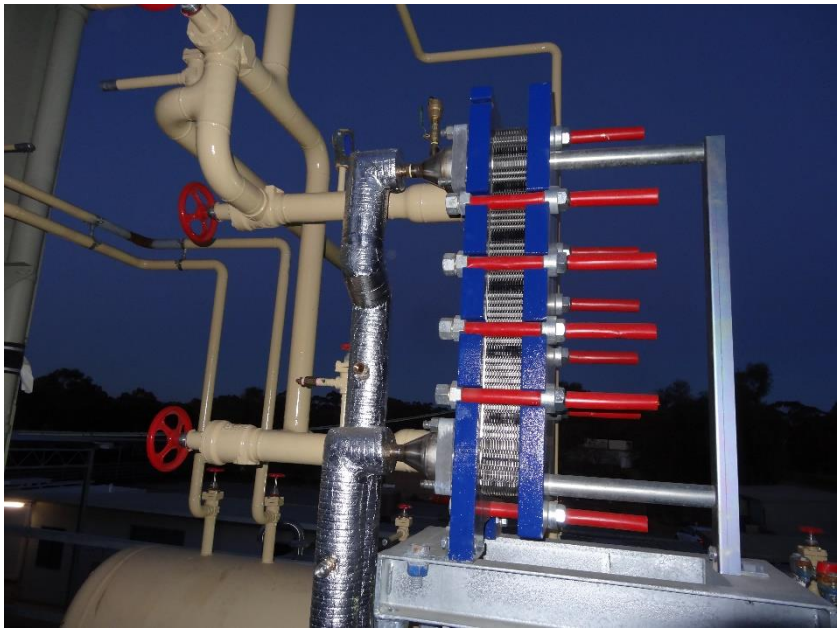
Case Study
Ryan Meat Company Nathalia Refrigeration Plant Replacement



Ryan Meat Company is a medium-sized abattoir in northern Victoria, specialising in red meat processing and sales to local meat wholesalers and butcher shops. The business has been in operation for 60 years, but following growth in the business, a desire to export, and rising power costs, there was a push to improve energy efficiency.

The refrigeration system is responsible for a large part of the company's energy costs, so it was an obvious target for efficiency improvements.

While the existing equipment was relatively clean and leak-free, a study by Minus40 revealed the plant was no longer operating at maximum efficiency. It had reached the end of its service lifetime, with insufficient capacity for the planned increase in production from 22,614 kg per day to 55,000 kg per day.

The system used a variety of synthetic refrigerants (including R22, R134a, R404a and R408a). Simply replacing the worn and inefficient components was not the most effective solution. Instead, the study recommended replacing the entire plant, providing greater capacity, improved efficiency, and eliminating environmentally harmful synthetic refrigerants.

Plant Design

Minus40 recommended installation of a central liquid recirculation two-stage ammonia refrigeration system, with water cooling. The carcass chillers and runner chiller are served by medium-temperature ammonia. The new blast freezer is served by low-temperature ammonia. The system now uses only natural refrigerant, – synthetic refrigerants have been completely eliminated. Ammonia has a zero Global Warming Potential (GWP) and zero Ozone Depletion Potential (ODP), ensuring the system presents no environmental risk if the refrigerant leaks.

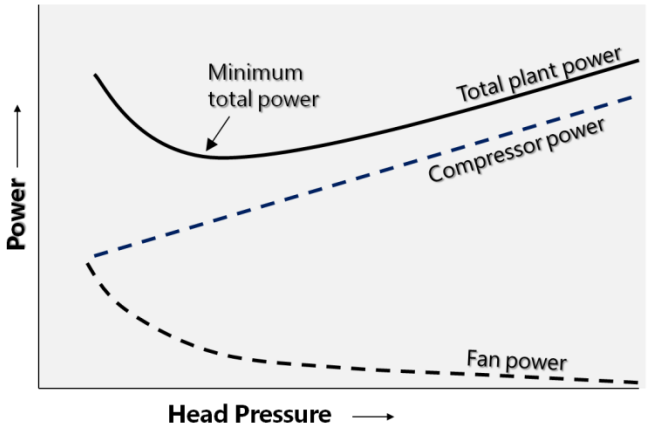
The proposal included a comprehensive automated plant control system, which enabled the plant to be operated for best energy efficiency.

Variable Head Pressure Control

While most refrigeration plants maintain a constant head pressure, efficiency is improved by maintaining the head pressure at the lowest possible value, which is based on the ambient conditions:

- High head pressure during peak load and hot/humid summer conditions.
- Reduced head pressure during periods of reduced load (such as when the ambient temperatures are lower, or there is lower production)

Reducing head pressure lowers the compressor power consumption, but requires an increase in condenser fan speed, and hence an increase in fan power consumption. The head pressure must be continuously varied to ensure both fan and compressor power consumption are minimised.



The minimum point is dependent on the plant's instantaneous load, and the wet bulb temperature. Load is calculated by the plant control system. Wet bulb temperature is determined by measuring ambient dry bulb temperature and relative humidity. With the appropriate sensors installed, the control logic is then programmed to calculate the head pressure set-point, and then operate components as necessary to achieve the set-point.

. Based on the desired head pressure, the control logic determines the appropriate fan speed. For this to be feasible, the condenser fan must have a Variable Speed Drive (VSD) installed, enabling smooth variation of speed.

Heat Recovery

Ryan Meat Company uses a lot of hot water on site for sterilisation, wash-down and boot-wash. Previously, town water was pre-heated in electrically-powered R134A heat pumps. Final heating in the hot water generator was powered by LPG. The new Ammonia plant's waste heat is used to pre-heat town water.

Heat recovery was achieved by installing:

- plate-type heat exchanger (which heats water using the waste heat of the high stage compressor)
- insulated hot water tank to store hot water
- necessary pipework and water pumps.

The amount of heat available varies according to the refrigeration plant operation. A variable speed driven pump was installed to pump water between the tank and the heat exchanger, with the speed varied to maintain constant hot water temperature. Another VSD pump was installed to pump water between the hot water tank and the boiler, where the speed was varied to maintain constant pressure.

Speed of the pump between the hot water tank and the hot water generator is controlled to maintain a constant supply pressure. The control system ensures that hot water delivered by the heat recovery system has constant temperature. The large volume storage tanks also ensures there is always sufficient hot water to meet demand by the hot water generator.

Evaporator Fan Speed Control

At higher fan speeds, a one percent reduction in fan speed results in a three percent reduction of its power consumption. Consequently, a moderate reduction in fan speed can provide a surprising reduction in energy costs. Fan speeds of 100% are only required during periods of maximum refrigeration load. During periods of lower room load (such as during 'carcass holding' mode), the fan speeds can be reduced with no effect on cooling.

The plant control system has been set-up to operate different fan speeds during various stages of carcass chilling, ensuring maximum possible efficiency. Reducing fan speeds also reduces associated load on the refrigeration plant, also reducing compressor power consumption.

Implementation and Energy Savings

Energy savings of 215 MWh per annum were expected after replacement of the old Freon units, along with improved control techniques. This accounts for 35.7% of the site's power consumption, with a value of $50,000.

The upgrades were completed in June 2014 and resulted in a successful Clean Technology Investment Program (CTIP) grant application, which assisted in funding the project.

In October 2014, measurement and verification indicated that the plant was already delivering an annual energy saving of 163 MWh, representing an improvements of 27.1% compared to 2013. Further optimisation of the variable head pressure controls is expected to increase energy savings.

Part of the drop in power consumption resulted from replacement of the unreliable R134A heat pumps.

Water at 55-60^{O}C is now provided to the boiler, also reducing LPG consumption by 10.4%

Replacing the old refrigeration system with an efficient ammonia system and recovering heat for hot water allowed Ryan Meat Company to save $ 51,694 per year.