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Ecolibrium

All natural
A new style for supermarkets?





100 per cent natural flavour

While we often point to the evolution of the commercial building sector as proof of HVAC&R's commitment to sustainability, the supermarket sector has every right to beat its chest too. **Sean McGowan** reports on the adoption of a new refrigeration system that uses only natural refrigerants.

Since the launch of its first "green" supermarket in Gisborne in 2005, Coles has remained at the forefront of developments in supermarket refrigeration.

While Gisborne represented the retailer's first foray into natural refrigerants, trials of CO₂ cascade refrigeration systems followed at a number of stores in



The Australian supermarket sector is going through a natural evolution.

New South Wales, including Westmead, Katoomba, Greenacres and Rouse Hills.

But it was the development of Coles Hallam in 2015 that consolidated this work.

Hallam was the company's first store to feature a combined, CO₂ cascade cooling plant, replacing the traditional approach of separate refrigeration and air conditioning plants – leading to a 20 per cent reduction in energy consumption and the store becoming the first Green Star-rated supermarket in Australia.

Now two years on, the brand-new Coles Coburg North supermarket in Melbourne's inner north has raised the bar, with a combined cooling plant (CCP) utilising carbon dioxide (CO₂) as the only working fluid.

Synthetic refrigerants – the standard option – have not been used for sub-critical cascade systems.



Coles Coburg North was a finalist in the 2016 AIRAH Excellence in Sustainability Award.

“The supermarket ... is the company's first partly solar-powered store, boasting the ability to generate 100kW of solar power”

The supermarket employs the use of other natural refrigerants such as hydrocarbons R1270 and R290 in refrigeration cases, and is the company's first partly solar-powered store, boasting the ability to generate 100kW of solar power.

The site, on the corner of Gaffney and Sussex Streets, was developed by the Coles Property Group. As well as the Coles supermarket, the development features 15 specialty stores and has been designed to meet a 4 star Green Star rating in keeping with local council requirements.

IN DEVELOPMENT

City Holdings provides facility management for Coles supermarkets, taking an “end to end, cradle-to-grave” approach to its support, from design through to project management, commissioning and the ongoing service and maintenance of the company's fleet of stores and assets.

So, when Coles first scoped the potential of the Coles Coburg North development, it charged City Holdings with the task of looking for alternatives to synthetic refrigerants in its next step to the future-proofing of its stores.

“The design concept was adopted from a project that Bitzer Australia had started working on in a conceptual way, which the City engineering team adapted and customised in partnership with Bitzer to suit the project requirements,” says Brian Toulson, M.AIRAH, senior refrigeration engineer with City Holdings.

The design concept for Coles Coburg North is much more complex than a standard cascade system. The challenge of commercialising it therefore required City Holdings to dedicate effort and time into developing its staff's skills to a required level.

Toulson says there is a wealth of CO₂ system design experience within City Holdings engineering team. However, it had little experience in using CO₂ in transcritical processes before the Coles Coburg North project.

“With such a change in technology and the lack of active projects of this type [at the time] in Australia to compare against, collaboration was of the utmost importance to the success of the project delivery,” he says.

“We drew on the local industry, with their international ties and local representation, to help develop the systems and the skill set required to develop the required specifics.”

TRANSCRITICAL

The critical control point (CCP) system implemented at Coles Coburg North is a three-stage transcritical CO₂ system using CO₂ (R744) as the only working fluid.

EYES ON THE BUILDING

Throughout the design of the CO₂ transcritical system at Coles Coburg North, it was important that the design team also kept tabs on the design and construction of the building occurring at the same time.

Of most importance was ensuring the new refrigeration system could integrate into the existing design building metrics without major alterations taking place.

Brian Toulson, M.AIRAH, says consideration to basic elements such as larger plant dimensions and heavier equipment weights meant that point loading on the plantroom floor required an increase in plant footprint to spread the floor loading on the concrete slab.

All interfacing services, such as power supply, mechanical services, water supply and others also needed to be considered at the design phase in order to ensure they could accommodate the new system.

This differs to other systems used across the Coles store fleet, where CO₂ is cascaded with another synthetic refrigerant such as R134a – or in the case of Hallam, where HFO-1234ze was trialled.

Toulson says the omission of synthetic refrigerants from the plant represents a major point of difference for the supermarket chain. It allows Coles to move one step closer to the removal of synthetic refrigerants across its entire store fleet.

The Coburg North site features a variable-flow chilled-water system for the constant-air-volume (CAV) cooling systems serving the supermarket and liquor store, as well as office and amenities areas. This is also used in the dehumidification of fresh make-up air, in concert with a desiccant wheel.

To cool the water, the system features two, almost identical integrated refrigeration systems, with a 125kW_r chiller on each. This cools the water from 12°C to 7°C via a flooded brazed plate heat exchanger evaporator connected to the high-stage +5°C fluid temperature vessel.

“The chilled water/CO₂ heat exchanger operates as a thermosiphon without the use of any CO₂ fluid pumps or mechanical aid,” says Toulson. “We control the water circulating pumps to match load requirements, and can shut down refrigerant flow in emergency situations to reduce the risk of freezing the water.”



Glass-door freezer display cases operating on CO₂.

As well as meeting the 250kW_r of air conditioning demand, the central plant serves heat loads of 40kW_r of low temperature and 320kW_r of medium temperature.

The 40kW_r low-temperature -35°C stage of the plant serves wide-island and glass-door freezer display cases operating on CO₂ for frozen food display, as well as the low-temperature cold rooms for food storage.

The 320kW_r medium-temperature -7°C stage of the plant serves dairy, meat, produce and delicatessen cases that have been specially designed to operate on CO₂. It also serves the department cool rooms.

Hydrocarbon R1270 has been used in conjunction with the condenser water-loop system in the adjoining liquor store. These refrigeration cases were developed in the UK to City Holdings' specifications.

"We also used R290 in display cases throughout the store," Toulson says, "such as at point-of-sale and in specialty display cases such as the bakery and fresh produce, which were developed in Italy."

TRADE EXPERIENCE

To counter the lack of trade experience in the installation and operation of the CO₂ transcritical system, City Holdings partnered with Melbourne Refrigeration Services. The two firms have a long-

standing working relationship over many projects.

With no readily available training course available at TAFE or other institutions, it opted to conduct its own in-house training for the CO₂ system installation and operating specifics. Included in the training were its own service technicians as well as those from Melbourne Refrigeration Services and electrical contractor ASI Electrics.

It also partnered with the major equipment manufacturers involved in the project, who conducted training sessions with the group. The remainder of the CO₂ training was done live on site during the installation, and at the time the system was commissioned.

Hydrocarbon training was conducted in partnership with Box Hill TAFE, with technicians and the City Holdings engineering group completing recognised theory and practical courses on the subject.

SYSTEM PERFORMANCE

Once the system was initially stabilised and operating after an initial commissioning period, City Holdings spent time experimenting with several of the functions built into the systems to both evaluate and improve overall system performance.

Toulson says there is additional functionality built into the plant to allow City Holdings the ability to retrieve data for future designs under different operating conditions.

"The thing with transcritical systems is that in order to operate the plant in a stable manner, the system must be tuned correctly," he says. "This requires the initial set-up to be correct and with a high degree of control accuracy.

"So you spend the time in the design and pre-works, setting your controls accurately and verifying that all components are operating correctly and as designed. Then when you start the system and let it run, you only have to deal with minor changes for tuning."

Now around two years into its operation, the first successful large-scale CO₂ transcritical refrigeration plant in a live, Australian retail outlet is delivering on its energy-efficiency promise.

“The Coles Coburg North project has achieved an energy profile showing a 17 per cent reduction over the recently enhanced modern base-fleet comparison stores,” says Toulson. “It has achieved energy-consumption figures to better any store in the fleet, with the added benefit of negating the use of synthetic refrigerants.”

This energy trend is nearly identical to that of the award-winning Coles Hallam store, even though there is around 25 per cent more refrigeration at Coles Coburg North.

“Even though Coles have added 25 per cent more load to the system,” Toulson says, “we are seeing very similar energy use (to Hallam), which is a big bonus for Coles and a saving in kW/kW comparison terms.”

WHAT WAS LEARNT

City Holdings senior refrigeration engineer Brian Toulson, M.AIRAH, shares some key lessons from the new Coles Coburg North project.

- Communicate well with your customer, and set realistic expectations relating to performance, your ability to deliver in a timely manner and the likely associated costs. Keep them regularly updated as to how the project is progressing.
- Plan ahead of time. New system implementation takes a lot of dedication and time spent, which costs a lot of money; however, failing to consider major influences can cost more money to rectify later.
- Build a dedicated and capable team around you and keep the team motivated in the same direction. A change of scale requires dedication from all involved.
- Project management with attention to detail. This helps reduce exposure to potential safety risks and elevated project costs. Your project manager should spend the time on site, must have a good rapport with the teams involved, have a high level of understanding of the technicalities involved and the expected outcome.
- Ensure you use trusted and verified componentry on your systems. Cheap knock-offs or nearly the same parts that “sort of look the same” won’t cut it. All natural systems are either high-pressure or have a high flammability aspect to them. So, ensuring that your components are built to the correct standard, are of high quality and are installed correctly helps keep the fluid in the pipes and substantially reduces the risk.

KEEP ON LEARNING WHILE YOU'RE EARNING

City Holdings senior refrigeration engineer Brian Toulson, M.AIRAH, may be an industry veteran, but that hasn't stopped him from continuing his professional development.

Indeed, Toulson is completing AIRAH's Professional Diploma in Building Services – HVAC&R. The course comprises 100 hours of online tutelage split across four units: Fundamentals: Equipment and Components; Systems; and Practice and Performance.

We spoke to Toulson a while back after he completed the two-day face-to-face orientation for the course held at TAFE NSW – Ultimo campus.

Toulson was impressed with the two-day orientation, saying it was

well organised, ran smoothly, was informative, and provided the course with great direction.

"The highlight for me was the access to the TAFE," Toulson says, "and having the different types of equipment explained by industry experts."

Toulson's main aim in doing the AIRAH-accredited PDBS–HVAC&R is to gain a deeper understanding of the air-side specifics of the industry.

"I have spent the majority of my time on refrigeration systems," he says, "and want to round out my knowledge to the air side."

For more information about the program, go to www.airah.org.au/PDBS

the Montreal Protocol, there will be a growing need to develop commercially viable solutions utilising natural refrigerants.

"With the challenges created by the diversity of climate and geography in Australia, and in the building designs that supermarkets operate in," he says, "there is a need for a variety of solutions."

"I expect the future lies within iterations of one or all of the systems used at Coburg North. So it really is exciting, and the Coles/City partnership has put them in a great position to future-proof their fleet in the near future." ■

PROJECT AT A GLANCE

The personnel

- **Client:** Coles Supermarkets
- **Electrical plant contractor:** ASI Electrics
- **Mechanical services design:** A. T. Gormanns & Associates
- **Mechanical services general contractor:** Boyle and Grigg Airconditioning
- **Mechanical services plant contractor:** City Holdings with Melbourne Refrigeration Services
- **Mechanical services plant design:** City Holdings with Bitzer Australia

HVAC equipment

- **Air-handling units:** GJ Walker/DST
- **Chillers:** Bitzer Australia
- **Compressors:** Bitzer Australia
- **Controllers:** Danfoss
- **Heat exchangers:** Alfa Laval
- **Freezer display cases (CO₂):** Hussman
- **Leak detection:** Danfoss
- **Refrigeration cases (CO₂):** Arneg and Hussman
- **Refrigeration cases (hydrocarbon R1270):** Carter Retail Equipment
- **Refrigeration cases (hydrocarbon R290):** Arneg
- **Valves (high-pressure):** Danfoss

(Source: City Holdings)



NATURAL PROGRESSION

The exclusive use of natural refrigerants in a mainstream supermarket represents a major step forward in commercialising such refrigeration systems, and a maturing of the Australian refrigeration and air conditioning industry.

"The successful, full-scale use of high-pressure CO₂, flammable hydrocarbon

refrigerants and the deployment of a condenser water-loop system at Coles Coburg North has proved to us that such systems are suitable for our climate and can perform to the highest standards and customer expectations," says Toulson.

He says as the Australian refrigeration industry moves away from HFCs towards natural refrigerants through legislation such as last year's Kigali amendment to