Eco-efficiency for Australian dairy processors

Fact sheet 4: Boiler optimisation

Dairy processing plants can use up to 80% of their total energy requirement to produce the steam and hot water needed for evaporative, heating and drying processes. Optimising boiler combustion and steam and water distribution systems can lead to increased capacity and considerable savings in water, energy and chemicals.

Using air-to-fuel ratio control equipment such as oxygen trim control ensures more complete combustion. Such equipment can reduce energy consumption by 1.5–2%. Potential savings in fuel are shown in Table 1.

The stack gas temperature should be measured under normal operating conditions after servicing and cleaning, and this optimal temperature regularly compared with the stack temperature. Major variations can indicate a drop in efficiency and a need to adjust air-to-fuel ratios. It is estimated that there is a 1% efficiency loss with every 5°C increase in stack temperature.[1]

Table 1: Fuel savings from installing online oxygen trim control[2]

Boiler capacity (MW)	Fuel savings ($/yr)	Payback period (yr)
0.5	3 816	2.0
1	7 620	1.0
3	22 860	0.3
6	45 720	0.2
9	68 580	0.1

Sizing and operating boilers efficiently

Boilers should be appropriately sized to meet, and then operated at, maximum possible design pressure. Steam should be generated and distributed at high pressure and reduced to the required pressure at the point of use, using pressure reducing valves.

Improving communication between the boiler house and production can help meet demand more efficiently. Boilers should be started up as late as possible and shut down as early as possible, while still meeting production needs.

To meet short periods of demand, a 'steam accumulator' will allow steam to flow through a large vessel of heated water.

Improving communications between boiler house and operators[3]

An Energy Management Team at Murray Goulburn Co-op. in Rochester identified that poor communication between the boiler plant and process operators was resulting in the boiler being run inefficiently at low load. The team developed new procedures and a communication plan. The average load of one boiler was increased from 30% to 60%, contributing to a 4% increase in steam-raising efficiency and a saving in fuel costs of $180 000/yr.

When a sudden peak load is imposed a proportion of this vessel's water is 'flashed off' into steam at the reduced pressure to protect the boiler from instantaneous loads.

High efficiency boilers

Boiler efficiency can be improved by installing heat recovery equipment such as economisers or recuperators.

An economiser is an air-to-liquid heat exchanger that recovers heat from the flue gases to pre-heat boiler feed water.

A recuperator is an air-to-air heat exchanger that is used to recover heat from flue gases to pre-heat combustion air. Variable speed drives can be retrofitted to combustion air blowers to continually match the load of the boiler.

Fuel consumption can be reduced by approximately 1% for each 4.5°C reduction in flue gas temperature.[4]

The treatment of boiler feedwater will help to minimise scale build-up, which acts as an insulator and inhibits heat transfer.

Optimising steam delivery

Recovery and reuse of condensate

Condensate contains valuable heat energy and should be returned to the boiler feed tank to save energy, water and chemicals. If condensate is contaminated, use a heat exchanger to preheat make-up water.

'A 5°C increase in the temperature of the feedwater will save around 1% of the fuel used to raise the steam.'[1]

Insulation of pipes

Insulation can help to reduce heat loss by as much as 90%. Sources of moisture should be removed to prevent insulation from deteriorating, and insulation that is damaged should be promptly repaired.

Repair of steam leaks and steam traps

Leaks allow live steam to be wasted, requiring more steam production, more fuel for heating and more chemicals for treatment. Regularly test and maintain steam traps to save energy and improve operating efficiency.

'A 1 mm diameter hole in a steam line at 700 kPa will lead to an annual loss of 3000 L of fuel oil or 43 000 m^3 of natural gas.'[1]

Rationalisation of boiler use and steam lines

If steam supply lines do not take the most direct route from the boiler to the point of use consider rationalising the pipework. Review boiler use, especially in plants that have progressively expanded over the years. Calculate the economic viability of upgrading or replacing old boilers. If replacing a boiler, investigate converting to a more efficient and clean fuel (e.g. coal fuel oil to gas).

Regular boiler maintenance

Scale acts as an insulator and inhibits heat transfer, so effective water treatment and blowdown for boilers is essential. Minimise the flow of make-up water needed by installing a conductivity probe to initiate blowdown when water exceeds a set value.

'A coating of scale 1 mm thick can result in a 5% increase in fuel consumption. If the thickness is to increase to 3 mm the fuel consumption can increase by 15%.'[5]

Improving condensate return[4]

Murray Goulburn Co-op in Rochester identified savings of around $200 000/yr in natural gas costs, through improving the efficiency of the condensate return system and improving repair and maintenance of steam leaks. By insulating the condensate return pipes, boiler feedwater temperature could be increased from 45°C to 65°C, thereby increasing the boiler efficiency by 3.3%.

Rationalisation of boiler use and steam lines

Peters and Browns ice-cream processing plant reduced its gas usage by $10 000/yr and its maintenance costs by $15 000/yr by decommissioning two boilers and using steam from their existing beverage plant boilers. The cost of implementation was $65 000 with a payback period of around 2.5 years.

Elimination of steam leaks

At Bonlac Foods in Spreyton, plant steam is generated and distributed at 40 bar for spray dryer air heating. All other duties use steam at 10 bar which is produced at four 'letdown' stations located near the points of use. Due to design faults the letdown stations were allowing the continuous leakage of steam. The plant rebuilt the stations and installed heavy-duty automated isolating valves. The improvements saved over $71 000 in coal supply costs. The payback period was 2 years.

1 Muller et al., *Modern industrial assessments: a training manual*, version 2.0, Rutgers University, New Jersey, 2001.
2 Adapted from SEAV 2002 (Gas costs $12/GJ: boilers operating 24/day, 350 days/yr, installation cost of boiler trim system $7500).
3 ITR 2003. Australian Government Department of Industry, Tourism and Resources. *Energy Efficiency Best Practice. Case study dairy processing sector, Murray Goulburn Rochester*, viewed March 2004, www.industry.gov.au/energybestpractice
4 SEAV (Sustainable Energy Authority Victoria), *Energy and greenhouse management toolkit*, SEAV, Melbourne, 2002.
5 MLA (Meat and Livestock Australia), *Steam generation systems*, MLA, Sydney, 1997.

This project (DAV447) was funded by Dairy Australia.
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
Fact sheet published August 2004.

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