Case Study
Fonterra Wagga Wagga Energy Efficiency Upgrade

MINUS40
www.minus40.com.au
P: (02) 8850 4811

Fonterra is a New Zealand-founded global dairy company with a global milk distribution of 22 billion litres of milk annually. The company's site at Wagga Wagga is the Riverina's only milk processor, with its *Riverina Fresh* brand providing white and flavoured milk, yoghurt and dairy desserts.

Many of the processes at the Wagga Wagga site require refrigeration. The refrigeration plant is responsible for most of the site's energy consumption. Minus40 found opportunities for significant energy savings with this equipment through improved efficiency.

A study done by Minus40 in 2010-11 found that the existing refrigeration plant design was ad-hoc, consisting of an ammonia chiller, an R22 chiller and also multiple individual Freon circuits. Many opportunities for improvement were identified, but the R22 chiller was found to be the most energy-intensive component.

R22 Chiller Replacement

The Wagga Wagga site was scheduled for increased production, but the existing refrigeration plant did not have capacity to support the increase. A chiller upgrade was inevitable, so it provided a compelling opportunity for efficiency improvement as well as capacity increase.

The existing R22 chiller was required to act as an "ice bank" - a practice in which the chiller produces ice during periods of low load, so that it can use this stored energy during peak load. This is a particularly inefficient practice – it is preferable to operate a chiller with capacity for peak load.

Replacing the R22 chiller also presented an opportunity for a much better environmental outcome. R22 is a type of HCFC (Hydro-chlorofluorocarbon) which is a substance with powerful ozone-depleting characteristics. It also has an extremely high Global Warming Potential (GWP) of 1780, indicating that the global warming effect of R22 is 1780 times larger than that of carbon dioxide. These two properties of R22 refrigerant are the reason for its phase-out.

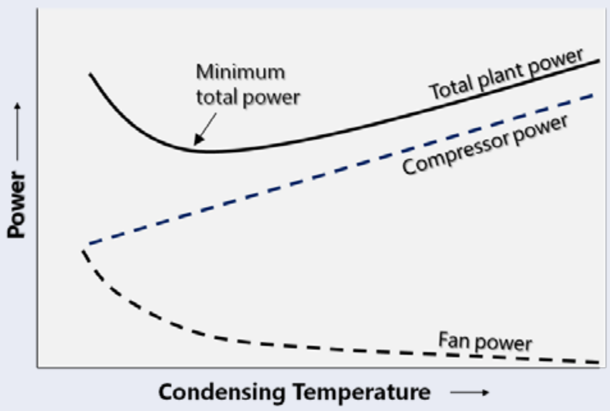
These considerations led to a solution with a new chiller run on ammonia. Although the unit is larger than the original unit, it is more efficient and has a far smaller environmental footprint.

Variable Cooling Water Temperatures

Introducing variable cooling water temperatures provided another opportunity for efficiency improvements. Cooling water systems are needed to remove the heat produced through condensing. Their temperature are commonly held at standard conditions, which are set to cope with peak-load. When the plant is operating with reduced load, or the ambient temperature is lower, the cooling water temperature can be reduced. Typically, a 1°C reduction in cooling water temperature results in a 3% power consumption reduction. Careful design can result in significant energy savings.

OPTIMAL CONDENSING TEMPERATURE

In order to reduce the condensing temperature, the speed of the condensing fans needs to be increased. It is known however, that an increase in fan speeds will increase their power consumption, especially at higher speeds. There is therefore a specific point at which the combination of compressor power and fan power is at a minimum, visible in the following graph. This minimum point varies with ambient and load conditions, therefore the plant control requires a specific algorithm which is able to constantly identify this point.



To implement variable cooling water temperatures at Fonterra, both a dry bulb temperature sensor and a relative humidity sensor were installed. This enabled a wet bulb temperature to be calculated, which is used to calculate the desired condensing temperature set-point. To reach this condensing temperature, the plant Programmable Logic Controller (PLC) varies the speed of the cooling tower fans.

This technique was applied to both the new ammonia chiller and the existing chiller. Variable cooling water temperatures were then used throughout the whole site, increasing energy savings.

Glycol Circuit Design and Control

A chiller's efficiency is maximised by maintaining the temperature differential across it. The existing glycol circuit at the Wagga Wagga site had a constant glycol flow rate, preventing it from responding to reduced load on the plant and decreasing efficiency.

Efficiency was improved by fitting the glycol circuit with Variable speed Drives (VSDs), and incorporating them into the plant control logic. The logic is then able to vary glycol flow rate in proportion to plant load This technique ensures that the chiller is always running at the most efficient conditions.

Project Implementation

Replacement of the R22 chiller, along with improved control techniques, was expected to provide an energy saving of 805 MWh per annum, accounting for 19% of the site's power consumption. The upgrades were completed for a capital cost of $458,643, and were expected to save the site $131,215 in energy and maintenance costs per year. The proposed upgrades resulted in a successful Clean Technology Investment Program (CTIP) grant application, which assisted in funding the project.

By April 2013, the initial installation was complete, and the plant already exhibited an annual energy saving of 672 MWh, which represents 16% compared to 2010. Further optimisation of the variable cooling water temperatures and glycol controls are expected to continue to increase the energy savings.

This project resulted in the awarding of the Energy Efficiency Council Best Industrial Energy Efficiency Project award in December 2013 – an acknowledgement of its success in reducing the site's power consumption

The energy savings facilitated by the refrigeration plant upgrade have been substantial.

We are pleased that the upgrade has been awarded Best Industrial Energy Efficiency Project.

John English, Fonterra Australia