Fact Sheet

AUSTRALIAN MEAT INDUSTRY COUNCIL

AMIC Australian Meat Industry Council

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No. 10

ECONOMISERS ON SCREW COMPRESSORS

FACT BOX: COEFFICIENT OF PERFORMANCE (COP)
The Coefficient of Performance of a refrigeration system is a measure of the efficiency of the plant, from a thermodynamic perspective. It is simply defined as a ratio between the cooling work done by the system, and the amount of power used by the plant. For example, a refrigeration plant doing 90kW of cooling duty and using 30kW or power has a COP of 3.0.

The refrigerant released by a refrigeration condenser is known as 'condensate' and this liquid is commonly stored in receivers before being supplied to either the field as high pressure liquid, or the low temperature vessels of the plant. In most cases this liquid is at the saturation temperature or only just sub-cooled.

A technique which can be applied to reduce the energy demands of a refrigeration plant is to reduce the condensate temperature, which not only reduces the amount of flash gas but also increases the Coefficient of Performance (COP) of the system.

CONDENSATE SUB-COOLING

Economisers can be installed on one or two-stage ammonia plant containing screw compressors on the high stage side. High stage compressors have an economiser port that provides suction pressure between that of the suction pressure of the high stage compressor and the discharge pressure (typically also the system condensing pressure). Generally, the produced suction pressure is equivalent to evaporating temperatures of 0-10°C.

This economiser port can be utilised in order to gain a cooling effect which can deliver a thermodynamic increase in efficiency in the order of 3-5% to the refrigeration plant. It is produced by expanding a portion of the high pressure liquid refrigerant from the liquid receiver to the intermediate suction pressure provided by the economiser port. The liquid therefore evaporates and is cooled. Sub-cooling this high pressure liquid refrigerant also reduces the amount of flash gas produced when it is expanded to the intercooler/high stage suction pressure. By reducing the flash gas introduced into the intercooler vessel a further increase in refrigeration plant efficiency is achieved.

Figure 1 - Screw compressor with economiser

ENERGY SAVINGS

The temperature to which the refrigerant can be sub-cooled is determined by the intermediate pressure at which the economiser vessel is operated. This in turn is influenced by the inter stage/high stage suction and condensing/high

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pressure liquid temperatures of the plant. For a typical two-stage system with an inter-stage temperature of -10°C and a condensing temperature of 35°C, the COP of the plant increases by 5% as shown in Figure 1.

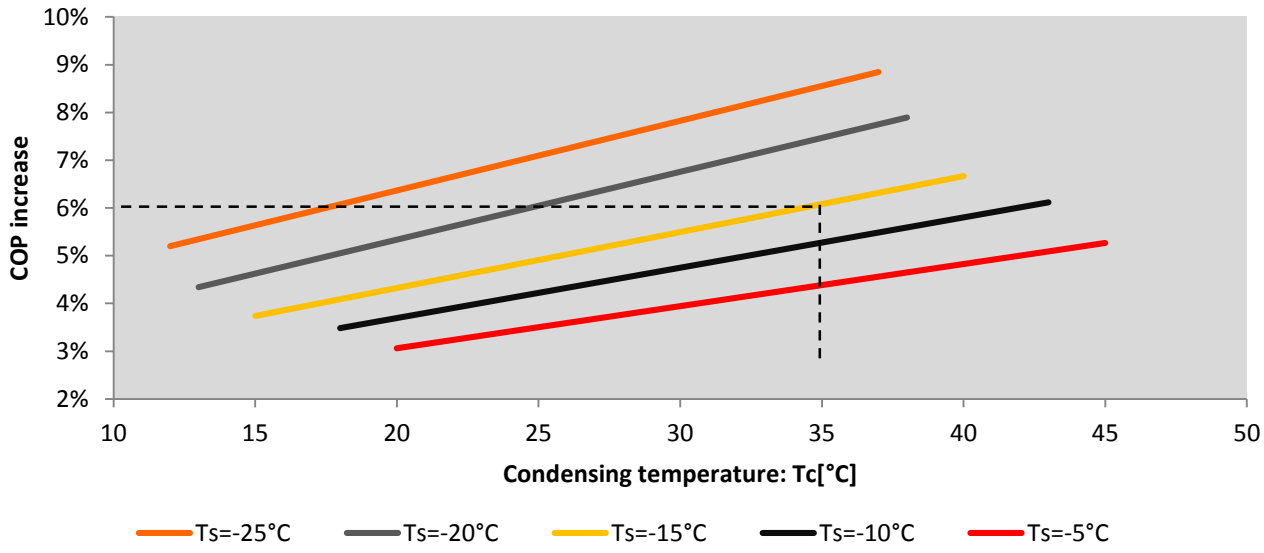

Figure 2 - COP increase resulting from the installation on an economiser, depending on the suction temperature (Ts) of the plant.

A meat storing and processing facility with refrigeration needs supplied by a single-stage ammonia plant with two high stage screw compressors has an annual energy consumption of ~3000 MWh. Upon receiving numerous recommendations as to how energy savings could be achieved, one such recommendation was to install an economiser, in order to reduce flash gas and to sub-cool the condensate. The installation of an economiser is often completed in conjunction with compressor staging and capacity control, and therefore at this site, the costing was completed including the costing for CSCC.

In order to install an economiser vessel, heat exchanger and control structures required for CSCC, the total project costs were estimated at $75,452. With expected energy savings of 3%, this corresponded to energy savings of 36 MWh, or financial savings of $6,949, allowing for a 10.86 year payback.