Case Study
Rivalea Corowa
Energy Efficiency Upgrades

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Rivalea is an Australian agri-food company based in Corowa NSW, with activities in feed milling, livestock production and meat processing.

The processing facility uses an ammonia refrigeration plant, which initially had an annual power consumption of 5.164 GWh. There were numerous opportunities for energy savings identified by Minus40 at Rivalea. Some of these were implemented in early 2013, with estimates of a 10-30% energy saving for the refrigeration plant. The improvements are outlined in this study.

Variable Head Pressure Control

Head pressure is the pressure at which the refrigerant condenses. In typical refrigeration plants, this is maintained constant at a level which is able to cope with peak-load conditions. In conditions of lower ambient temperature or lower load, the constant head pressure is higher than required, and the plant uses energy inefficiently. If plant conditions are monitored carefully, the control logic can vary the head pressure set-point continuously, maintaining maximum efficiency. This technique known as *variable head pressure control*.

This technique was implemented at Rivalea by first installing an ambient dry bulb sensor and relative humidity sensor, along with devices required to determine the compressor load. The enabled both the ambient wet bulb temperature and instantaneous compressor load to be determined. Based on these values, the required head pressure set point was calculated dynamically.

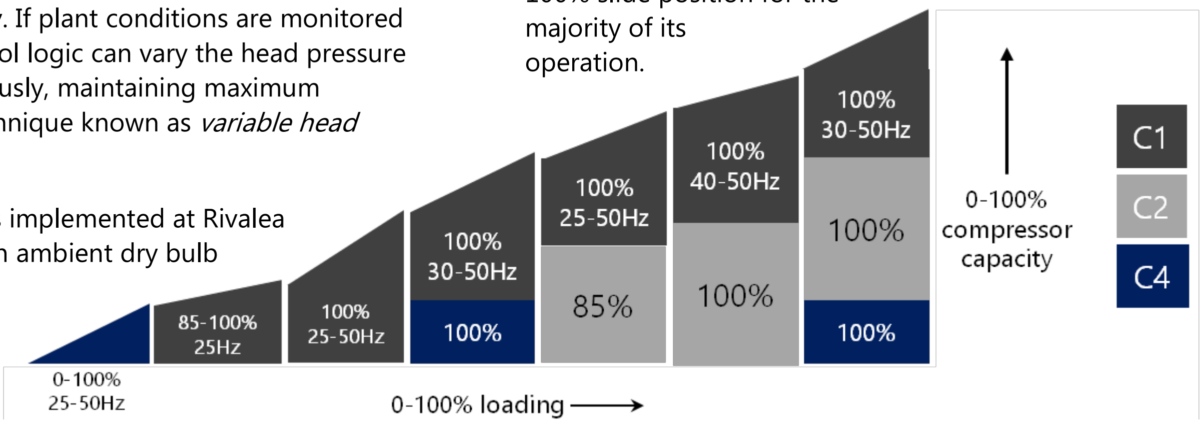
To achieve the required dynamic head pressure set points, the plant logic controls the condenser fan speed. Fans at the Rivalea plant were already fitted with variable speed drives (VSDs), enabling their speeds to be changed as required.

Since the condenser fans lose energy efficiency at low speeds, the three installed fans were controlled with staged operation at lower levels, enabling each fan to operate in its efficient working range.

Compressor Staging and Capacity Control

The plant consists of four compressors – three for the high stage, and one for the low stage. Two of the high stage compressors already had VSDs, and it was therefore advantageous to design a staging and capacity control logic for them. This logic dynamically determines the best combination of compressors for the required compressor capacity. The compressor staging graph below highlights the need to stage individual compressors throughout operation so that 0-100% loading of overall capacity can be smooth.

The low stage compressor also required automatic capacity control to maintain its efficiency. When staging was required, the plant logic was programmed to ensure that the compressor initially increases capacity by means of mechanical slide control, and then reaches full capacity via speed control. This method enables most of the capacity variation to occur using speed control, and hence the compressor is in 100% slide position for the majority of its operation.



Condensate Sub-Cooling

The Rivalea site is a two-stage ammonia plant and features a high stage screw compressor. Like almost all sites of this type, it was possible to achieve significant energy savings by sub-cooling the refrigerant condensate using an economiser.

This technique utilised the screw compressor economiser port, which is at an intermediate pressure between the high stage suction pressure and the discharge pressure of the screw compressor. Introducing the high pressure refrigerant from the liquid receiver (which is at discharge pressure) to the economiser causes an expansion, and therefore cooling of the liquid. There are two main advantages of this sub-cooling:

- thermodynamic increase in efficiency introduced to the system
- reduction in the amount of flash gas produced into the intercooler vessel, further increasing the system's capacity.

Heat Recovery

Compressors produce a lot of heat – heat which is wasted in typical refrigeration plants. On a meat processing site such as Rivalea, there is high demand for hot water, including wash-down water. At these sites, the "waste heat" is valuable.

To recover the heat, it was necessary to install a high stage discharge desuperheater, and also heat recovery oil coolers onto two high stage screw compressors. Only two of the compressors operate for long enough periods to make heat recovery feasible, as shown on the operating graph. The solution employs two stages of heat recovery; first the water is fed through the discharge gas desuperheater, and then it is fed through the oil coolers for further heating.

A new hot water tank was required to store the additional hot water, along with all the associated pipework to connect the tank.

Heat recovery provided an expected energy saving of 3,780 GJ due to the reduction of gas required for water heating. This corresponds to a financial saving of $86,260 per year.

The heat recovery system at Rivalea was so efficient that hot water temperatures of 70°C were achieved which indicates a 50-55°C reduction in heating that the existing gas burner is required to produce when compared to the original system.

Implementation

All variable speed drives and other control devices needed to be monitored throughout the Rivalea plant. This involved installing sensors at some locations, and connecting all sensors to the programmable logic controller (PLC). Some pressure sensors also needed to be connected to the PLC via transmitters

Variable speed drives were added for compressor C1 and C3.

Heat recovery implementation involved more substantial works, including:

- High Stage discharge de-superheater
- Heat recovery oil coolers on the two high stage screw compressors
- Hot water tank
- Cold water feed pump with variable speed drive
- Hot water supply pump

Level sensors, switches and other devices were also fitted to the new and existing hot water tanks.

Government Support

Minus40 has a strong track record of helping clients to qualify for government support. The Rivalea upgrade project benefitted from the Minus40 whole-of-project expertise to attract the following benefits:

- NSW Government Energy Saver Program – this covered part of the cost of the initial audit, which established the feasibility of the resulting upgrade.
- Low Carbon Australia (now Clean Energy Finance Corporation) – this provided low-cost financing for the upgrade work.
- AusIndustry Clean Technology Investment Program – a co-contribution towards the upgrade.