

# CRF leads the way with natural refrigerants

A multi-million dollar cold storage project in Victoria's western districts is one of the first of its kind to utilise a 'cascade' carbon dioxide and ammonia system with enormous capacity, as Sean McGowan discovers.

Lamb processing company CRF (Colac Otway) processes an average 6000 head of lamb daily. Its plant services Coles supermarkets, providing full carcasses and cuts of lamb to their distribution centres throughout Australia, as well as servicing export customers.

After developing a state-of-the-art processing plant which opened in 2000, the company was still forced to send any meat they needed frozen some 150 kilometres to Melbourne, and as a result the company's management explored the feasibility of building a cold storage facility on the adjacent site of sister company Otway Fresh, to reduce costs and increase the plant's efficiency.

From the outset, CRF were keen to explore the use of natural refrigerants in the project. After a detailed tender process and study was undertaken, a 'cascade' carbon dioxide/ammonia system became the preferred option.

## Carbon dioxide is used in staffed areas while ammonia is isolated in the plant room.

The project would also be the first of its kind in Australia to apply natural refrigerants to an automatic air blast-freezing tunnel, commonly known as an AABF.

The resulting AABF installed at Otway Fresh is capable of freezing 1610 bulk packed export meat cartons within 24 hours. The design allows for future expansion should the need arise, which would double the capacity of the unit.

The design makes provision for a three-fold increase in the cold storage capacity and future carton chilling facility, which they say could be in the form of an automatic storage and retrieval system.

Steve Baum, consultant with meat processing specialists Meateng on the job, says the AABF was selected due to the varying sizes and depths of cartons used on site. As carton sizes range from 15kg to 25kg, Baum says the alternative option of plate freezing, which requires similar size cartons, could not be considered.

### Using natural refrigerants

Baum says carbon dioxide was chosen because it is a non-toxic, non-flammable gas that offers good thermal properties and has minimal global warming potential. It also offers the advantage of not affecting processed meat in the event of a refrigerant leak.

The use of carbon dioxide in conjunction with ammonia instead of an ammonia-only installation was also deemed to be a better option in terms of occupational health and safety.

While ammonia has a global warming potential (GWP) of 0, and offers high efficiency in refrigeration, it remains toxic, with large ammonia leaks in recent times proving extremely hazardous to workers and local residents. As such, the tender for the project dictated that no direct ammonia would be used in the project's occupied areas.

## Using carbon dioxide also offered CRF increased productivity.

In the cascade configuration used for this project, carbon dioxide is used in staffed areas while the section of refrigeration plant using ammonia is isolated in the plant room and can be more easily contained in the event of a leak.

Carbon dioxide does, however, carry the risk of displacing oxygen in a room (as would a fluorocarbon refrigerant), so a large enough leak in a confined space could potentially cause suffocation, and as the gas is odourless, leak detectors were installed in all areas to ensure early detection in the event of a leak.

Finally, the design team noted that carbon dioxide systems operate under a positive pressure at all times, removing the risk of air and other contaminants from being drawn into the system, which can accumulate inside ammonia-only systems increasing condensing pressure and running costs if left unattended.

### Productivity and evaluating costs

Using carbon dioxide also offered CRF increased productivity.

While AABFs in these applications traditionally operate on a 48 hour turn-around, the design team found that using carbon dioxide in a cascade system with ammonia allowed the turn-around time to be halved, with operating cost analysis indicating that this outcome could be achieved more economically and efficiently than using ammonia alone.

A detailed study was undertaken to compare the capital cost of an AABF carbon dioxide system on a 24 hour turn-around with that of a 48 hour turn-around in a conventional tunnel and ammonia refrigeration system.

The study concluded that 24 hour freezing using a carbon dioxide/ammonia cascade system consumed less energy in

this case than 24 hour freezing using a two-stage ammonia plant, but more energy than a 48 hour freezing cycle using a two stage ammonia plant.

Realcold's Brian Edwards concluded that using carbon dioxide would allow for a cost saving on pipework, as it requires smaller pipes than an ammonia-only system, and because copper could be used to make carbon dioxide pipes for -50°C systems.

Furthermore, he added that the savings in capital costs between 24 hour and 48 hour carton freezing tunnels exceeded the increased cost of the carbon dioxide/ammonia cascade refrigeration plant room when compared with the cost of a conventional ammonia plant room.

After evaluating the relevant costs, 24 hour freezing with cascade carbon dioxide/ammonia was shown to be a lower capital cost solution than both 24 hour and 48 hour freezing with ammonia only.

### Overcoming challenges

The use of carbon dioxide also created a range of challenges to the design team, such as the need to source suitable materials for the system, as the majority of commercially available materials were not suited to applications of below -40°C.

The combination also had an impact on the choice of cascade condenser - a component vital to the function of the carbon dioxide/ammonia design - which was significantly more expensive than an equivalent ammonia-only model.

As carbon dioxide systems also operate at a higher pressure than ammonia systems, the vessels containing carbon dioxide were required to be purpose designed, again proving more expensive than vessels required for an ammonia system of the same capacity.

### Saving costs and emissions

The system at Otway Fresh has been designed to provide versatility which will allow for further cost savings in some circumstances.

For instance the AABF as installed can be set to operate on a 48 hour cycle rather than a 24 hour cycle, which uses less energy and means the system operator has the ability to extend freeze times in periods of low production, thereby reducing operating costs.

The 24 hour freezing cycle offered by the carbon dioxide/ammonia cascade system has also allowed stock holding and inventory levels to be reduced, and while it is still early days, the team believes the plant is operating as designed.

Not only has the project prompted several enquiries from other meat works, but Victorian State Environment Minister John Thwaites lauded the project an environmental success, with the choice of carbon dioxide helping to cut greenhouse pollution by as much as 900 tonnes per year.

He said this saving is the equivalent of removing 210 cars from Colac's roads, or the energy used to power almost 40 homes in the town for a year. ■

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