Eco-efficiency for Australian dairy processors

Fact sheet 9: Chemical use

Chemical use for dairy processing

The cost of chemicals for dairy processing plants can be several hundred thousand dollars per year and a significant proportion of total operating costs. The dairy processing industry uses a wide variety of chemicals for cleaning, for pH control of process and waste streams, and for treating water for process and auxiliary uses such as boilers and cooling towers.

Type and function of cleaning chemicals

Chemicals are used to remove organic soiling (e.g. proteins such as casein) and inorganic soiling (e.g. magnesium and calcium from hard water). Most soils are a combination of organic and inorganic deposits, such as 'milkstone', which is a combination of calcium caseinate and calcium phosphate.[1] The nature of milk protein residue varies greatly with temperature, and thus different equipment requires different cleaning regimes.

Detergents used for cleaning usually consist of a mixture of ingredients that interact both chemically and physically with the soiling. Inorganic alkalis (e.g. caustic soda and potassium hydroxide) are commonly used to remove fats, while inorganic acids (e.g. phosphoric, nitric and hydrochloric acids) and organic acids (e.g. hydroxyacetic and citric acid) are used to remove difficult soiling such as mineral deposits.

Sanitisers (e.g. chlorine dioxide and peroxides) are used to reduce micro-organisms to a level that is safe for public health and product quality.

Water is the primary constituent of all dairy processing chemicals, and should be tailored for the plant's water supply. Hard water can result in scale build-up, which affects the capacity of detergents and sanitisers to contact the surface and can lead to excessive scaling in boilers and cooling towers. Such water may require treatment such as ion exchange, or the use of detergents and sanitisers that are specifically formulated for hard water.

Water conditioning saves chemicals[2]

A UK dairy produces cultured milk products such as yoghurt. The company overcame problems with limescale and milk-scale build-up on heat exchangers by installing three 'Hydroflow' physical water conditioning units that prevent build-up of limescale deposits by electroprecipitation. The heat exchanger is now cleaned weekly, with half the amount of acid.

Optimising chemical use

Reducing chemical use by careful selection, optimal utilisation and recovery, *without* compromising processing or food safety standards, can result in substantial savings while also improving the plant's environmental performance. There are two main types of environmental impacts from chemicals used in dairy processing plants. The high level of salts in dairy effluent from sodium-based chemicals (caustic) can affect land and groundwater; and nitric and phosphoric acids can alter nutrient levels in discharges to waterways. There are numerous factors that influence the cleaning process, and many of these are interlinked. Changes should not be made without considering the overall impact on cleaning effectiveness and product quality.

• Install multi-use or full recovery CIP systems that allow the reuse of chemicals and rinse water.	**Upgrade of CIP system to include recovery tanks** Murray-Goulburn in Koroit upgraded its major CIP set for the evaporators to include separate dirty and clean caustic tanks; these increase recovery, improve the quality of the chemical supply, and reduce effluent volume and plant downtime. The initiative saves $80 000/yr, with a payback period of 13 months.
• Conduct regular audits of cleaning systems.	**Auditing of dosing equipment** National Foods in Morwell reduced caustic and acid timer settings on its CIP system. During the early stages of commissioning the plant, there were problems in product quality and cleaning times were increased. As the quality issues were resolved it was found that the times were above recommended levels and could be reduced without comprising product quality.

1 AJD Romney (ed.), *CIP: cleaning in place*, Society of Dairy Technology, Cambridge, 1990, Chapter 1, 'Principles of cleaning'.
2 Manufacturing talk, Physical water conditioning saves chemicals, time. *Hydropath UK*, 2003.

• Work with your chemical supplier to optimise the type and blend of chemicals to meet your specific cleaning requirements.	**Alternative detergent use**[3] Bonlac Foods in Stanhope were using a CIP process with an alkaline solution and an acid detergent to clean equipment. The acid detergent was replaced by Stabilon® detergent, which is a combination of complex agents, wetting agents, anti-foam agents, cleaning activators and emulsifiers. As a result CIP cycle time reduced from 6 h to 4.5 h, allowing more time to produce cheese, and elimination of the acid detergent in the CIP process. The net benefit was an extra $310 per day.
• Use automatic dosing systems and optimise the concentration of the cleaning chemicals for each different task.	**Review of CIP chemical concentrations** National Foods in Morwell reduced its caustic concentrations on its dessert cooker and set specific acid concentrations on its individual CIP sets. The caustic concentration on the dessert cooker was reduced to 1.5%. Changes to both acid and caustic concentrations totalled approximately $100 000 per year.
• Install process control and instrumentation.	**Instrumentation for cleaning improvements, Dairy Farmers, Malanda** Dairy Farmers in Malanda audited all its CIP processes. Optical sensors were used to fine-tune water and milk interfaces, and conductivity and turbidity meters were used for cleaning improvements. Estimated savings for the improvements were $211 500/yr.

Alternative chemicals

• Consider the use of biodegradable chemicals.	A number of biodegradable organic acids (e.g. acetic and citric acids) are used in the dairy industry instead of inorganic acids. Peroxyacetic acid is used as an alternative sanitiser to chlorine
• Use enzyme-based cleaners.	**Enzyme cleaner for cold surfaces** Murray Goulburn in Maffra use cold surface cleaners (enzymes in conjunction with mild detergents) to reduce caustic-based cleaners. While the cold surface cleaners require more frequent rinsing with acid, the reduced use of caustics has benefited the environment as well as operators' health and safety.
• Trial reduced phosphoric and nitric blends.	**Change to nitric acid blend** Dairy Farmers in Jervois changed from CB93 (phosphoric acid) to CB96 (nitric acid) because equipment was not being cleaned adequately. The initiative resulted in a superior clean and reduced phosphate load in water used for irrigation.

Alternatives to using chemicals

Ozone is a powerful oxidising agent that destroys micro-organisms by oxidising the cell membrane. Examples of ozone use in Australian dairy processing are so far limited to trials on cooling tower water treatment. Ultraviolet (UV) disinfection systems destroy micro-organisms through interaction with microbe DNA. UV light has been used by some Australian dairy processors to disinfect water used for cleaning and for treating condensate.

Supply and handling of chemicals

Some chemical suppliers will enter into service agreements with their customers, where they provide an advisory service that is built into the cost of the chemicals they sell.

Performance-based contracting is another way that two companies can collaborate to improve performance. Purchasing chemicals in bulk or at higher concentration may be more economical and can save on packaging.

Consolidation of suppliers and bulk purchasing, Dairy Farmers, Bomaderry

Dairy Farmers in Bomaderry previously used nine different chemical suppliers to meet its chemical needs. The plant has since changed to just one supplier. It took a few months for the plant and the supplier to come up with a range of chemicals equal to those they were previously using, but they are now supplied at a reduced price.

3 Environment Australia, *Cleaner production demonstration project, Bonlac Foods* Stanhope 2001.

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For further information see the *Eco-efficiency for the Dairy Processing Industry Manual*, August 2004 or contact the UNEP Working Group for Cleaner Production: phone 07 3365 1432, email p.prasad@uq.edu.au
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