Case Study

AUSTRALIAN MEAT INDUSTRY COUNCIL

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No. 2

RIVALEA COROWA ENERGY EFFICIENCY UPGRADES

BACKGROUND

Rivalea is an Australian agri-food company based in Corowa NSW, with activities in feed milling, livestock production and meat processing. The meat processing facility utilises ammonia refrigeration plant for refrigerating meat. This plant consumed 2.86 gigawatt hours (GWh) of electricity annually, which represented a significant operating cost for the business. As the result, the decision was made to investigate ways of improving the energy efficiency of the refrigeration plant at the site.

OPPORTUNITIES

The following measures for improving refrigeration plant energy efficiency were identified:

Variable Head Pressure Control - Head pressure is the pressure at which the refrigerant condenses. This is usually maintained at a constant level that 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 wastes energy. If plant conditions are monitored, the control logic can vary the head pressure set-point continuously to maintain maximum energy efficiency.

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.

Condensate Sub-Cooling – the refrigeration plant features two high stage screw compressors. Therefore it was possible to achieve significant energy savings by sub-cooling the refrigerant condensate using an economiser.

Heat Recovery - Compressors expel heat as a by-product of their operation. This heat is usually not reused, and therefore goes to waste. Meat processing sites require hot water for a range of processing and cleaning purposes. Therefore the opportunity existed to use the waste heat from the compressors to pre-heat water, which would offset boiler energy use.

MEASURES IMPLEMENTED

Implementation of energy efficiency measures required monitoring of variable speed drives (VSDs) and a range of other control devices. Sensors were installed at some locations and connected to the programmable logic controller (PLC). Some pressure sensors were also connected to the PLC, using transmitters. VSDs were added to compressor C1 and C3.

Variable head pressure control was implemented by installing an ambient dry bulb sensor and relative humidity sensor, along with devices to determine the compressor load. This allowed measurement of both the ambient wet bulb temperature and instantaneous compressor load. Based on these values, the required head pressure set point was calculated dynamically. Compressors were staged and capacity controlled by implementing logic to dynamically determine the best

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combination of compressors for the required capacity. The low stage compressor required automatic capacity control to maintain its efficiency. When staging was required, the updated plant logic ensured 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.

The two-stage ammonia plant features two high stage screw compressors. An economiser was installed to enable sub-cooling of the refrigerant condensate. This increases the thermodynamic efficiency of the system and reduces the amount of flash gas produced into the intercooler vessel, further increasing the system's capacity.

A high stage discharge desuperheater was installed, and heat recovery oil coolers were fitted to two high stage screw compressors, C1 and C2 in Figure 1. This enables recovery of the waste heat from the condensers for use in hot water production. 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. In addition to heat exchangers, heat recovery implementation required installation of a new hot water tank and associated pipework, a cold water feed pump with variable speed drive and a hot water supply pump. The new and existing hot water tanks were fitted with level sensors, switches and other devices.

OUTCOMES

Annual electricity savings from the refrigeration plant upgrades is expected to be 710 MWh, with financial savings of $127,232.

The heat recovery system achieves hot water temperatures of 70°C, representing a 50-55°C reduction in gas-fired heating demand compared with the original system. This equates to a gas saving of 2,176 GJ, or $65,100 annually.

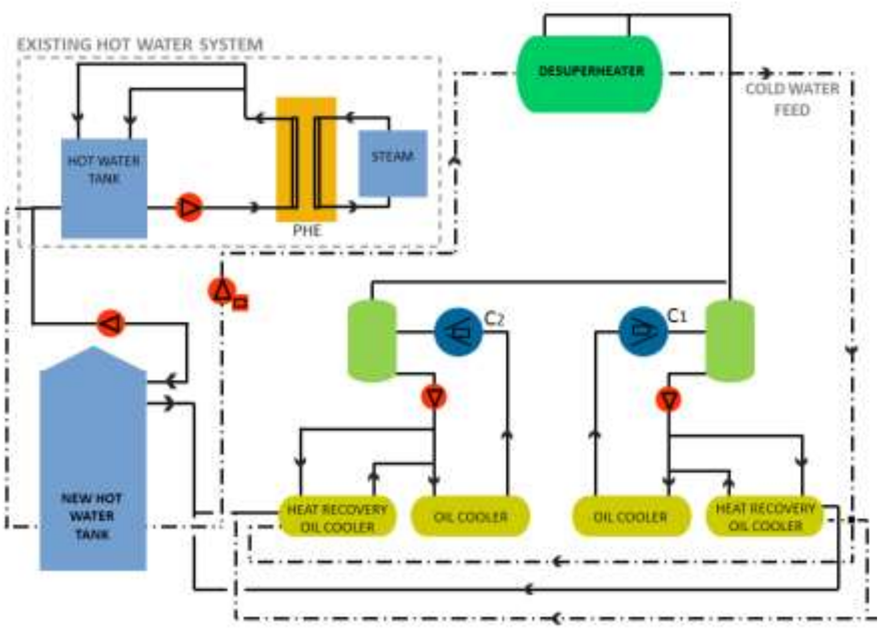

Figure 1 – Schematic showing waste heat recovery from condensers