Eco-efficiency for Australian dairy processors

Fact sheet 7: Yield optimisation and product recovery

Efficiently utilising raw materials and optimising product yield are important aspects of eco-efficiency. Materials such as raw or pasteurised milk, cheese or whey, and components of milk such as fat, lactose and protein, can be lost during processing and end up in wastewater or solid waste streams. These losses represent a waste of resources that could otherwise be recovered as products or co-products. They also contribute to the pollutant load of the waste streams, resulting in increased treatment and disposal costs. Opportunities to make substantial savings by reducing product loss during processing and cleaning are outlined below. They include effective wastewater management, plant layout and design, and efficient processing and process control. Table 1 shows some sources of product loss in dairy processing plants.

Advanced process control

Murray Goulburn in Koroit and Predictive Control Pty Ltd undertook a project to examine the potential for Advanced Process Control control (APC) technology to enhance the operation of evaporators and spray dryers. A Model Predictive Controller was used for integrative control to keep the process achieving its maximum potential. The system consisted of an evaporative controller, a dryer outlet temperature controller, a dryer moisture controller, and an optimiser to coordinate the evaporator and dryer. Constant maximum evaporation was achieved by manipulating the evaporator feed rate, taking into consideration the concentrate tank level and dryer feed rate.
The results indicated that, for a 70 000 L/h evaporator, there was potential for an increase in powder production capacity of 3% and savings of $491 000/yr. The project cost $192 000, with an annual support contract of $20 000.[1]

Table 1: Sources of product loss in dairy processing plants

Dairy product	Area of potential product loss	Waste stream
Common to all	Tankers, tanks and pipelines not sufficiently drained before cleaning	Wastewater
	Loss during cleaning, product changeovers, start-up and shutdown	Wastewater
	Spills due to frothing or poor process control	Wastewater
	Production capacity issues or stoppages causing equipment to be drained of product	Wastewater/solid waste
	Leaks, e.g. filling machine heads	Wastewater
	Reject product, including in processing and returns of final product	Wastewater/solid waste
	Variations in raw materials or packaging	Wastewater/solid waste
	Separator de-sludge	Solid waste
	Filling or packing machine inefficiencies, e.g. overfills, underfills	Wastewater/solid waste
Cheese and whey	Curd adhering to processing equipment, e.g. cheddaring machines	Solid waste
	Cheese fines and milk fat lost to whey	Loss to whey stream
Powdered products	Entrainment of liquid product in evaporators to condensate	Wastewater
	Entrainment of powder fines in spray dryer exhaust	Solid waste
	Product deposition on heated surfaces	Wastewater
Yoghurts and dairy desserts	Residue on processing equipment due to high viscosity	Wastewater

1 M Mackay, *Investigation of the ability of model predictive control to increase powder production capacity at Murray Goulburn's Koroit Plant*, DRDC internal document, 2002.

The cost of lost product

The components that make up the true cost of waste product are not only the raw material costs but also the cost of processing (heating, pasteurising, cooling, pumping), the cost of waste packaging, and also wastewater treatment and discharge or solid waste disposal costs.

Based on the cost of raw ingredients alone, there are opportunities for substantial savings. For example, assuming a BOD_5 strength for undiluted milk of 100 000 mg/L, a wastewater flow of 300 ML/yr, and a typical BOD_5 of untreated waste of 2000 mg/L, the volume of lost milk to the waste stream is 6 ML/yr.

This equates to milk losses of $1.5–3 million per year!

A 5–10% improvement in yield can therefore lead to substantial savings.

Milk recovery system for reject filled product

Eco-efficiency opportunities

Below are some examples of waste minimisation and yield optimisation opportunities carried by Australian dairy processors.

- Optimise start-up and shutdown procedures and changeovers by fine-tuning timers and accurately detecting product interfaces. Implement procedures to accommodate unexpected shutdowns.
- Optimise product formulation with computer-aided programs for the blending of ingredients. Standardise milk and milk powders with retentates and permeates.
- Optimise production scheduling so that processing capacity matches filling capacity (e.g. adequate-sized intermediate storage tanks to buffer short breaks in filling).
- Minimise waste during separator de-sludging by optimising bowl opening frequency. Install a filter before separators to reduce discharge frequency.
- Collect first flush of process equipment. Where possible, blend back into the process; otherwise dispose of as animal feed.
- Use pigging systems to minimise water used for cleaning and maximise product recovery.
- Design each process step to keep waste at an absolute minimum (e.g. sufficient sloping of pipes; installation of pumps that facilitate complete drainage and adequate drainage time).
- Develop an effective wastewater management program that accurately measures wastewater volumes and loads, to provide a more comprehensive picture of how much loss is occurring and where.
- Use bag filters and cyclones to capture product in dryers, for blending back into product stream or using as animal feed.
- More reliable instrumentation can increase product yield (e.g. a self-cleaning light-absorption turbidity meter for quick response to changes in milk solids concentration; and a combination of temperature, pH and conductivity meters to monitor CIP frequency, effectiveness and chemical loss).

Optimising start-up and shutdown procedures

National Foods in Crestmead fine-tuned its product start-up and shutdown procedures to maximise product recovery, and saved $40 000/yr or around 60 000 L of milk.

Recovery of product during changeovers

Dairy Farmers in Bomaderry installed a valve arrangement, balance tank and product pump to catch all interface product from bottling machine changeovers.

Around 500 L per day is now collected — a saving of $160/day. The payback period was 1 month.

Milk filters to reduce product loss

Murray-Goulburn in Koroit installed milk filters before the separators to reduce discharge frequency. This initiative increased the length of time between discharges from 20 minutes to 50 minutes, saving $40 000/yr, with a payback period of 1 year.

Optimising product formulation

Warrnambool Cheese and Butter in Allansford recovers milk permeate from an ultrafiltration plant to standardise milk powder. Almost 100% of the milk permeate is utilised for standardising and any excess permeate is sold to other dairy companies. The payback period for the project was 8 months.

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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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