Roche Ireland

USES EED TO CUT EMISSIONS – AND COSTS

The Roche group is a leading international healthcare company whose principal businesses are pharmaceuticals and diagnostics. Headquartered in Basel, Switzerland, it is active in over 150 countries and employs around 62,000 people worldwide.

THE BIG PICTURE

Roche Ireland Ltd, a subsidiary of the Roche group, is based in Clarecastle, Co. Clare. It operates as a manufacturing centre of excellence for the production of active pharmaceutical ingredients.

As a consequence of the *Montreal Protocol on Substances that Deplete the Ozone Layer*, industry faces the challenge of phasing out ozone-depleting substances (ODSs).

CENTRALISED REFRIGERATION PROJECT

In 2007, Roche instigated a project to design a new, centralised refrigeration system, using an ammonia refrigerant to replace a number of Freon R22 units currently providing cooling across their manufacturing processes. Since a primary objective of the project is to design the most energy-efficient solution, it applied an Energy Efficient Design (EED) approach to the project. This design effort was part-funded by Sustainable Energy Ireland under the Industrial Best Practice Initiative.

Roche investigated opportunities for the new system to supply cooling at a number of different temperatures, instead of a traditional design based on a common supply circuit covering the entire site at the lowest required temperature. The approach taken by Roche was to ensure that life cycle costs of the new plant were as low as possible. The new system provides energy savings by operating compressors with higher evaporator temperatures for a large proportion of the cooling needs.

28% SAVING IN CAPITAL COSTS

The centralised refrigeration system had a lower capital cost than a system incorporating a number of individual refrigeration systems. The centralised system was designed with a total refrigeration capacity of 1200 kW, compared to a total capacity of 2000 kW for independent, decentralised units – thus saving around 28% of capital costs.

It was calculated that a power saving of more than 30% could be achieved by such a design, which equates to the following savings:

Energy	925 MWh per annum
Cost	€100,000 per annum
CO_2 emissions	575 tonnes

ADVANTAGES OF AMMONIA

To eliminate ODSs, Roche chose to use ammonia in a centralised refrigeration system. Ammonia is widely accepted as one of the most efficient refrigerants, especially in temperature ranges from -40˚C to 5˚C Ammonia offers three major advantages over other industrial refrigerants:

1. Since it has superior thermodynamic qualities, ammonia-based systems use less energy.
2. It is more environmentally-friendly, with no ozone depletion or global-warming potential.
3. Its recognisable odour is a useful safety asset.

Ammonia is however mildly toxic and explosive at very high concentrations so safety features such as low charge technology, Ammonia Detection Systems, Extraction systems and suitable Personal Protective Equipment (PPE) have been designed into the final solution to keep the system as safe as possible.

KEY EED DECISIONS

To achieve the increase in energy efficiency required, Roche recommend a series of EED measures, as follows:

The use of ammonia

Ammonia is proven to have good energy consumption characteristics, with a high coefficient of performance (COP) due to its high latent heat, especially in low-temperature applications. The charge of ammonia will also be kept to a minimum by using a low-pressure float-type ammonia feed.

Multiple-application refrigeration system

One of the main sources of energy efficiency in this project is that the same ammonia system can be used to refrigerate several different streams of coolant. In periods of low to medium load, the lead compressor will be heavily loaded, with the load spread across multiple cooling streams. So, instead of multiple compressors operating at reduced efficiency, there is one lead compressor operating at a very efficient level. Also, the surface areas of all the condensers are commoned; the plant thus has the benefit of stand-by surface area in normal operation, and the condensing temperature can be reduced as a result.

Multiple evaporating temperatures on one system

The central system is designed to produce cooling streams at three different temperatures. The temperatures required by Roche are: -17˚C, -25˚C and -45˚C. The -45˚C system feeds into the higher stage. This allows the compressors to operate at three different suction pressures.

Open flash economiser vessel

This vessel acts as a condenser for the -45˚C part of the system, thereby keeping the pressure lift required of the compressors to a minimum by taking flash gas directly back to intermediate ports in the compressors. It also allows a substantial part of the cooling to be carried out at a much higher temperature (-8˚C), which effectively creates a fourth suction pressure.

VSD compressors

The design includes Variable Speed Drive (VSD) screw compressors on both the -25˚C and -17˚C suction headers. Using VSDs to achieve each of the temperature levels means that the fixed (direct drive) compressors can run at 100% load continuously and VSD compressors can come in to modulate with cooling demand as necessary. This ensures that the system is always operating at maximum COP.

Evaporative condensers

These have been incorporated to reduce the energy used in the compressors. They allow the condensing temperature to be reduced – typically by up to 5˚C compared with water-cooled condensers using cooling tower water – which will reduce compressor power consumption by 15%.

Coolant distribution

VSDs are used to control the speed of the pumps and thus vary the flow in the coolant streams to match the cooling demand.

Monitoring and recording

The design incorporates continuous COP monitoring, using flow meters and thermometers in the coolant stream and electricity meters on each Motor Control Cabinet (MCC). This monitoring provides one of the most important key performance indicators for energy efficiency in this system.

SAVINGS AND BENEFITS

The current COP of the plant is measured at approximately 1.6. The COP of the new plant is calculated at 2.9. This increase in efficiency gives substantial returns on energy – 925 MWh. This energy saving equates to 575 tonnes of CO_2 annually.

NOT A 'COSTLY OBLIGATION' BUT OPPORTUNITY TO SAVE

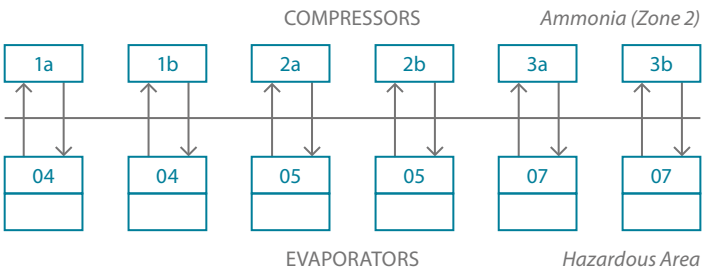
Roche has designed an energy-efficient refrigeration system using an EED project approach. This design uses best available technology for each process in the system. If implemented, this will substantially increase the energy efficiency of its cooling systems.

Several elements of this project are easily replicated, which is significant as many plants are now obliged to switch to non-ozone-depleting refrigerants to conform to the Montreal Protocol. Rather than being perceived as an expensive obligation, this can actually be seen as an opportunity to implement a similar EED – and to cut energy costs as well as CO_2 emissions.

"We rigorously scrutinised the design of the proposed new refrigeration system. As a result, Roche will reduce its carbon footprint and the site will have a robust and reliable refrigeration plant."

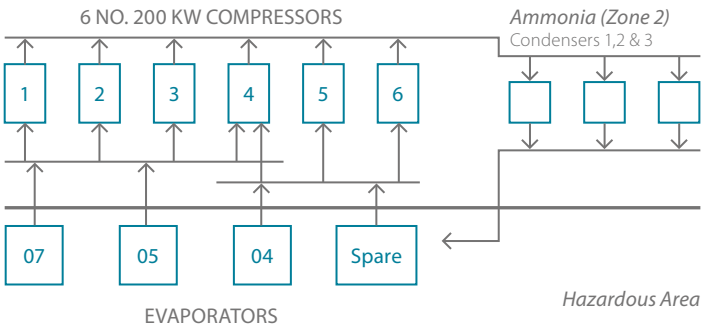
Matthew McDonagh,
Head of Facilities,
Roche

BLACK BOX – CONVENTIONAL OPTION



SCHEMATIC OF INTEGRATED SYSTEM

This shows different suction headers for different temperatures, Common Compressors for efficiency, and common condensers.



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