20 min
Cream separator	Caustic (3 – 4 oz/gal) Acid (1 – 2 oz/gal)	3.5 hr	1 – 1.5 oz/gal	2 hr 15 min	1 hr 15 min

Table 2. CIP cycle time savings and extended production after implementation of OSA cleaning regimen.

Although a full wash (i.e. caustic wash and acid rinse, 3.5 hr total) is performed once per week for the cream separator, the total down time for the production facility was reduced. The overall number of CIP cycles per week did not change, but cleaning became more efficient. This is exemplified not only in the reduction of the total downtime, but also energy and water savings (**Figure 2**). As less water was being used, the total amount of energy needed to heat the water was also reduced. The total water savings for the test facility were 1 million gallons per year – approx. 3 acre feet (**Figure 2**).



Equipment	Gal of water saved / day	Days/ yr using OSA	Gal of water saved / yr
Silos (3)	720	365	262,800
Tankers (12)	2400	313	748,800
Cream separator	350	313	109,550

Figure 2. Total water savings for cycles using OSA (2013 vs. 2014 data). For some of the equipment, a full CIP cycle (caustic and acid steps) is run per week, thus the number of OSA CIP cycles is 313.

Overall cleanliness of the system was improved even after a decrease in traditional cleaning temperature (**Table 3**) of 15 -35°F, depending on the equipment, and reduced chemical usage by ca. 4 fold (**Table 2**). The recommended use temperature of OSA is 120-140° F (50-60˚C), this in contrast to standard alkaline wash temperatures of 140°-160°F (60-70˚C), with the added benefit of little to no foaming during CIP. Temperatures below 100°F are not recommended as they may cause fats to redeposit onto other surfaces. Every 10˚reduction in water temperature translates to an approximate energy savings of 158.8kJ/gal of water (**Table 3**). OSA renders the surfaces free of protein and mineral deposits, even along edges or other hard to reach areas (**Figures 3a. and 3b**). The energy savings from these changes correspond to a decrease in energy use of 90 thousand kWh / yr.

Equipment	Caustic wash Temperature	OSA Temperature	Delta T	Wash water volume saved (gal/cycle)	Energy savings (kWh/cycle)
Silos (3)	155°F	140°F	15°F	100	6.4
Tankers (12)	155°F	140°F	15°F	100	6.4
Cream separator	175°F	140°F	35°F	300	45

Table 3. Energy savings after replacing the two step traditional cleaning cycle with OSA.

Figure 3a. Separator prior to cleaning cycle after 20 hours of production equivalent to 550K gallons of milk.

Figure 3b. Separator after cleaning cycle using 1.4 % OSA.

Conclusions

The advantages of OSA detergent have been proven in a typical medium milk processing facility. The facility was able to reduce the total CIP cycle time, with its consequent water and energy savings. The combination of faster rinse times and lower CIP wash cycle temperatures, also allowed the processor to expedite raw trucks turn time and filling of the raw tanks.

However, the benefits are beyond the monetary savings. There is a positive impact on the quality of the final product by providing a cleaner surface. In turn, by leaving a cleaner surface, OSA enhances acid sanitizer performance. The active ingredients in sanitizer formulations are typically highly reactive molecules that “attack” any organic deposits on a surface. Also, the presence of certain minerals, can affect their activity by either a chemical interaction or by physically hindering their ability to reach microorganisms present on the surface. Thus, the presence of soil residues can negatively affect the ability of a sanitizer to reduce the viable number of microorganisms on a surface. A cleaner surface is sanitized more efficiently, resulting in higher production quality.

The data presented in this study is typical of a milk processing facility. However, depending on the specific details on equipment, schedule and production for each facility, the impact of OSA may vary. While in some processing plants the alkaline wash step may be totally eliminated, in others, as it was the case for the cream separator in this study, its frequency is at least reduced.

By reducing or eliminating an additional wash and rinse step, the processing plant’s cleaning time, water, energy and chemical use are minimized and cleaning capacity is maximized. In some cases, the amount of cleaning time necessary maybe reduced to such a level that the need for capital investments for additional processing equipment may be avoided. Water and chemical discharges are reduced, both of which translate into a more sustainable production process with less environmental impact. Impact of effluent in waste water system is also diminished by the elimination of chlorine as well as the reduction in amount of daily effluent. The work of the cleanup crew can be better utilized by eliminating steps, eliminating the need for overdosing chlorinated cleaners to compensate for chlorine loss and providing a cleaner surface that improves the performance of acid sanitizers.