SPRING 2018

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READY MADE, NATURALLY COOL

Kishore Matta, Managing Director, Jewel Fine Foods

p. 20

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Andrew Williams
Editor

BREAKING NEW GROUND

— Editor's Note by Andrew Williams

Competition between different natural refrigerant-based HVAC&R solutions is becoming fiercer than ever – not just in commercial applications, but in industrial systems too. CO_2 transcritical and low-charge ammonia options are shaking up an industrial market for natural refrigerants in which traditional ammonia systems have long held sway – hence this issue's focus on industrial refrigeration.

Growing competition between CO_2, ammonia and hydrocarbons was very much apparent at Chillventa 2018 in Nuremberg, Germany, with visitors to the world-leading HVAC&R tradeshow discovering how natural refrigerants have become mainstream options as HFCs are phased down (p. 44).

This issue's Technology Focus, meanwhile, takes a closer look at the increasing competition between ammonia and CO_2 in industrial applications in Australia. The low-charge trend is attracting new customers to ammonia, while new technology is helping to bring CO_2 to higher capacities (p. 60).

Closer to home, Jewel Fine Foods is striving to provide Australia with the freshest and highest quality ready meals. This commitment to excellence extends to production, where the food manufacturer is turning to ammonia to improve sustainability (p. 20).

Emergent Cold, one of the country's biggest cold storage providers, is considering riding the low-charge ammonia wave as a means of improving efficiency in industrial refrigeration systems (p. 16).

Faced with the need to reduce operating costs amid rising energy prices in Australia, Drakes Supermarkets is turning to natural refrigerants for its new Adelaide distribution centre (p. 28).

Indeed, as gas prices in Australia continue to rise, so too is interest in CO_2 heat pumps – with local suppliers ready to meet the demand. Automatic Heating has installed a CO_2 heat pump that is delivering energy savings at a residential complex in Melbourne (p. 56).

Beyond these shores, this issue's price theme continues with a look at soaring prices of HFCs under the European Union's F-Gas Regulation. Perhaps Australia can expect to experience similar price changes in future resulting from its own legislation (p. 14).

This issue also looks at two foreign retailers that have embarked on natural refrigerant journeys. Germany-headquartered food wholesale specialist METRO AG opened its first two CO_2 transcritical-based stores in Russia this year (p. 42), while Casa Ley has become one of the first food retailers in Mexico to install a CO_2 transcritical system, in a supermarket in Culiacán (p. 38).

In the Swedish city of Malmö, E.ON is harnessing waste heat from sewage treatment and waste incineration plants for district heating – thanks to ammonia heat pumps (p. 30).

International cooperation between Germany's GIZ, the Indonesian government and local manufacturers, meanwhile, is helping Indonesia to adopt propane chillers (p. 32).

Reporting from our ATMOsphere Asia conference reveals that interest in natural refrigerant technology and its potential to increase energy efficiency while reducing greenhouse gas emissions is rapidly growing throughout Southeast Asia (p. 48). And the Gustav Lorentzen conference in Valencia in June showcased the latest research into natural refrigerants from leading experts around the world (p. 52).

Enjoy the issue!

In this issue

ACCELERATE
ADVANCING HVAC&R NATURALLY
AUSTRALIA & NZ

About
Accelerate Australia & New Zealand

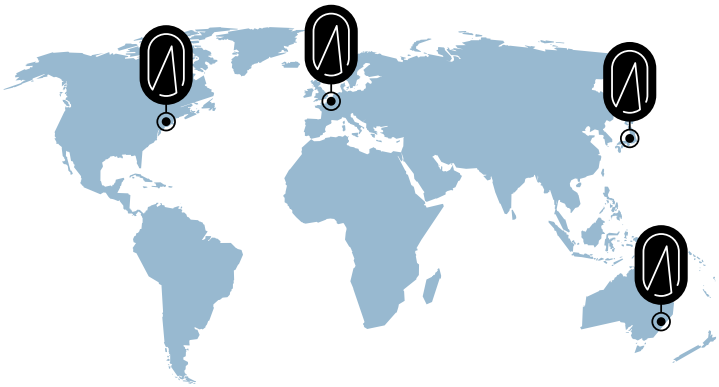
Brought to you by shecco, the worldwide experts in natural refrigerant news, *Accelerate Australia & NZ* is the first quarterly news magazine written for and about the most progressive business leaders working with natural refrigerant solutions in all HVAC&R sectors.

The *Accelerate* family of magazines includes editions in Europe, America, Japan, China, Asia, and Australia & New Zealand.

Printed copies are available to pick up at leading HVAC&R tradeshows and are posted to key end users and industry professionals.

www.accelerateAUNZ.com

Accelerate publisher shecco's network spans the globe with offices in Brussels, Tokyo, New York and Sydney.



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NOV–

13-15.11

CIAAR 2018
Shanghai, China

The Shanghai International Automotive Air-Conditioning and Refrigeration Technology Exhibition 2018 focuses on product innovation and industrial upgrading in China's mobile refrigeration and air-conditioning industry.

www.autocoolexpo.com/en

15.11

AIRAH Awards
Melbourne, Australia

Built on a history of recognising excellence and achievement, the AIRAH Awards will return in 2018 to honour those who have made significant contributions to the HVAC&R industry. The Awards presentation dinner hails high achievers, stand-out projects and ground-breaking research.

www.airah.org.au/awards

22-24.11

REFCOLD India
Gandhinagar, India

REFCOLD, an initiative of ISHRAE & NurembergMesse India, is India's first event on refrigeration and the cold chain.

www.refcoldindia.com/event

26-27.11

World Summit on Climate Change & Global Warming
Tokyo, Japan

The theme of the conference series is '*Climatic Change: Happening Here and Happening Now*'.

www.meetingsint.com/conferences/climatechange

28-30.11

Asia Cold Chain Show 2018 (ACCS 2018)
Bangkok, Thailand

The Asia Cold Chain Show (ACCS) is an exhibition and conference on the cold chain, cold logistics, cold transport, cold storage, material handling and cold supply chain sectors.

www.asiacoldchainshow.com

FEB

6-7.12

13th International Symposium on New Refrigerants & Environmental Technology
Kobe, Japan

JRAIA is hosting the International Symposium on New Refrigerants and Environmental Technology, the so-called Kobe Symposium, which has been held every two years since 1994. Symposium topics include the latest developments in HVAC&R equipment, and international and domestic legislation. Japanese-English translation is available in all sessions.

www.jraia.or.jp/english/symposium/index.html

13-15.12

India Cold Chain Show 2018
Mumbai, India

Running in its 7th edition, the India Cold Chain Show (ICCS 2018) is the leading exhibition and conference for the cold storage, cold logistics, temperature controlling, refrigeration, storage, distribution and cold supply chain sectors in India.

http://indiacoldchainshow.com

12.02.19

ATMOsphere Japan 2019
Tokyo, Japan

The natural refrigerants conference returns to Tokyo the day before the Supermarket Tradeshow, Japan's largest retail exhibition.

www.atmo.org/events.details.php?eventid=74

28.02-02.03.19

ACREX India 2019
Mumbai, India

ACREX India returns to Mumbai to celebrate its 20th edition. Participants from more than 25 countries will attend the buildings and HVAC exhibition.

www.acrex.in

AUSTRALIA & NZ IN BRIEF

HC charge limit increase to go to final IEC vote

In a move that could widen the use of hydrocarbons as natural refrigerants worldwide, a crucial subcommittee of the International Electrotechnical Commission (IEC) on 20 October approved advancing to the decisive next stage in a standards process that could increase the charge limit on A3 (flammable) refrigerants from 150g to 500g under the standard 60335-2-89.

IEC subcommittee SC61C analysed comments received from national committees during the CDV or Committee Draft for Vote stage into IEC standard 60335-2-89.

The subcommittee has now decided that the charge-limit draft should go to a final vote phase (FDIS) by the end of 2018, paving the way for the final document and standard to be prepared for the final vote. Assuming this vote is positive, the standard could be published in early 2019.

"Most of the CDV comments proposed by WG4 were accepted, except the maximum charge of A2L, which will remain 1.2 kg," said Marek Zgliczynski, who chairs the IEC SC61C subcommittee on adopting the proposed update. This means the IEC is likely to approve the propane charge limit increase from 150g to 500g.

"Now it will take 2-3 months [to move to the] final vote, where we will need the support of all," said Zgliczynski, manager of commercial refrigeration product engineering for Embraco.

The vote represents the latest milestone in a lengthy standards process that will determine whether the higher charge limit is ultimately enacted as an international standard. ■ MB

U.S. Supreme Court won't hear HFCs case

The U.S. Supreme Court on 9 October declined to hear the appeal of a 2017 Court of Appeals case that restricted the Environmental Protection Agency's ability to regulate HFCs under the Significant New Alternatives Policy (SNAP) program, according to multiple published reports.

The ruling coincided with the first day on the Supreme Court of newly confirmed justice Brett Kavanaugh, who, in his former role as a judge on the U.S. Court of Appeals for the District of Columbia, wrote the 2-1 decision in the HFCs case, *Mexichem Fluor v. EPA*. Kavanaugh did not participate in the Supreme Court's decision to decline to hear the case.

In addition to coinciding with Kavanaugh's installation on the Supreme Court, the high court's decision to decline to hear *Mexichem Fluor v. EPA* came in the wake of a new report from the Intergovernmental Panel on Climate Change (IPCC) highlighting the environmental hazards posed by greenhouse gases like HFCs.

"Coming only a day after the world's leading climate scientists called for urgent action to curb dangerous carbon pollution, the court's decision lets irresponsible companies continue harming our planet — even though safer alternatives exist," said David Doniger, an attorney and senior strategic director for NRDC, quoted by TheHill.com.

In reaction to the Appeals Court decision and the EPA's subsequent actions, four states – California, New York, Maryland and Connecticut – have committed to preserving the EPA's original HFC restrictions at the state level. ■ MG

ARC re-awarded licence scheme contract

The Australian Refrigeration Council (ARC) has been re-awarded the contract to administer the country's refrigeration and air-conditioning (RAC) licence scheme for up to nine years. The ARC has administered the scheme successfully – in partnership with industry and government – since its inception in 2005.

ARC Chairman Kevin O'Shea said the hard work of industry and the vital role that climate control plays in the modern world had paved the way for the licence scheme to continue.

"The RAC industry is vital to modern life. Without it, surgery can't be performed, and supermarkets and laboratories won't function properly. Our industry also leads the world in environmental stewardship, with access to cutting-edge technologies," said O'Shea.

"The higher skill levels within industry have directly delivered improved environmental outcomes, consumer protection and energy efficiency, through better quality services and work practices," he said.

The RAC licencing scheme is administered by the ARC on behalf of the Australian Government, under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995. ■ DY

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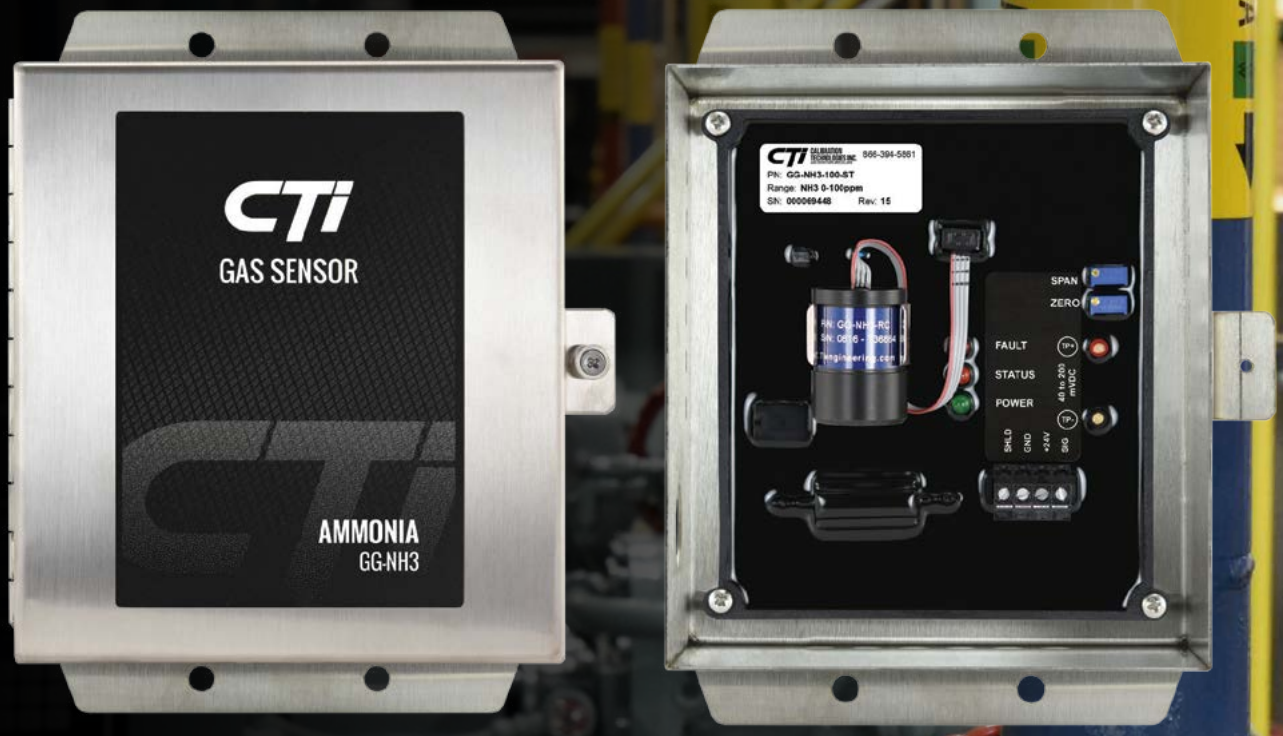

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AUSTRALIA & NZ IN BRIEF

Tasmanian distillery installs CO_2 heat pump

Located in Pontville, Tasmania, the 199-year-old Shene Estate and Distillery uses locally sourced ingredients and traditional methods to produce some of Australia's best gin and single malt whiskeys.

It installed installed Mitsubishi Heavy Industries' Q-ton, CO_2 air-to-water hot water heat pump in July 2017.

Conventionally, the water used in the distillation process is heated using an instantaneous electric hot water heater. However, in an era of increasing electricity prices, this was becoming expensive and unsustainable for the business.

Gas was also under consideration at first. But given that the estate is not currently connected to the gas grid, this option was ultimately ruled out. This led the business to look for alternative energy-efficient solutions capable of operating in the region's low outdoor winter temperatures.

Taking account of the distillery's daily water volume and temperature requirements as well as the colder temperatures experienced by the distillery in winter, Shene opted for the Q-ton.

The Q-ton achieves a COP (coefficient of performance) of 4.3 by delivering 30 kW of output power from only 7 kW input.

At the time of installation, the distillery anticipated saving 60% per year on energy bills compared to an instantaneous heater. ■ DY

Hillphoenix has 400+ transcritical sites in North America

Over 400 Hillphoenix transcritical CO_2 systems have now been installed in North America, the most of any supplier, said Scott Martin, director of business development and industry relations for the Conyers, Georgia-based OEM.

"When you walk into our factory, the [transcritical CO_2] units are everywhere. It's exciting!" said Martin during an interview at the Food Marketing Institute's Energy & Store Development Conference in Atlanta, Georgia, held on 23-26 September.

The total number of transcritical systems from all suppliers in North America is 615+, according to estimates from sheccoBase, the market development arm of *Accelerate Australia & NZ* publisher shecco.

ALDI US has been the leading user of Hillphoenix's transcritical units. As of June 2018, the chain had installed transcritical CO_2 systems – mostly from Hillphoenix – in 130 stores, according to Amber Hardy, director of energy management for ALDI US.

The ability of enhanced transcritical systems to operate efficiently in warm climates has helped spread sales throughout North America, including such hot locales as California, Florida, Alabama and South Texas, said Martin.

Most of the warmer-climate stores use adiabatic condensers, though Hillphoenix has begun testing other technologies; these include parallel compression in a Houston, Texas, store and three others; and an ejector in a Sprouts Farmers Market store in Woodstock, Georgia. Some of the stores with parallel compression also use adiabatic compressors, Martin added. ■ MG

Japan's environment ministry requests A$101m NatRef subsidy

Japan's Ministry of Environment (MOE) in September asked for ¥8.1 billion (A$101 million) in natural refrigerant subsidies for the 2019 financial year (FY). The budget request has been submitted to the Ministry of Finance for review.

The Japanese government is expected to confirm the actual budget amount in early 2019.

The FY 2019 natural refrigerant subsidy will continue to be available in the same industrial sectors: cold storage, food manufacturing and food retail.

For FY 2018, the MOE asked for ¥9.4 billion (A$118 million). The actual confirmed amount was ¥6.4 billion (A$80 million).

In July, Japan's Ministry of Environment (MOE) announced the first round of companies to be awarded subsidies for natural refrigerant system installations for FY 2018 in the cold storage, food processing and retail sectors.

A total of 98 companies with plans to install natural refrigerants in a combined total of 139 locations around Japan have been awarded subsidies.

Notable recipients in the commercial sector include some of Japan's largest convenience store chains, among others. Examples include retail and logistics giants Aeon, COOP, Family Mart, Lawson and Yamato Transport.

In the cold storage and food processing sectors, notable recipients include some of Japan's largest consumer food and drinks brands such as Asahi Breweries, Kewpie, Meiji, Morinaga Milk and Maruha Nichiro, as well as large cold storage service providers Yokohama Reito and Nichirei Logistics, among others. ■ DY

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HFC prices skyrocketing in Europe

Hydrofluorocarbon (HFC) prices rose from less than €2 per ton of CO_2 equivalent (/t CO_2eq) in 2014 to an average of €23/t CO_2eq at the beginning of 2018, according to a study carried out for the European Commission, the executive arm of the European Union.

— By Marie Battesti

The new EU F-Gas Regulation, finalised in 2014 and in force since 2015, aims to reduce the European Union's use of hydrofluorocarbons (HFCs) by 79% by 2030. It has already been having a pronounced impact on prices, according to a study by *Öko-Recherche* and CITEPA.

Öko-Recherche and CITEPA, Europe-based organisations dedicated to environmental research, are monitoring HFC prices on behalf of the European Commission to evaluate the effectiveness of the EU F-Gas Regulation and its quota system. 1 January 2018 heralded a 37% cut in the quota of HFCs available in the European Union.

Average purchase prices of R134a, R410A and R404A were under €2/t CO_2eq in 2014, but jumped to between €7/t CO_2eq and €23/t CO_2eq at the beginning of the first quarter of 2018, the study said.

In a webinar entitled '*Monitoring of refrigerant prices against the background of the F-Gas Regulation (EU)*', Barbara Gschrey of *Öko-Recherche* spoke of price increases for R134a, R410A and R404A throughout the supply chain (gas producers, OEMs and service companies).

For instance, service companies' selling price for R134a has increased by €23 per kilogram (/kg) since the new EU F-Gas Regulation was adopted, while their selling price of R410A has risen by €46/kg.

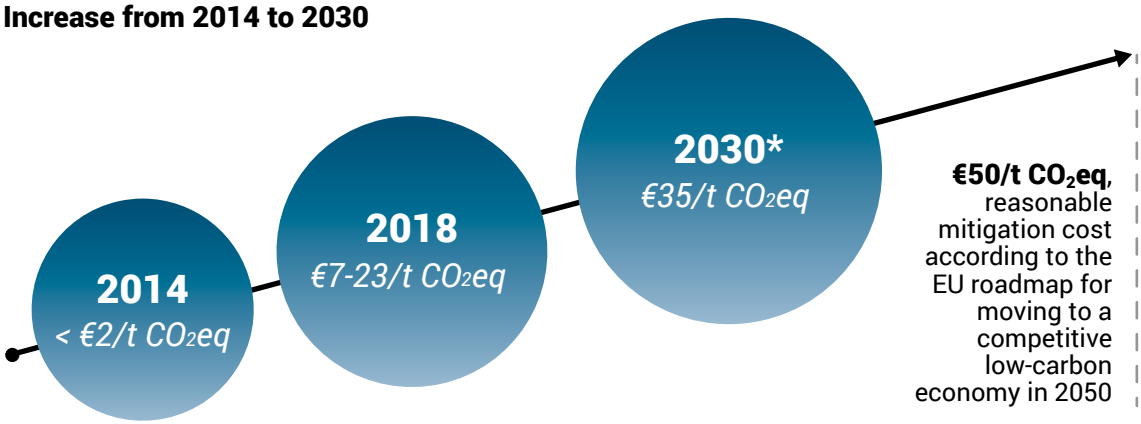
With Europe currently experiencing such dramatic increases in HFC prices, Australia can be expected to experience similar price changes in the near future as a result of its own legislation.

In Europe, soaring HFC prices are creating more opportunities for natural refrigerant-based technologies to serve as inexpensive, future-proof and environmentally friendly solutions for heating, ventilation, air-conditioning and refrigeration (HVAC&R).

In August, EU HVAC&R industry group AREA warned of growing illegal imports and black market trade in refrigerants in some European countries. Higher prices and imminent shortages of these refrigerants have been attracting the attention of criminals, who are increasingly stealing HFC cylinders. ■ MB

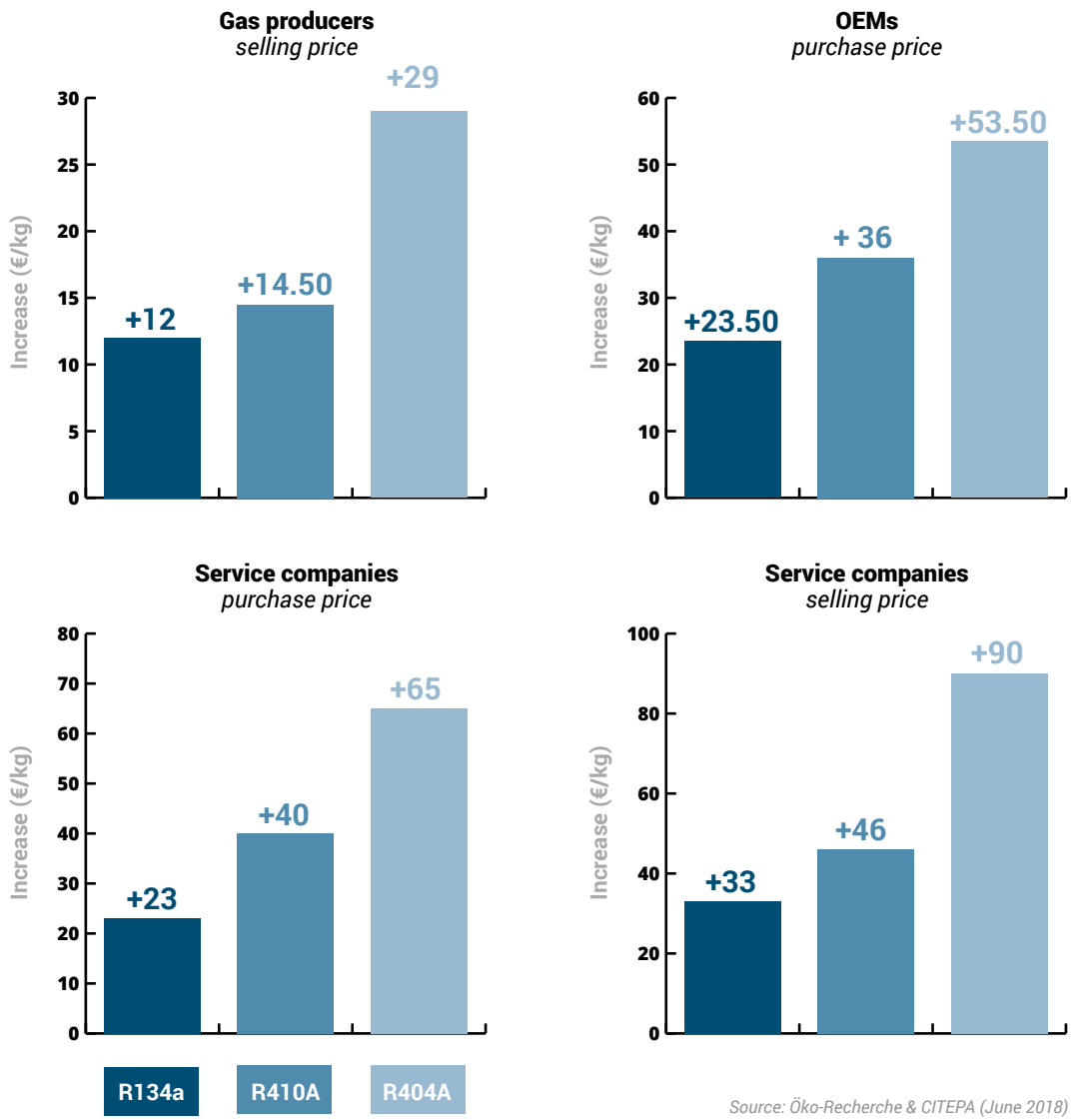
HFC PRICE DEVELOPMENT IN EUROPE

Increase from 2014 to 2030



*Study carried out for UBA in 2015 by Öko-Recherche (forecast)

Prices of commonly used HFCs across the supply chain in Europe (2014-Q1 2018)



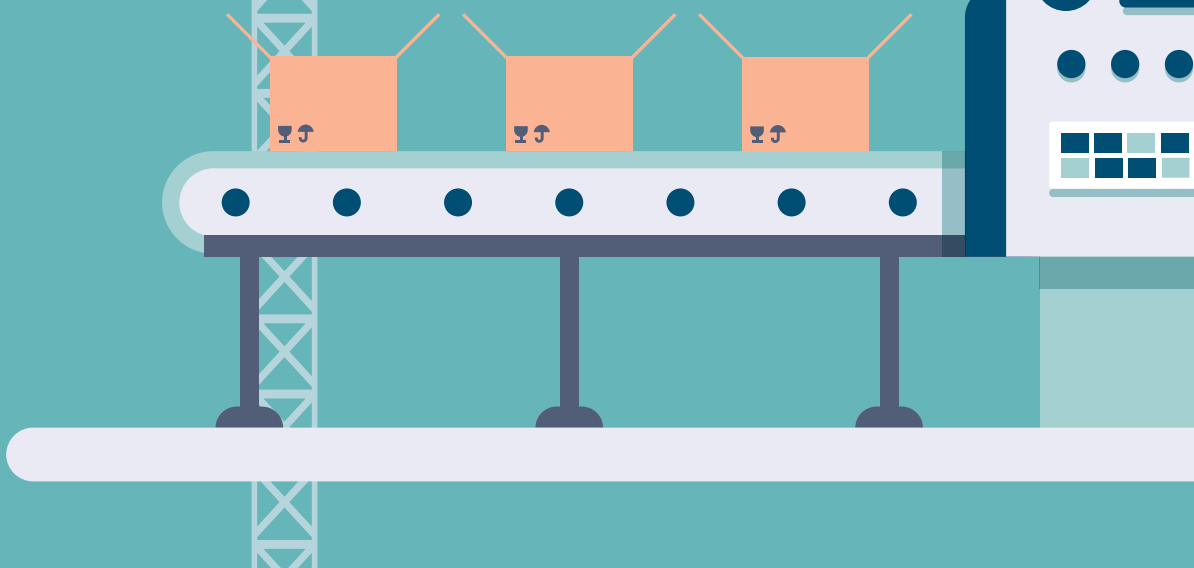
Source: Öko-Recherche & CITEPA (June 2018)

shecco Base

COLD STORAGE FIRM MULLS LOW-CHARGE NH_3 MOVE

Emergent Cold, one of the biggest cold storage providers in Australia, is considering riding the low-charge ammonia wave as a means of improving the efficiency and lowering the ammonia charge in industrial refrigeration systems.

– By Charlotte McLaughlin & Devin Yoshimoto



Swire Cold Storage Pty. Ltd. has a proud history in Australia – a fact that did not escape United States-headquartered Emergent Cold LLC, which acquired the company and absorbed it into its own operations on 22 December 2017.

Emergent Cold now possesses Swire's cold storage sites on the Australian mainland. The firm – one of the biggest cold storage operators in Australia – has 10 sites, located in Banjup, Western Australia (WA); Cannon Hill, Queensland (QLD); Dry Creek, South Australia; Laverton, Victoria (VIC); Lurnea, New South Wales; Lyndhurst, VIC; and Welshpool, WA, with three sites in Hemmant (QLD). It also has two locations in Vietnam; one in Song Than and one in Bac Ninh.

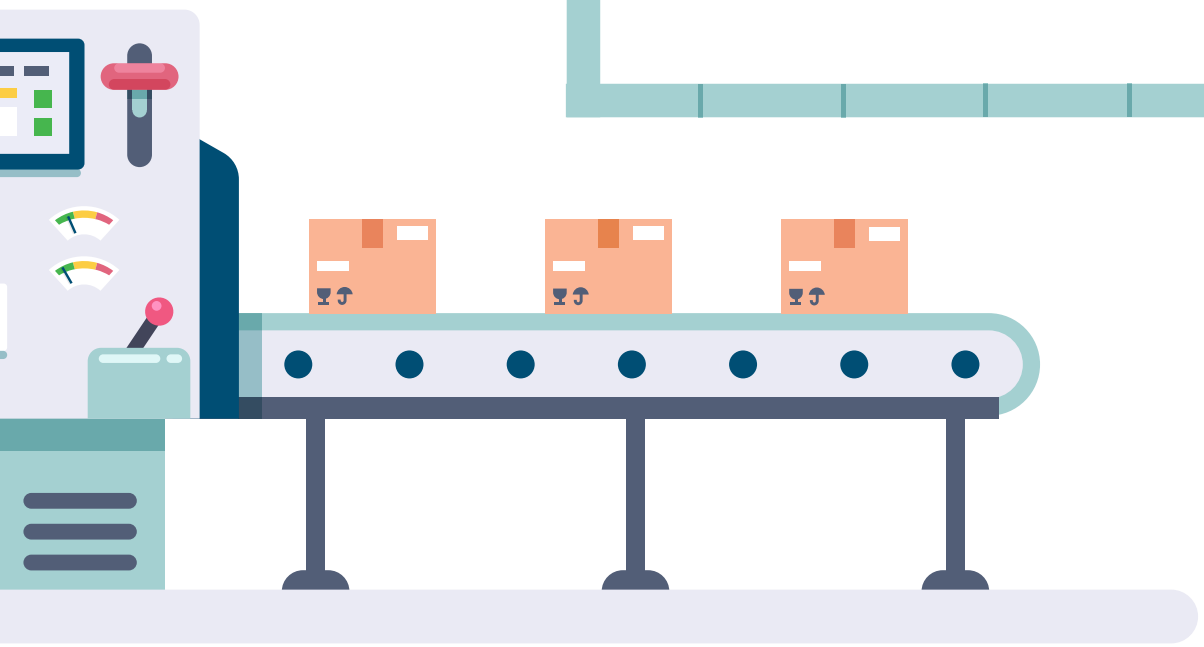
The 10 Australian sites run off traditional ammonia systems but Michael Nolan, general manager (facilities & engineering), Emergent Cold, is looking to harness the latest industrial refrigeration technologies in the future.

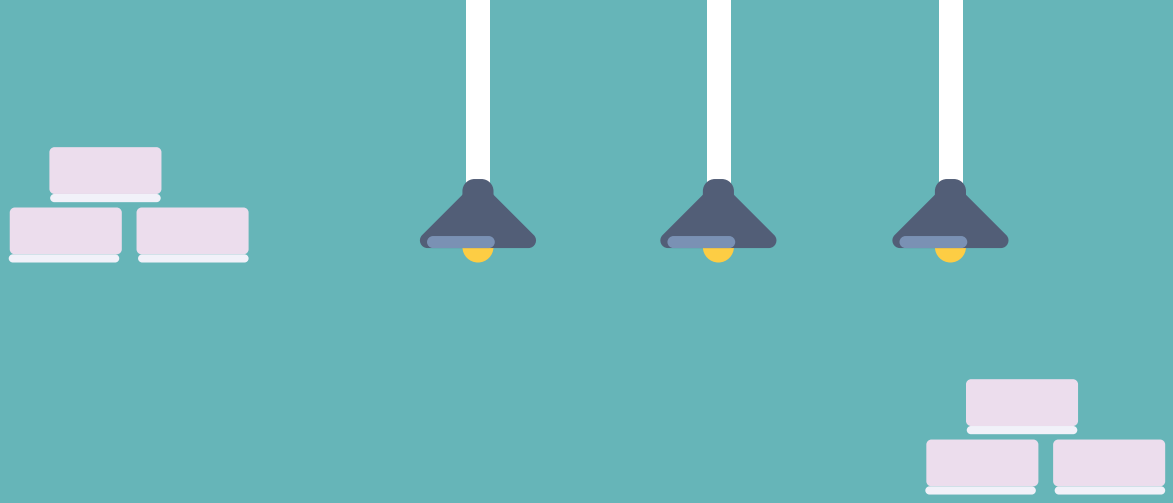
Nolan has been quite happy with ammonia so far, but believes there is more to come for the natural refrigerant. "I expect to see many of the cold stores we own run efficiently for 50 years, with the same ammonia plant," he said, adding: "Ammonia is also very well-suited to warm climates."

"Our longer-term focus is to understand where refrigeration technology is headed for us beyond liquid overfeed ammonia for 'new builds'," Nolan told *Accelerate Australia & NZ*. "We think it is central plant, low-charge ammonia, but we need to stay somewhat open to other natural refrigerant solutions."

The cold storage provider, which boasts 300,000+ pallets' (65m cu. ft.; 19.8 m^3) worth of cold storage space in Australia, retrofitted its last R22 (HCFC) system to ammonia in 2014.

"These [systems] range in storage capacity from 15,000 freezer pallets up to 55,000 freezer pallets," Nolan says. "Typically the ammonia systems have an electricity rating of 500 kW to 1,500 kW, and use a liquid overfeed ammonia design. In the future, we see our systems heading to a much lower ammonia charge."





SAVING A SMALL FORTUNE

The company is considering low-charge ammonia for future plants, while monitoring transcritical CO_2 developments in the USA, due to a strong focus on saving energy. "The main focus for Emergent Cold is energy efficiency," Nolan says. "We have seen electricity prices going up. Energy efficiency is very important to profitability and to reducing carbon emissions back upstream. This favours natural refrigerants."

For cold storage providers, reducing annual energy consumption often saves thousands of dollars. Large refrigeration plants can have annual energy bills to the tune of millions.

"The difference in cost between an average efficiency plant and a high efficiency plant can easily be 25 to 50%. The capital cost may only be 10 to 15% more," Nolan argues. "Refrigeration represents around 85% of our sites' electricity consumption, so getting that efficient is challenging but rewarding."

HUMBLE BEGINNINGS

Nolan's interest in environmental issues is linked to his passion for food."I always seem to have been around food!" he tells *Accelerate Australia & NZ*. "I grew up on an irrigation farm in northern Victoria – traditional wheat and sheep. Professionally, I have worked at various food manufacturers."

His experience with food led him to work at UK-headquartered multinational chocolate giant Cadbury's as a young engineer back in the 1990s. "Cadbury's had a lot of small (ozone-depleting) CFC plants to re-locate," from a Red Tulip site in Prahran in inner Melbourne to a large site in Ringwood, outer Melbourne.

In 1990, Nolan was the project manager for re-locating and expanding the refrigeration plants with his Cadbury's manager Peter Hosken. This is when he used ammonia for the first time. "I project-managed this, which was essentially a heat exchanger sitting on top of a big square tank full of ethylene glycol-water as a secondary refrigerant. The secondary refrigerant at -15°C was circulated around the factory for use as process cooling. This was cooled by an existing ammonia plant," Nolan says.

"10 years later, around year 2000, the last ammonia evaporator coil in the factory was replaced by an ethylene glycol-water coil. The project outcomes taught me the importance of strategic goals, collaboration, getting cap-ex investment aligned, and what all this can mean for achieving the desired end game," he adds.

Adopting natural refrigerants has become a crucial part of Emergent Cold's work. "This helps us stay competitive – using future-proof refrigerants allows us to concentrate on aspects such as a safe, efficient and reliable plant," Nolan says.

"We are seeing an expansion of natural refrigerant design solutions really being accelerated out of Europe and the USA. They are now becoming a mature solution and settling into the phase of refinement and coming down the cost curve," he argues.

Nolan is confident that Emergent Cold will continue down the natural refrigerant path in Australia. "We are committed to natural refrigerants for reasons mentioned already – running costs, reliability and the environment." ■ CM & DY

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READY MADE, NATURALLY COOL

Jewel Fine Foods strives to provide Australia with the freshest and highest quality ready meals. This commitment to excellence extends to production, where the food manufacturer is turning to ammonia to improve sustainability.

— By Devin Yoshimoto

Kishore Matta, Managing Director, Jewel Fine Foods

Photography by: Simon Anders.

> *As a natural and highly efficient refrigerant, ammonia is key to Jewel being environmentally sustainable.*
>
> – Kishore Matta, Managing Director, Jewel Fine Foods

For more than twenty years, Jewel Fine Foods has strived to offer Australians fresh ready meals of the highest standard. This passion for excellence also extends to sustainability, with the leading Australian chilled food manufacturer keen to show leadership on reducing greenhouse gas emissions.

"At the core of Jewel Fine Foods is the desire to feed people really good food," said Managing Director Kishore Matta upon receiving the national Telstra Australian Medium Business Award in 2016. The Telstra Business Awards recognise Australia's most remarkable small and medium-sized businesses.

"Jewel currently produces a range of meals, soups and salads in the Thai, Indian, Malaysian, Vietnamese, Chinese, Mexican and European cuisines, to name a few," Matta told *Accelerate Australia & NZ*.

Jewel Fine Foods' new 16,200 m^2 production facility in Banksmeadow, Sydney – where production capacity is expected to double – is demonstrating how using natural refrigerants helps growth and sustainability to go hand-in-hand.

Jewel's customers include all of Australia's largest supermarket chains – including Coles, Woolworths, IGA, Costco, Metcash and Aldi. The firm also has partnerships with large global organisations and airlines.

"Years ago, we made it a priority to simplify the work of chefs in large kitchens," Matta told *Accelerate Australia & NZ*.

"Today, we continue to simplify the lives of families – providing high quality, affordable, freshly prepared, convenient and ready-to-eat meals," Matta says. "All you have to do is add heat."

The heat addition process is an easy one for many people to imagine, reminding them of preparing food at home. It is the heat removal process – which takes place in food manufacturing facilities worldwide – that is harder to understand.

Yet it is here that Jewel Fine Foods deserves recognition for taking its place among industry leaders whose use of natural refrigerants is contributing to advancing energy-efficient and environmentally sustainable refrigeration technology around the world.

Matta epitomises such leadership. He founded Jewel Fine Foods (JFF) in 1997, and today serves as the firm's managing director. He is currently leading the business through a significant period of growth.

Jewel Fine Foods presently operates in Sydney, but its origins are in New Zealand, where Kishore and his wife Indrani opened a small restaurant called *Jewel of India* in 1991.

Factory floor at Jewel Fine Foods Banksmeadow, Sydney.

The restaurant's success led Kishore and Indrani to open up a one-room food production facility, where they began making samosas for customers to eat at home.

Naturally powered growth

Fast-forward to today and the company has grown to more than 250 employees, producing 30 million meals per year and boasting annual revenue of A$100 million.

Underscoring this growth is an ambitious target of increasing current production to 40 million meals by 2019.

To achieve this, in January 2017 the company opened a new 16,200 m^2 ready meal production facility in Banksmeadow, Sydney, where an ammonia-based refrigeration system serves all the site's cooling, freezing, and air conditioning needs.

The ammonia system plays a key role in achieving the company's operational growth and sustainability goals, which Matta sees as going hand-in-hand.

"As a natural and highly-efficient refrigerant, ammonia is key to Jewel being environmentally sustainable," he says.

The new site is capable of producing over 50 million ready meals per year.

The ammonia pumped recirculation system is fitted with propylene glycol and water chillers, as well as evaporative condensers. The total operating ammonia charge is 5,000 kg.

It was commissioned in two stages, firstly in January 2017 with the second stage beginning operations in July.

Efficiency through design

Prior to opening the new factory, JFF had already decided that its refrigeration system would operate on ammonia.

"Within the [project] tender, ammonia refrigeration was non-negotiable due to its high efficiency as well as it being natural," says Peter Sayer, head of engineering at Jewel Fine Foods.

Sayer says the decision to use ammonia stems directly from the company's philosophy of actively reducing its environmental impact wherever possible. (See box on facing page: *Natural refrigeration, aerobic digestion and recycling*).

"We are working towards this by utilising ammonia as our refrigerant together with other initiatives," Sayer explains.

JFF selected local industrial refrigeration contractor Tri Tech Refrigeration Australia (TTRA) to support the company during this major installation. TTRA's previous work with natural refrigerants, as well as with JFF itself, made itself the right fit.

"Jewel had a smaller ammonia system installed at our old site on Gardeners Road, Mascot by TTRA in 2012/13 and its capacity was upgraded in 2016," says Sayer.

"Due to this relationship TTRA was asked to quote on the system for the new factory."

As with most industrial applications of refrigeration systems, the biggest factor in achieving optimal energy efficiency comes down to good system design.

Temperature requirements and cooling applications for industrial vary much more widely than they do in commercial food retail applications, such as supermarkets and convenience stores.

JFF worked closely with TTRA not only to precisely identify the proposed new factory's refrigeration needs, but also to do so with a view towards possible future upgrades and expansion.

Sayer describes the key factors that influenced the system's design.

"The scope of the project was to convert the warehouse to a high care, chilled, ready meals facility – including processes that required the use of chilled water, spiral freezers and chilled areas," he explains.

TTRA's previous work with Jewel Fine Foods included the installation and commissioning of an ammonia chiller system at the company's old facility in nearby Mascot.

"The chiller was used to chill water to serve a rice cooker vacuum heat exchange system," says Ananth Arkal, senior project engineer for Tri Tech Refrigeration Australia.

"In early 2016, the water chilling system was converted to a glycol chilling system to serve tumble chillers for indirect cooling of pouched products," he adds.

At the new factory in Banksmeadow, ammonia serves as the primary refrigerant in a traditional centralised, pumped configuration that recirculates the refrigerant while secondary heat transfer fluids – propylene glycol and water – are also used for other cooling processes.

The factory's soup spiral freezer and impingement freezer are cooled directly by the pumped recirculating liquid ammonia.

The propylene glycol, chilled by the primary ammonia system, is used to cool the storage rooms as well as several types of 'critical process equipment'.

The company employs a 'Cook, Quench, Chill' machine (used to cook and cool rice, pasta and vegetables) and a tumble chiller, which is used to quickly chill batches of food wrapped in flexible plastic wrapping.

Chilled water is used for air conditioning in the facility's cooking area, as well as in the 'rice cooker vacuum heat exchange system'.

The ammonia system was commissioned in late January 2017 and was expanded in July that year, to add production capacity.

"Start-up and commissioning went very well," says Sayer. "Tri Tech Refrigeration Australia supported us all the way through, and continues to do so. The system is reliable and performs as per specification."

Going forward, Sayer says that the company is looking to gain even more energy efficiency by using heat reclaim to "pre-heat our sanitation water".

Natural refrigeration, aerobic digestion and recycling

The emphasis that Jewel Fine Foods places on using natural refrigerant ammonia goes hand-in-hand with other sustainability initiatives that the company has put in place to reduce its environmental footprint.

One of these, explains Jewel's head of engineering, Peter Sayer, is the facility's use of a so-called 'ORCA aerobic digester' for organic food waste. The system uses microorganisms to safely break down waste food into a liquid that is discharged through existing plumbing infrastructure.

The system "can divert up to 378 tons of food waste per year from landfill".

In addition, the company strives to minimise waste from plastic used for packaging.

Jewel's managing director, Kishore Matta, says the company uses 100% recyclable packaging for all its products.

"We try to use as much recycled sleeves and materials as possible to support reduction in landfill," he adds. "In addition, film scraps which are left over from sealing trays are sent for recycling."

Jewel Fine Foods' Indian ready meals.

Designing ammonia systems

Industrial refrigeration systems generally require a higher level of system design consideration, for example compared to systems used in commercial food retail.

This is especially true in factories and production facilities with widely varying requirements for cooling and freezing temperatures, which is the case at Jewel Fine Foods.

"It is well known that ammonia is the most energy-efficient refrigerant due to its thermal properties, when the system is appropriately designed and installed," says Ananth Arkal, the senior project engineer at Tri Tech Refrigeration Australia who led on the JFF project.

That's why TTRA went the extra mile to install additional features at the Banksmeadow facility that maximise the already excellent energy efficiency of ammonia as a refrigerant itself.

Variable speed drives (VSDs) are increasingly being used in industrial and commercial refrigeration systems. VSDs help control the output of each component in a more precise manner according to the degree to which it is needed, as opposed to switching completely on or off.

At the Banksmeadow facility, all of the main compressors, condenser fans, chilled water and glycol pumps, and under-ceiling air-cooling units were fitted with VSDs.

An automatic air purger was installed, "to ensure any non-condensable gases in the system are promptly removed, so as to have the system operating at its best possible efficiency by minimising head pressures to the furthest extent possible".

Future maintenance costs were kept to a minimum by installing a "thermosyphon oil cooling system, which has no ongoing maintenance requirement".

In the refrigeration system plant room, a ventilation and leak detection system was installed along with additional leak detectors in the roof space.

Arkal explains that, "crossover piping and valves were installed to ensure back-up in the event of compressor failure or maintenance".

The second-hand compressor packages and condenser were installed during the second stage, for equipment lead time reasons.

GEA Duo Pack compressor package for propylene glycol chilling duty.

System specifications

There are four ammonia temperature levels in the system:

APPLICATION 1:
Soup spiral freezer, impingement freezer.

Refrigerant: Direct ammonia pumped recirculation.

Compressor package:
1 x GEA 'L' compressor package. 1 x second-hand compressor package.

Refrigeration capacity: 640 kW

Ammonia temperature: -15°C

Operating air temperatures:
-10°C (soup spiral freezer),
-2°C (impingement freezer).

Plant room with ammonia pumped recirculation and water chiller compressor packages.

APPLICATION 2: Cold storage rooms, air conditioning, 'Cook-Quench-Chill' and tumble chiller equipment

Refrigerant: Propylene glycol cooled by a gravity-fed ammonia system.

Compressor package: 1 x GEA Duo Pack compressor package, including 2 x GEA 'S' compressors.

Refrigeration capacity: 1,900 kW

Ammonia temperature: -9°C

Operating air temperatures: Multiple between +2°C and +10°C (storage rooms), multiple between +3°C and +10°C (ventilated production/ processing rooms).

APPLICATION 3: Cooking area air conditioning, rice cooker vacuum heat exchange system

Refrigerant: Chilled water cooled by a gravity-fed ammonia system.

Compressor package: 1 x GEA 'M' compressor package.

Refrigeration capacity: 1,100 kW

Ammonia temperature: +6°C

Operating air temperatures: Multiple between +15°C and +20°C (ventilated production/ processing rooms).

APPLICATION 4: Lasagna spiral freezer/chiller (Stage 2)

Refrigerant: Direct ammonia pumped recirculation.

Compressor: Second-hand compressor

Pumps: GEA Witt liquid pumps

Refrigeration capacity: 200 kW

Ammonia temperature: -16°C or -42°C depending on operating mode (product chilling and freezing).

Operating air temperatures: -12°C or -35°C (depending on operating mode).

Evaporative condensers: 3 x new; 1 x second-hand.

Leak detection: Danfoss

Variable speed drives: Danfoss

Control systems: Allen Bradley PLC, Citect SCADA

(Left to right: Ananth Arkal, Senior Project Engineer, Tri Tech Refrigeration Australia; Peter Sayer, Head of Engineering, Jewel Fine Foods; Matt Atkinson, General Manager, Tri Tech Refrigeration Australia; David Herbert, Maintenance Manager, Jewel Fine Foods)

Sayer is confident that the company will look into further use of increasingly advanced ammonia-based refrigeration systems as it looks to grow its food production business in future.

Asked what advice he would offer similar businesses that are interested in adopting ammonia-based systems rather than their HFC-based counterparts, Sayer says, "the environmental and efficiency benefits of ammonia massively outweigh the risks".

"Ammonia systems are flexible for different operations, processes and temperatures versus set systems, so you can also future-proof your factory."

Ammonia: Jewel's key to sustainability

Refrigeration and freezing systems are one of the most energy-intensive yet critical processes in delivering our food supply. Refrigerant leakages, meanwhile, can have a devastating impact on the environment.

None of this escapes Matta, whose business acumen – and perhaps sense of social responsibility too – comes from his unique background.

Born and raised in Mumbai, India, at the age of 18, Matta decided to set out on his own journey and join India's Merchant Navy, where he eventually worked his way up to ship captain.

"After sailing the globe for 14 years, I decided to quit my job and settle in Australia," says Matta. "With no prior experience in the food manufacturing industry, I used my management experience from the Merchant Navy and love for food to create Jewel Fine Foods."

Matta's core beliefs forged during his navy days continue to guide the company today. They encompass not just his company's bottom line, but also the true impact that businesses like his have on society.

"As Australia is one of the largest per capita contributors to climate change, we need to urgently and substantially reduce greenhouse gas emissions and actively support international mitigation measures to reduce global emissions," he says.

Matta recognises that his work at Jewel Fine Foods – like that of Australian industry in general – has only just begun. "Australian companies are slowly introducing changes to support environmental sustainability for the future," he says.

"For example, the recent shift in supermarkets no longer providing disposable plastic bags is a small step in the right direction. But in terms of energy efficiency, many improvements could be made through low-cost behavioural changes," he argues.

Continual training and education is important. "Engineering and operational staff require the knowledge that is essential in order for them to implement these changes and integrate them into day-to-day operation," Matta says.

Awareness of the role played by natural refrigerants in delivering sustainable food production is increasing among industry, yet few customers realise that their food can be cooled naturally.

The continued success and leadership of businesses like Jewel Fine Foods, therefore, is vital in communicating this message.

"Our focus is to continue doing what we do best, by growing and extending our capabilities in food, to deliver outstanding, superior quality, convenience meals in a range of cuisines," Matta says. ■ DY

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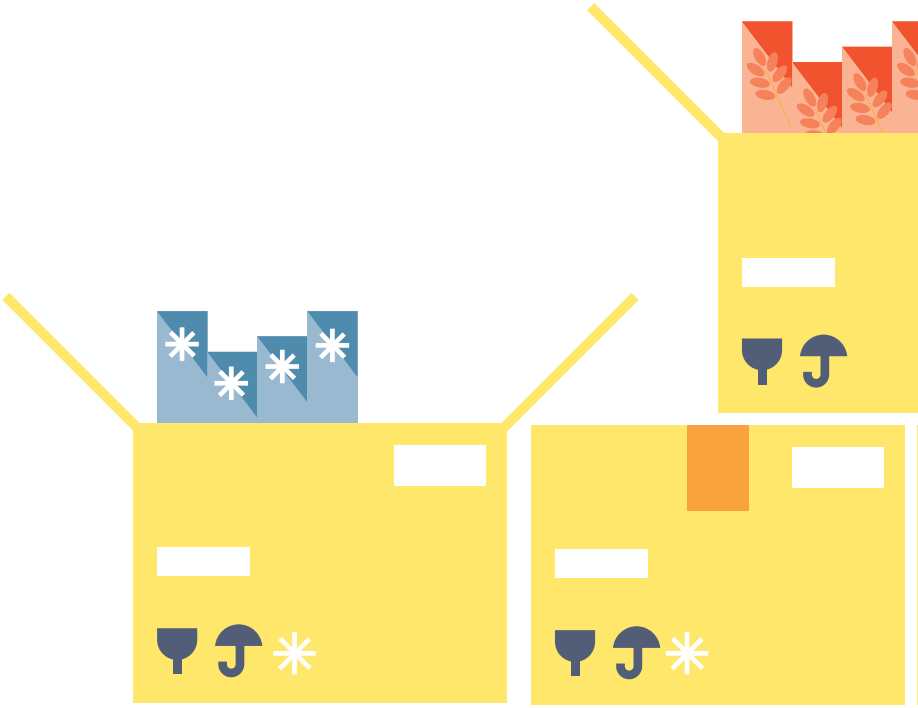
DRAKES OPTS FOR AMMONIA TO COOL NEW WAREHOUSE

Faced with the challenge of reducing operating costs in a climate of rising Australian energy prices, Drakes Supermarkets is turning to natural refrigerants to carry it into the future – not least in its new Adelaide distribution centre.

– By Andrew Williams



In June 2019, Drakes Supermarkets plans to open a new A$90m distribution centre in the northern suburbs of Adelaide. In keeping with the independent retailer's commitment to natural refrigerants, the facility's cooling system will be based on ammonia.

The 50,000 m² building will occupy a 17-hectare site in Edinburgh North, a northern Adelaide suburb that is part of the City of Playford local government area.

"Our Adelaide distribution centre is a major investment in the sustainable future of Drakes Supermarkets in South Australia," said Bob Soang, Drakes' general manager.

Drakes Supermarkets is one of the largest independent grocery retailers in Australia, with an annual turnover of over A$1 billion. It currently operates around 60 stores in the states of South Australia (SA) and Queensland (QLD).

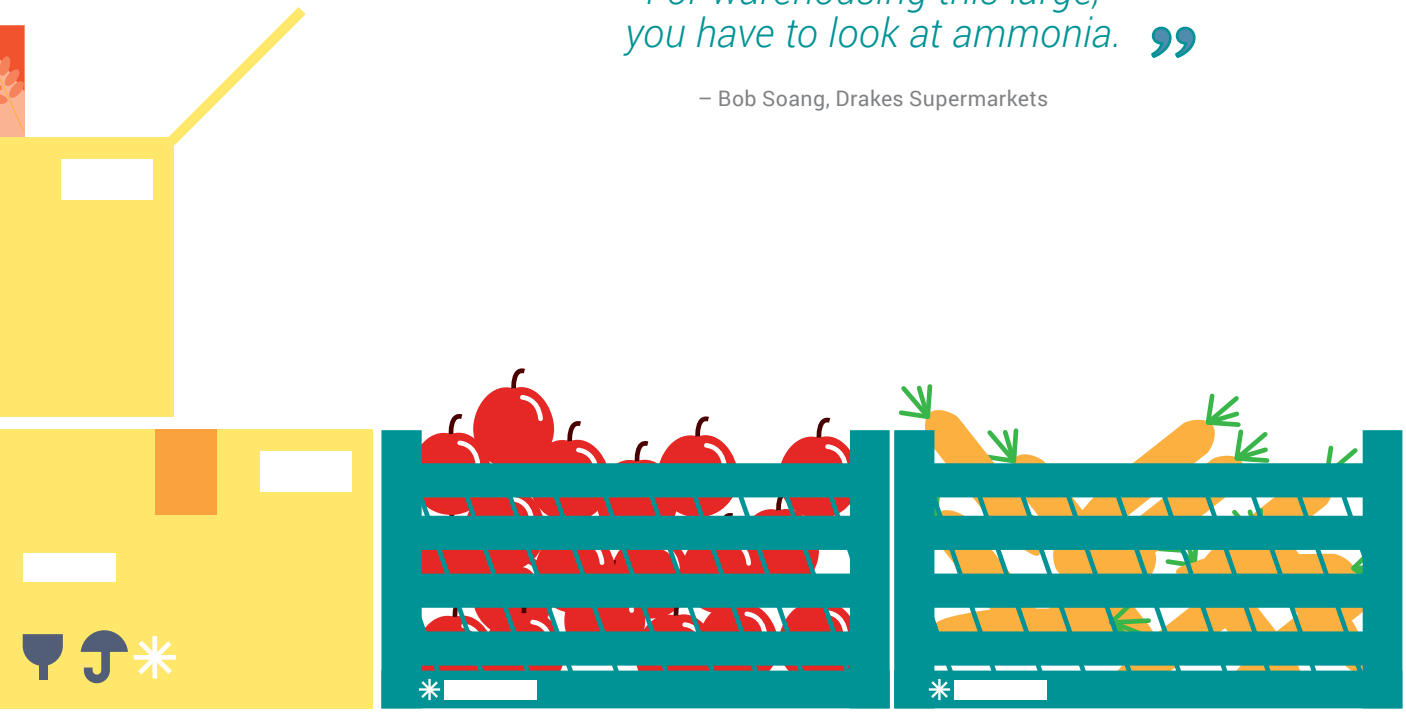
Construction of the new distribution centre is expected to employ some 300 people. The centre, whose expected pallet capacity is 52,000, will require 150-250 full-time staff once it opens in the middle of next year.

"As a local family-owned business we are pleased to create so many jobs in the northern suburbs of Adelaide," Soang said.

The refrigerated area to be served by the ammonia system is 12,500 m². The frozen goods section will have a pallet capacity of 6,000, with space for another 9,000 in the chilled goods area.

Soang chose Gordon Brothers Industries Pty Ltd. as the refrigeration contractor for the Adelaide facility. Founded in 1917, Gordon Brothers is Australia's oldest industrial refrigeration business and has been working with ammonia since day one.

> *For warehousing this large, you have to look at ammonia.*
>
> – Bob Soang, Drakes Supermarkets



Drakes, meanwhile, is proud to have been the first retailer to install a transcritical CO_2 system in a southern-hemisphere supermarket. That system was commissioned in December 2007 at a Drakes Foodmarkets store in Angle Vale, north Adelaide.

"As we're the largest independent, we've always felt that there is some onus on us to do some of the pioneering," Soang told *Accelerate Australia & NZ* last summer (see '*The Big Comeback*', summer 2018 edition).

Earlier this year, Drakes opened three new CO_2 transcritical stores, located at Goodwood Road, Wayville (SA), Stebonheath Road, Penfield (SA) and Ardrossen Road, Caboolture (QLD).

Strong business case for natural refrigerants

Environmental sustainability is not the only thing driving Drakes to adopt natural refrigerants to serve its HVAC&R needs.

On 1 July 2017, South Australia made global headlines. On that day, the state overtook Denmark for the dubious honour of having the world's most expensive electricity, reported the Australian Broadcasting Corporation. The ABC detailed price hikes announced by Australia's three largest energy retailers at the time.

In a retail sector where profit margins are already razor-thin, fluctuating energy costs can therefore have a dramatic effect on a food retailer's bottom line.

For this reason, Soang fully expects natural refrigerants to make greater inroads into industrial refrigeration at Drakes too.

"For warehousing this large, you have to look at ammonia," he said.

At the time, Soang admitted that his knowledge of ammonia-based refrigeration systems remained limited, but said the efficiency benefit of ammonia systems was piquing his interest. "Perhaps that might be the future – the next step," he said. ■ AW

SWEDEN GETS THE AMMONIA TREATMENT

Using the heat from Malmö's sewage treatment and waste incineration plants, four ammonia heat pumps deliver heating to approximately 100,000 homes in the Swedish city. *Accelerate Europe* reports.

– By Charlotte McLaughlin & Andrew Williams

Malmö's western harbour area.

Heating and cooling buildings and industry currently accounts for half of the European Union's energy consumption, according to the European Commission, the EU's executive branch (2016 figures). In EU countries, heating and hot water alone account for by far the biggest share of final energy use, with 79% taken up by residential areas.

Germany-headquartered E.ON – one of the world's largest investor-owned electric utility service providers – is looking at ways to reduce greenhouse gas emissions from the electricity and heating it supplies to European and global households and businesses.

"We will reduce our absolute carbon footprint by 30% [by] 2030 compared with 2016," says E.ON in its 2017 Sustainability Report.

With this in mind, the utility, "will reduce the CO_2 intensity of our customers – i.e. the CO_2 intensity of our power sales – by 50% until 2030 compared with 2016".

"One example is Sweden, where renewables already account for more than 50% of energy consumption," the report says. "In line with this, our local [Swedish] unit […] intends to [provide to its customers] 100% recycled or renewable energy by 2025," it adds.

In Sweden, E.ON owns extensive electricity, district heating and gas networks. District heating networks centralise heating for entire residential and commercial areas, increasing the efficiency of heating compared to individual systems and thus saving costs. "We are going to supply district heating energy that is either recycled or renewable by the year 2025," says Mats Egard, E.ON Sweden's heating segment project manager.

"In 2014-2015, we made an internal investigation of different solutions for the district heating of the future," Egard says. The company chose heat pumps as one option, along with biomass and other renewable technologies, to mitigate greenhouse gas emissions from heating.

Installing the heat pumps

E.ON first decided to use heat pumps for district heating in southern Sweden, where the company opted to install four GEA ammonia heat pumps each with a heating capacity of 10 MW (in total 40 MW), next to a sewage treatment plant and waste incinerator in the harbour area of the city of Malmö. "We started in 2015 and then we got our investment decision in May 2016. We signed the contract in July with *Francks Kylindustri* [a Swedish contractor specialised in cooling and heating with ammonia]," says E.ON Sweden's Egard.

The heat pumps take advantage of the waste heat from the sewage and waste plants, in the harbour area, to provide heating to approximately 100,000 homes in greater Malmö. Installing the four GEA heat pumps took approximately 14-15 months. Groundwork began in August-September 2016, "and we commissioned the last heat pump at the end of December 2017," says E.ON's Egard.

E.ON decided to use the sewage water to provide base heat for the heat pump due to the higher temperature emitted by the sewage plant (14°C) – making the water warmer than the sea near Malmö. "In January and February, sometimes the seawater even goes below zero, and then it's impossible to get any heat out of it. That's when the heat is at its most valuable – when it's colder outside," Egard says. "The sea outside Malmö is too shallow. If you have deeper seas, you always have 4°C at the bottom of the sea, but you don't have that here."

Kenneth Hoffmann, GEA's product manager for heat pumps, was also involved in the Malmö project. "They have [seawater heat pumps] a lot in Norway with the deep fjords, but then you can get down to the bottom of the sea, which is perhaps 20-30 metres deep – you have a constant temperature down there of 8°C," he says.

The four heat pumps withdraw 30 MW of heat from the sewage water. "On average the wastewater is chilled from 14°C to 8°C," writes Hoffmann in an Institute of Refrigeration (IOR) paper on '*Large-scale heat pumps for high efficiency district heating projects*'. "The energy harvested is upgraded to useful heat for the district heating network through the heat pumps," he adds.

The heat pump has been integrated with the district heating network to work in conjunction with the nearby waste incinerator plant. "The water from the city returns to the waste incinerator plant at around 50°C, where in the flue gas economiser it is heated to around 55°C" before going into the heat pump at 66°C, Hoffmann explains in the paper.

"The water then returns to the waste incinerator plant where it is […] heated to the requested temperature by the heating network, which can vary depending on the heating demand from 70°C to 90°C. The heat pump is designed for delivering heat up to 80°C, but will rarely deliver temperatures above 71°C," the paper says.

The four heat pumps work in parallel to deliver the promised temperatures. Each has a coefficient of performance (COP) above 3.50, "so for each 1 kWh of electricity used by the heat pump, 3.5 kWh of heat is produced for the city," says GEA's Hoffmann.

The heat pumps, then, are certainly helping E.ON to deliver on its sustainability commitments. ■ CM & AW

Rolling out propane chillers in Indonesia

With the support of the German Ministry of Environment (BMU), the Indonesian government and local manufacturers, Indonesia is beginning to roll out propane chillers in the commercial and industrial sectors, setting the stage for more natural refrigerant uptake in the country.

– By Devin Yoshimoto & Jan Dusek

In 2012, Indonesia began phasing out the use of hydrochlorofluorocarbons (HCFCs) under its HCFC Phase-out Management Plan, which aimed to reduce 80.4 ozone-depleting potential (ODP) tonnes of national HCFC consumption by 2018.

At the time, R22 was a widely used refrigerant in Indonesia's commercial and residential air-conditioning sectors. Although its use has fallen significantly since it was banned nationwide under Stage 1 of Indonesia's HCFC Phase-out Management Plan in 2015, R22 has largely been replaced by hydrofluorocarbons (HFCs) such as R134a, which are themselves now scheduled to be phased down under the Kigali Amendment to the Montreal Protocol.

One company, however, saw an opportunity to grow its business by looking into the development and manufacture of air-conditioning systems based on natural refrigerant propane (R290) as an alternative to HFCs.

AICOOL Air Conditioning and Chiller (AICOOL), which operates under PT Ilthabi Mandiri Tehnik, is a local, family-owned business that has been making refrigeration and air-conditioning systems for close to fifty years.

Today, the company operates three factories with around 600 employees. It primarily does business in the Indonesian market.

In 2012, as Indonesia began to phase out HCFCs, AICOOL Managing Director Iwan Chandra saw an opportunity to develop and expand its manufacturing capabilities into propane-based (R290) refrigeration and air-conditioning systems.

"Looking at all the alternatives, I realised that there were many, many choices available," Chandra told *Accelerate Asia*, a sister publication of *Accelerate Australia & NZ*.

"Soon, however, we realised that R290 was a very good alternative."

The gas, as a refrigerant, Chandra says, "was already available locally in Indonesia for a very long time".

Indonesia remains one of the world's largest producers of natural gas. State-owned energy company Pertamina has been supplying propane since 2005 – actively encouraging its use in the Indonesian market.

AICOOL soon became the first manufacturer in Indonesia to produce R290 chillers for commercial and industrial refrigeration and air-conditioning applications, training its own staff in-house.

It wasn't until a couple of years later, however, that AICOOL began to ramp up production of the chillers.

LEFT
Barokah Sri Utami, also known as Emmy, president-director of PT Phapros, where two propane chillers have significantly reduced energy use.

> *"The technology is there, the people are there, the institutions are there, the standards are revised…this is a good opportunity for everybody."*
>
> – Iwan Chandra, AICOOL

Green chiller project in Indonesia

In 2014, BMU – the German Federal Ministry of Environment, Nature Conservation and Nuclear Safety – commissioned the Green Chillers NAMA (Nationally Appropriate Mitigation Action) project in Indonesia.

The project's goal was to actively facilitate the development of Indonesia's market for green cooling technologies through pilot projects, training and certification, and by creating standards.

Over the next few years, AICOOL, in close co-operation with Indonesia's Ministry of Energy and the German Corporation for International Cooperation (GIZ; *Deutsche Gesellschaft für Internationale Zusammenarbeit*), began to manufacture more R290 chillers for the purpose of performance testing and analysis as well as training.

These chillers were installed at the University of Indonesia, as well as at the Bandung and Bali State Polytechnics' vocational schools, for the purpose of training and performance testing.

The Indonesian National Standardisation Agency worked at the same time to publish new and updated refrigerant safety and energy efficiency standards, paving the way for further development of the R290 chillers.

To date, AICOOL counts a total of ten R290 chillers installed in the Indonesian market. Chandra expects this total to hit 100 units next year.

NatRefs for pharma sector

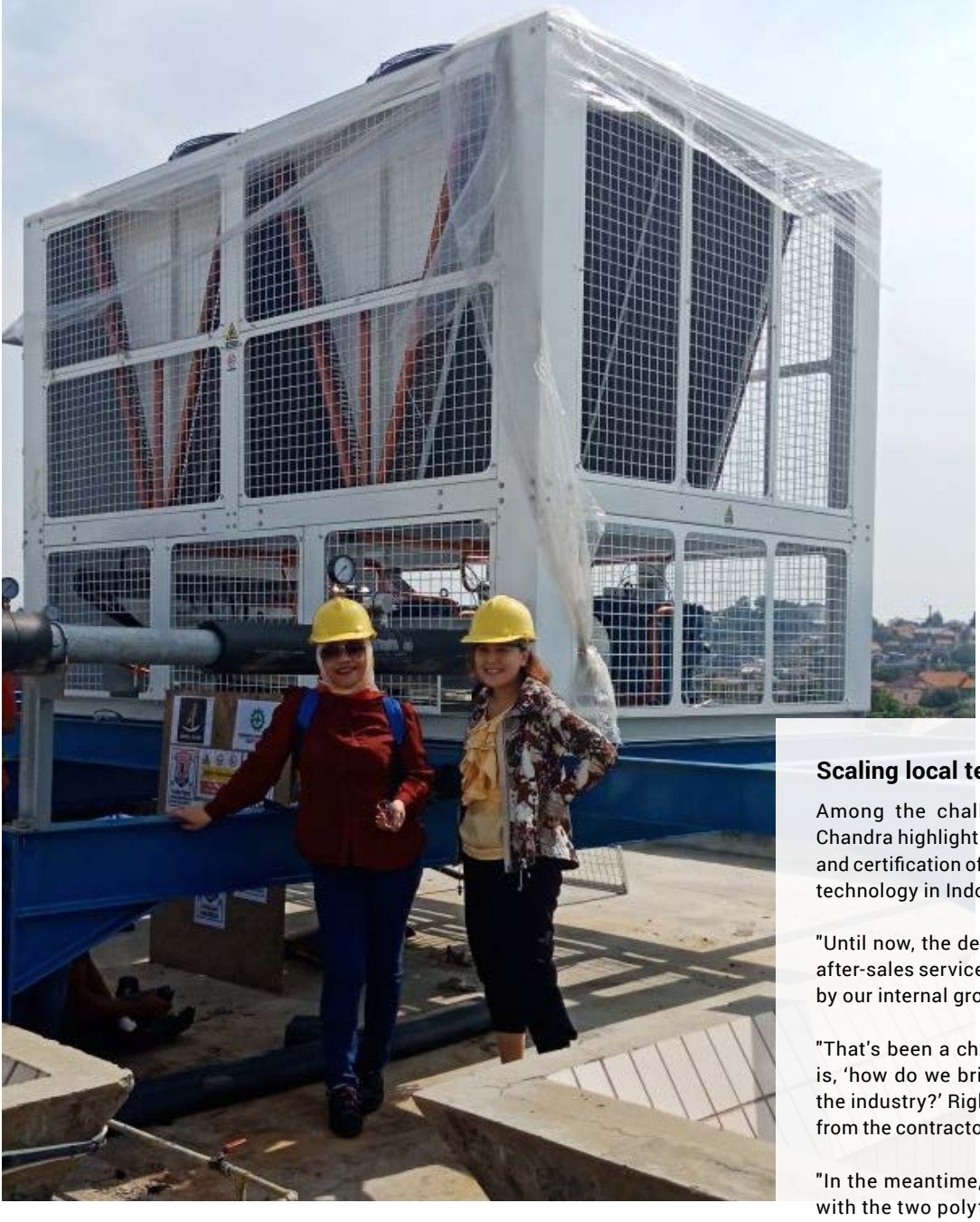
At the beginning of 2018, as an official Green Chillers NAMA pilot project, large Indonesian pharmaceutical company PT Phapros installed and commissioned two AICOOL R290 chillers, replacing two existing R134a units, at its production facility in Semarang, Central Java.

The two chillers each have a cooling capacity of 231.9 kW and each use around 30 kg of propane.

The chillers are used to cool various rooms for drug production, storage and breeding of bacteria in PT Phapros' production building.

The old R134a chillers used 545,387 kWh of electricity per year, costing the company around IDR 600 million (~A$55,589) per year in energy costs. The new R290 chillers are expected to use only 151,078 kWh per year, resulting in around IDR 160 million (~A$14,823) per year in energy costs.

Though the R134a chillers were very old systems, with capacities that were significantly larger than needed, the reduction still translates to a cost saving of around IDR 440 million (~A$40,764) per year. The company estimates the payback period to be around 2.5 years and its annual greenhouse gas emissions to be reduced by 356 metric tons of CO_2e (CO_2 equivalent) per year.



LEFT

Herlin Herlianika (left) and Indira Darmoyono (right); (GIZ Green Chillers NAMA Project consultants) with the commissioned R290 chiller.

Barokah Sri Utami, president-director of PT Phapros, highlights the role that natural refrigerant systems play in demonstrating the company's commitment to its own, as well as Indonesia's, sustainability goals.

"PT Phapros' vision and mission is to become the leading pharmaceutical company with a strong commitment to social responsibility for our environment," she says.

The company considers the installation of natural refrigerant systems to play a central role in a number of programmes the company is pursuing to achieve its sustainability goals.

"These programmes span simple actions, from using energy efficiently and cultivating mangrove plants to investing in the two green chiller units for our production plant," she says.

Barokah Sri Utami recognises the importance of aligning PT Phapros' sustainability strategy with what is currently happening globally.

"Natural refrigerants have low global warming potential compared to synthetic refrigerants, so they are effective for reducing the risk of climate change and global warming that disturbs the Earth's balance," she says.

"PT Phapros' environmental strategy is in line with the Indonesian and global initiatives to mitigate and adapt to global warming and climate change," she adds.

Scaling local technician training

Among the challenges still facing AICOOL, Chandra highlights the need to scale up training and certification of technicians to work with R290 technology in Indonesia.

"Until now, the design, testing, installation and after-sales service of the units has all been done by our internal group," says Chandra.

"That's been a challenge. So the question now is, 'how do we bring this to the right scale for the industry?' Right now, I need a lot of support from the contractors and from other companies."

"In the meantime, we are working very closely with the two polytechnics that are introducing this technology. Currently we have about 30-40 technicians who have R290 certification," he says.

Asked how the company deals with the issue of flammability, Chandra says the use of propane is quite safe as long as proper training and safety precautions are in place: "We haven't seen yet any serious accidents from flammability."

"We use gas detectors and put the units outside and away from any possible sources of sparks. We also use clearly visible flammability signage, and enclose the area so that it is only accessible by trained and certified people," he explains.

Though AICOOL works closely with its overseas suppliers to import key components, Chandra stresses that it is important to assemble and manufacture the completed chiller units locally.

"Sharing from my own experience in manufacturing R290 systems, it is very good technology for local industries because you need local support," says Chandra.

From left to right: Philipp Schukat, GIZ Indonesia; Sunandar, Coordinating Ministry for Economic Affairs, Indonesia; Kai Berndt, Green Chillers NAMA Project, GIZ Indonesia; Barokah Sri Utami, PT Phapros; Herlin Herlianika, HEAT; Rida Mulyana, Ministry of Energy and Mineral Resources, Indonesia.

"You cannot import these big units with R290. You need a local manufacturer, you need a local installer, and you need local after-sales support. But the technology is very good, easy to handle, and cheap compared to other high-pressure or secondary loop systems," he argues.

Indonesian government promotes NatRefs

The Green Chiller NAMA project term concludes in 2018. However, Chandra is confident the stage has been set for local manufacturers in Indonesia to take advantage of the opportunity to use natural refrigerant systems on a bigger scale in future.

"With the Green Chiller program's successful pilot projects, I think we are now all convinced that we have the technology in Indonesia," he says.

"Of course, now they are only pilot projects on a small scale, but we are very confident that this will grow more and more as others in our industry begin to follow."

The Indonesian government, for its part, sees local use and manufacture of R290 chillers as an effective means of achieving its sustainability targets while growing its economy at the same time.

"We support the installation of hydrocarbon chillers," says Rida Mulyana, director-general of Indonesia's Directorate-General of New, Renewable Energy and Energy Conservation.

"This technology is more energy efficient with very low-GWP refrigerants and can be locally produced," says Mulyana, referring to local providers AICOOL and Pertamina as examples.

"The programme also gives Indonesia an opportunity to enhance its capacity for developing and adopting clean technology by using domestic resources, which is very much in line with Indonesia's economic policies on enhancing local content," he says.

Showing the government's commitment to supporting the adoption of natural refrigerants in general, Mulyana says, "we fully support the implementation of energy-efficient and climate-friendly technology in Indonesia".

"We hope hydrocarbon or other natural refrigerant-based technology will be widely used as an alternative to synthetic refrigerants," he adds.

"We also encourage local manufacturers to start investing in climate-friendly technology, specifically hydrocarbon technology," Mulyana says.

AICOOL's Chandra remains hopeful. "The technology is there, the people are there, the institutions are there, and the standards are revised. Also, the market is big enough and we can do everything locally without importing everything," he says.

"This is a good opportunity for everybody." ■ DY & JD

Casa Ley's pilot CO_2 transcritical store in Culiacán, which opened in August.

MEXICAN RETAILER PILOTS CO_2 TRANSCRITICAL

Casa Ley – owner of the *Tomateros de Culiacán* pro baseball team – is one of the first food retailers in Mexico to install an all-CO_2 refrigeration system, testing the technology in the country's hot climate. *Accelerate America* reports.

– By Michael Garry & Andrew Williams

Photography by: César Rodríguez.

Casa Ley, a major food retailer in Northwest Mexico that operates 246 stores, has formed some fruitful relationships with businesses in the United States.

One of them started with baseball.

Based in Culiacán in the state of Sinaloa, Casa Ley owns the *Tomateros de Culiacán* baseball team, which plays in the Mexican Pacific League.

In 1980, Juan Manuel Ley, son of company founder Juan Ley Fong, met with Peter Magowan, then CEO of Safeway stores and future president of the San Francisco Giants.

Ley and Magowan bonded over their mutual love of baseball. That friendship led to a joint venture the following year in which Safeway gained a 49% stake in Casa Ley, allowing the Mexican chain to enter a period of rapid expansion. (Casa Ley regained full ownership in January 2018.)

Casa Ley's decade-long relationship with another U.S. company, Columbus, Georgia-based refrigeration manufacturer Kysor/Warren, a division of Heatcraft Worldwide Refrigeration, has led to a new opportunity – becoming the first supermarket operator in Mexico to install a climate-friendly transcritical CO_2 refrigeration system in one of its stores, a new 75,347-sq-ft. (22,966-m^2) supercentre in Culiacán that opened in August.

"We believe as a company we have to be very responsible to our communities and our customers and employees," said Juan Manuel Ley-Bastidas, son of Ley and current CEO and chairman of Casa Ley. "And a big part of that is taking care of the environment."

"It's not just for publicity or for marketing," he added. "It's really caring about our kids and communities."

Like other stores in Mexico, Casa Ley has also installed propane beverage coolers provided by vendors.

Casa Ley's installation of transcritical refrigeration will be closely watched by other Mexican retailers as well as by those in the southern regions of the U.S. to see how it performs in the hot ambient temperatures that persist year round in Mexico.

From their analysis of market and policy trends in Mexico and other countries around the world, Casa Ley executives could see that refrigeration technology was moving toward using "less

> *"We are constantly looking at new ways to do business."*
>
> – Juan Manuel Ley-Bastidas, Casa Ley (pictured below)

polluting gases," Ley-Bastidas said. In selecting a transcritical system from Kysor/Warren, "we wanted to get ahead of legislation and stay ahead of the curve".

Mexico, as a participant in the Montreal Protocol, will prohibit the use of R22 in 2024; Casa Ley is working on transitioning away from R22 in the few stores still using it to a lower-GWP, drop-in alternative.

In its other stores, Casa Ley uses R404A, but Mexico is expected to ratify the Kigali Amendment, which calls for a phasedown of HFCs like R404A. As an Article 5 country, Mexico would have until 2024 to freeze HFC production/consumption at baseline levels, and until 2045 to reduce it by 80%.

Kysor/Warren transcritical CO_2 rack, Culiacán store.

ACCEPTABLE RETURN ON INVESTMENT

The cost and installation of the transcritical unit and adiabatic condenser came at a premium of about 30% over a traditional DX system, said Ley-Bastidas. But with the expected operational savings, Casa Ley would gain an acceptable return on investment for the system, he added.

Manuel Ruiz Dorado is Casa Ley's head of management acquisitions and sustainability. Dorado's department "constantly researches the Internet, picks the brains of our suppliers and attends trade fairs to look at what's going on and what's new and being used in other parts of the world," said Ley-Bastidas. "We are constantly looking at new ways to do business."

The Casa Ley executive who proposed installing a CO_2 system to the company's management was Rafael Francisco Navarro Torua, senior maintenance manager. The selection of transcritical, he said, was the result of a "search [for] better energy efficiency" and because "this is where the retail industry is heading".

Because this technology is new for Mexico, Kysor/Warren decided to simplify the design, said Ignacio Varela Chaparro, Kysor/Warren's business development lead, who was in charge of the Casa Ley project.

That is why, for example, an adiabatic condenser was used rather than parallel compression and an ejector, though adiabatic condensers are more expensive. (The system also does not include heat reclaim.)

"This is the first [transcritical] store, so they don't have technicians qualified to [handle ejectors and parallel compression]," Chaparro said. "And adiabatic can provide the same energy benefits, maybe more."

Ley-Bastidas acknowledged that Casa Ley's installation of the transcritical CO_2 system would serve as a year-long test of factors like energy consumption and maintenance to determine whether the chain will proceed with this technology as a standard for new stores. "It's too early to tell, but I believe all of our initial premises will be met," he said.

THE WARM CLIMATE CHALLENGE

Undoubtedly the biggest challenge facing retailers in Mexico when it comes to transcritical technology is the hot year-round climate, which in Culiacán includes high humidity. This means that the system will often operate in an environment that is approaching or above CO_2's critical point of 88°F (31°C), when the gas exists as a supercritical fluid (a mix of gas and liquid) and is cooled but not condensed at the gas cooler/condenser outlet; this can undercut the system's efficiency.

"It was a concern," said Dorado with regard to the high ambient temperatures of Mexico. "But that is why this is a test to validate what we will see after using the equipment for a year."

The Güntner adiabatic condenser used by the transcritical CO_2 booster system is able to condense the CO_2 at lower wet-bulb temperatures on hot days, improving the system's efficiency. "Adiabatic keeps the system subcritical for as long as possible," said Chaparro.

With the adiabatic condenser, Casa Ley's transcritical system could consume 5% to 10% less energy than a conventional DX system, Chaparro said.

Training support was a key consideration in selecting suppliers for the transcritical project, said Ley-Bastidas. Kysor/Warren conducted training sessions for technicians from Casa Ley and Zavala Refrigeration, the local contractor that installed the transcritical system.

Kysor Mexico, meanwhile, makes available professional maintenance and emergency service by trained technicians to end users of its systems. ■ MG & AW

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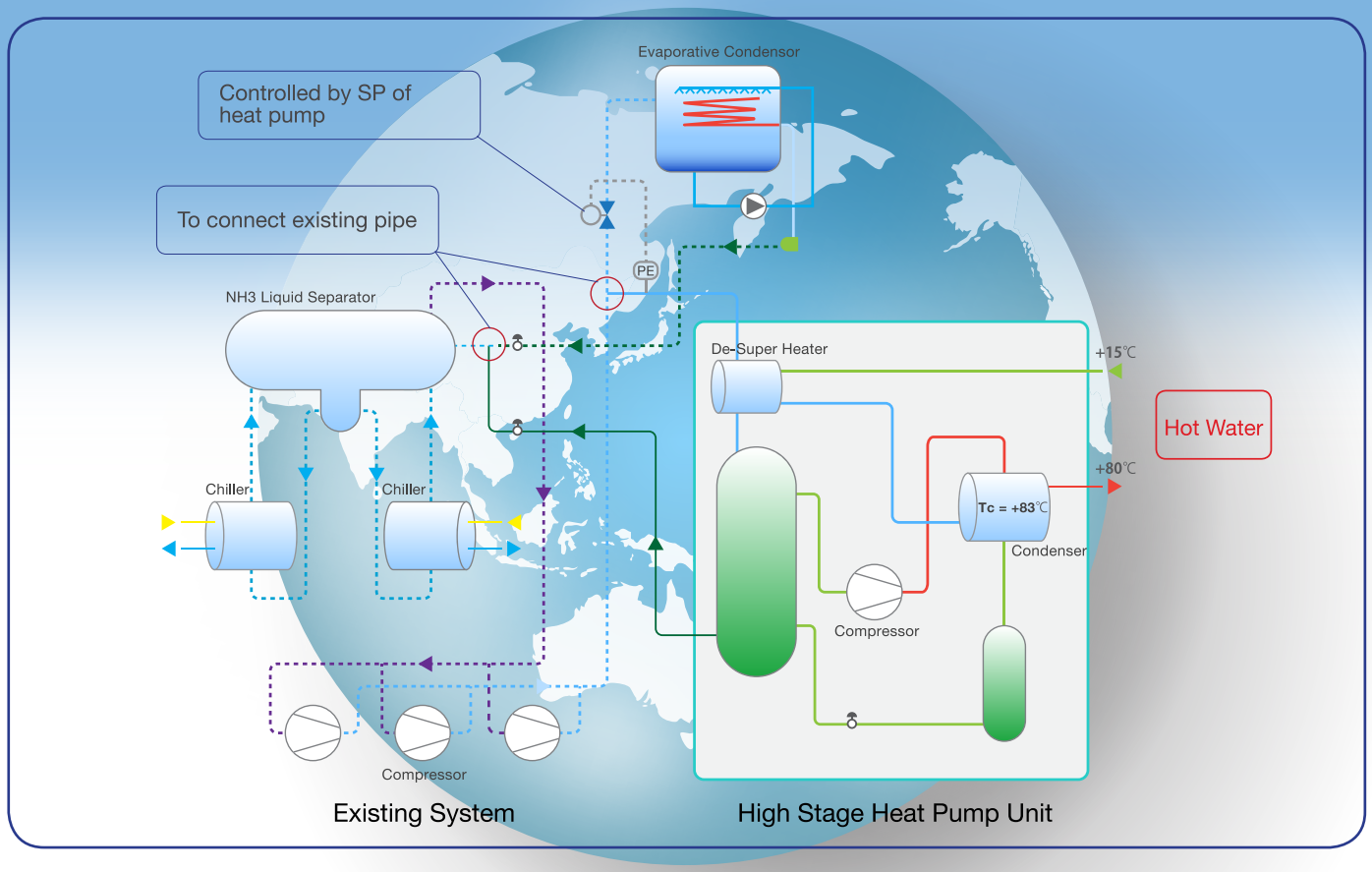

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MAYEKAWA

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MOSCOW CALLING

This year, Germany-headquartered food wholesale specialist METRO AG opened its first two CO_2 transcritical stores in Russia. *Accelerate Europe* reports.

– By Charlotte McLaughlin & Andrew Williams

Germany-based METRO AG is a world-leading international food wholesale company that has built a global reputation as a committed player in environmental protection efforts.

METRO's F-Gas Exit Program is widely seen as one of the most forward-thinking initiatives to phase out the use of HFCs in the world today. In place since 2013, it aims to phase out f-gases in all the company's stores worldwide by 2030, replacing them with natural refrigerant systems where it is technically and economically feasible to do so.

"METRO operates in 35 countries worldwide. Today in more than 170 of our stores we are using natural refrigerants," Olaf Schulze, METRO AG's director of energy management, investments and technical solutions, told *Accelerate Europe* (July 2018 data).

The two CO_2 transcritical stores in Russia – the first of which opened on 26 July in Aparinki, near Moscow, with the second opening on 23 August in Odintsovo, a western Moscow suburb – are significant milestones in this journey.

"By using this technology, METRO is one of the most progressive companies in the sector in Russia," Schulze says.

This is not the first time a CO_2 transcritical system has been installed in Russia's food retail sector. In 2016, Russian retailer Magnit opened a hypermarket in Voskresensk, a city 88 km southeast of Moscow, using a CO_2 transcritical booster refrigeration system.

Local manufacturer Nord-SM provided that system, with the cooperation of Danfoss and the United Nations Industrial

1 / Exterior of METRO store in Aparinki, near Moscow.

2 / Cabinets inside the Aparinki store.

Photography by: METRO AG

2 /

Development Organisation (UNIDO), which undertook some preparatory work. Switzerland-based Frigo-Consulting provided technical support.

Russia is also a signatory to the global HFC phasedown under the Kigali Amendment to the Montreal Protocol.

"Following the Kigali Amendment in 2016, Russia has been tasked with reducing its CO_2 emissions by 40-45% by 2025. As a consequence, Russian retailers are now pushing the roll-out of CO_2 refrigeration systems," said Marcus Hoepfl, managing director, Frigo-Consulting.

To the knowledge of *Accelerate Europe*, the Aparinki store is the first time that a CO_2 transcritical store has been achieved in Russia without the backing of an international project.

For Schulze and his team, implementing the F-Gas Exit Program in locations unfamiliar with CO_2 transcritical technology is certainly more challenging than business as usual. "To implement these projects, we have to consider the entire supply chain, the technology, experienced installers, and an efficient and safe maintenance and repair process," Schulze explains. "Our refrigeration systems are the backbone for the sale of food in our stores. We cannot afford to compromise here."

METRO Russia now boasts two transcritical CO_2 stores, 25 subcritical CO_2 stores, and one ammonia cold storage centre, according to Schulze (September 2018 data).

Russian installer Ingenium, based in Rostov-on-Don (a town in southern Russia), carried out the METRO installation in Aparinki. It also provided two CO_2 racks to refrigerate the 6,547 m^2 cash and carry store.

Aparinki is the first time that Ingenium has installed a CO_2 transcritical system in a supermarket. "For three years we have been using CO_2 in subcritical systems," Anton Rostokin, deputy director of engineering at Ingenium, told *Accelerate Europe*. "More than 10 projects (similar in size) were implemented with CO_2 subcritical."

Ingenium's first installation of a transcritical CO_2 system was at its own training centre. To familiarise itself with the technology, the Russian installer also sought training from other European manufacturers and institutes.

"We were trained on the basis of the companies Bitzer and Danfoss," Rostokin says. "Additional training was conducted at an institute in Belgium."

The two Ingenium racks provide the store cabinets with 85.77 kW of low-temperature cooling and 224.85 kW of medium-temperature cooling. They provide high-temperature free cooling to the tune of 262.04 kW.

The CO_2 transcritical system in Aparinki uses monitoring controls from Danfoss, compressors from Bitzer, gas coolers from Güntner and cooling furniture from Freor.

"We started in Moscow because in other Russian regions, we are still scouting for the right installer capacities for transcritical," METRO's Schulze explains.

Switching things up

METRO's second CO_2 transcritical store in Russia opened in the city of Odintsovo, the administrative centre of Odintsovsky District in the Moscow Oblast region, on 23 August 2018.

For this 10th METRO store in the Moscow region – which has a trading area of approximately 5,800 m^3 – the retailer decided to work with a different Russian contractor called LAND, based near St. Petersburg, according to Holger Guss, head of building services and engineering at METRO AG.

Danfoss provided the monitoring controls again, while this time Dorin provided the CO_2 compressors for the LAND-manufactured transcritical rack. Frigo-Consulting was again involved in the design of the project. The gas coolers are from Güntner and the refrigerated glass-door cabinets are from Arneg, which provided 80 cabinets.

The Odintosovo installation also features heat reclaim and parallel compression. 150 kW of reclaimed heat warms the store in winter, according to Schulze. The system provides 73 kW of low-temperature cooling, 202 kW of medium-temperature cooling, and 260 kW of high-temperature cooling (built with a free cooling system).

METRO is planning to open more CO_2 transcritical stores in the Moscow area. "Solntsevo [will follow] in December […] with transcritical CO_2," Schulze says. ■ CM & AW

Natural refrigerants shine at Chillventa

With competition between CO_2, ammonia and hydrocarbons more fierce than ever, visitors to Chillventa 2018 discovered how natural refrigerants have now become mainstream HVAC&R options as HFCs are phased down. *Accelerate Australia & NZ* reports from the Nuremberg home of one of the world's biggest HVAC&R tradeshows.

– By Andrew Williams & Charlotte McLaughlin

Source: NürnbergMesse

> *"Natural refrigerants are the trend going forward."*
>
> – Luis Felipe Dau, president and CEO, Embraco

In all the applications and markets in which Embraco is active, "natural refrigerants are the trend going forward," Luis Felipe Dau, president and CEO of the Brazilian multinational, told *Accelerate Australia & NZ* at Chillventa 2018.

Dau was talking about hydrocarbons, and about the focus of Embraco in particular. But his words captured the spirit of this year's Chillventa, which saw a record number of companies offer natural refrigerant-based HVAC&R solutions.

Chillventa 2018 broke a number of records. 35,490 visitors from 125 different countries streamed through the exhibition doors to visit 1,019 booths from 45 nations, spread across a trade area that was 2% bigger than the previous edition's in 2016. Visitor numbers were up 10%, with exhibitor numbers up 4%.

NATREFS SPREADING IN HVAC MARKET

Natural refrigerants have steadily been gaining market share in refrigeration and HVAC markets around the world. This is particularly true in Chillventa's home continent of Europe, where the new EU F-Gas Regulation – finalised in 2014 and in force since 2015 – aims to reduce the European Union's use of hydrofluorocarbons (HFCs) by 79% by 2030.

The EU phasedown, in fact, has already led to price rises – creating more opportunities in Europe for natural refrigerant-based technologies to replace them as market-ready, environmentally friendly and inexpensive alternatives (see '*HFC prices skyrocketing in the EU*', page 14).

Commercial refrigeration end users are already adopting natural refrigerants at a promising rate. For example, an estimated 16,000+ supermarkets in Europe already use CO_2 transcritical systems, according to estimates from sheccoBase, the market development arm of *Accelerate Australia & NZ* publisher shecco.

The HVAC market, however, has been slower to pick up speed. But at Chillventa 2018, there were signs that this is beginning to change.

Euroklimat, for example, displayed its new propane-based (R290) heat pump at the show. With a propane charge of 5.5 kg, it has a heating capacity of 60 kW and is designed for outdoor installation.

"We did the first test and this is a prototype, it is not ready for the market," Giulia Fava, product developer at the Italian manufacturer of commercial and industrial heating and cooling solutions, told *Accelerate Australia & NZ*.

Euroklimat is currently testing the new unit in the laboratory and out in the field, with a view to putting it on the market in January-February 2019.

The unit on display targeted commercial buildings. Euroklimat is aiming "to have ready next year a range of propane heat pumps from 30 kW up to 150 kW," she said.

The unit uses Frascold compressors, an ATEX-certified pressure transducer and pressure transmitter, and CAREL's microprocessor. Asked how the prototype had performed in testing, Fava said, "it is working well, down to -20°C".

GROWING INTEREST IN HEAT PUMPS

Fava said the firm decided to invest in this unit after receiving many requests from customers. "Most of our customers for propane are from northern countries. Two years ago they started asking us, 'Please, we need a heat pump down to -20°C!' and we didn't have it. So now we are trying to answer their requests."

Propane wasn't the only natural refrigerant to feature in HVAC equipment on display at Chillventa. The Yukon CO_2 chiller range, displayed for the first time by Italian system manufacturer Enex, can now be used as a reversible heat pump and air-conditioner in commercial buildings.

"We are now installing the first versions with reversible operations," said Sergio Girotto, president of Enex. "It means they work as heat pump in winter and as a chiller in summer."

The Yukon, Enex's new family of CO_2-based 'plug and play', medium-sized water/brine chillers, comes in two offerings. One uses a pressure receiver for units up to 60 kW that permits a capacity increase and assures redundancy. The second unit, which uses gravity-fed evaporators, is a larger range of up to 450 kW and can be used with Enex's en*jector* technology.

"Nobody believed so far that CO_2 could be a good refrigerant for water chillers, but [with the Yukon chiller range] we proved that it is efficient," Girotto said. "[The en*jector*] makes the chiller efficient at 35°C ambient temperature."

The Yukon is particularly suited to space cooling in medium and large commercial buildings with significant demand for hot water, such as hotels, hospitals, gyms and wineries.

> *The ejector gives us that extra energy efficiency we need to operate in warm climates.*
>
> – Kenneth Bank Madsen, Advansor

CO_2 TRANSCRITICAL FOR ALL CLIMATES

Market interest in CO_2 transcritical systems has grown dramatically in the past four years as technology developments such as ejectors help to overcome their operational limitations in warm climates, according to Kenneth Bank Madsen, business development manager at Danish multinational Advansor.

"Interest in our transcritical CO_2 racks has been huge," Madsen told *Accelerate Australia & NZ*. "We can clearly see a development since the last Chillventa, in 2016," he said.

Madsen was presenting Advansor's CO_2 transcritical systems for industrial and commercial applications. "We have a complete offering, from northern to southern Europe – we cover all climates," he said.

Ejector technology helps in this regard. "The ejector gives us that extra energy efficiency we need to operate in warm climates," said Madsen, presenting a rack designed for Portugal that is capable of operating in temperatures of up to 43°C.

Italian multinational compressor manufacturer Dorin, meanwhile, believes CO_2 transcritical is poised to take off in industrial applications within the next 3-5 years as larger compressors hit the market, Giovanni Dorin, the firm's marketing manager, told *Accelerate Australia & NZ*. "We're ready to ride that wave," he said.

Asked how the market for CO_2-based HVAC&R technologies had changed since the last Chillventa in 2016, Dorin said, "component availability and access to technology is more widespread".

NEW CO_2 CONDENSING UNIT

Leading global compressor manufacturer Tecumseh announced at Chillventa the launch in 18 months' time of its first CO_2 condensing unit.

Tecumseh is developing the CO_2 condensing unit "to extend its product range that is compliant with European regulations" such as the EU's F-Gas Regulation and Eco-Design Directive, the Ann Arbor, Michigan-headquartered company announced.

> *For CO_2, component availability and access to technology is more widespread.*
>
> – Giovanni Dorin, *Officine Mario Dorin*

Tecumseh was exhibiting a prototype of the new condensing unit at its Chillventa booth. The firm will face competition from Panasonic, which was pushing its new VF Series of CO_2 condensing units for refrigerated and frozen goods at the show.

The Japanese multinational launched a 15 kW model on the European market this summer. A 4 kW unit has been available in Europe since last year.

The new product line-up offers customers a combination of 4 kW and 15 kW units for small to medium-capacity cooling and freezing applications, Shigeru Dohno, managing officer (food retail and commercial equipment business) at the Panasonic Corporation's appliance company branch, said at Chillventa.

The VF Series targets the retail and food service sectors, such as small supermarkets, convenience stores and garage forecourts. It also serves the restaurant and hotel sectors.

Since its European launch in 2017, Panasonic has installed the 4 kW units in 250 stores in Europe, from Iceland in the north to Italy and Spain in the south.

With so many new products on show at Chillventa, the future looks bright for natural refrigerant-based HVAC&R solutions. ■ AW & CM

World Guide to CO_2 transcritical refrigeration

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FULL STEAM AHEAD: NATREFS IN SOUTHEAST ASIA

With the Kigali Amendment to the Montreal Protocol requiring countries around the world to put in place HFC phasedown strategies, ATMOsphere Asia 2018 showcased Southeast Asia's rapidly growing interest in natural refrigerant technology to increase efficiency while reducing greenhouse gas emissions.

– By Devin Yoshimoto

At ATMOsphere Asia 2018, Kiat Ananda Cold Storage, the largest cold storage/third party logistics service provider in Indonesia, made the business and environmental case for using NH_3/CO_2 systems in cold storage facilities.

"Basically, we run our business while taking care of humanity, the environment and the business all together in one," said Ray Soraya, CEO of Kiat Ananda Cold Storage, a Jakarta, Indonesia-based company that offers cold supply chain management services for frozen food products.

"Some say it is not easy but believe me it can be done," Soraya told the audience at the Suntec Convention & Exhibition Centre in Singapore on 4 September 2018.

"It is our values that are driving these changes – it's what you believe," he said.

ATMOsphere Asia 2018 – organised by *Accelerate Australia & NZ* publisher shecco – attracted some 160 registered attendees from 82 organisations, including 27 end users, 23 speakers and 14 sponsors and partners. In a sign of growing interest in natural refrigerants in Southeast Asia, nearly 30% of the delegates were joining an ATMOsphere conference for the first time.

> "TYPICALLY, YOU ARE LOOKING AT COPs OF AROUND SEVEN TO EIGHT COMBINED, WHEN YOU ARE CHILLING WATER AND HEATING WATER AT THE SAME TIME."
>
> – Wynand Groenewald, chief technology officer, Sphere Solutions

Strong business case for NH_3-CO_2 cascades

Kiat Ananda operates five cold storage warehouses in Jakarta, Surabaya and Bali with blue-chip customers including household names such as Starbucks, the Coca-Cola Company and Unilever.

"The initial investment [for natural refrigerant systems] is high but again we have proven that it can be done. With our case studies, we can be a leading example in the market," Soraya said.

Hamzah Priyantoro, Kiat Ananda Cold Storage's operations director, argued that using NH_3/CO_2 cooling systems had increased operational safety and reduced costs. "The most important thing for businesses is low operating costs and reducing energy consumption," he said.

"The upfront costs [for NH_3/CO_2 systems] will be paid back faster than the regular f-gas refrigerants. I think that's the good point of using natural refrigerants – that it is supporting the business growth of the cold chain and supply chain sectors in Indonesia."

Bringing technology to Southeast Asia

Technology suppliers made the case for the energy saving potential of CO_2 heat pumps in Southeast Asia's hospitality sector.

Wynand Groenewald, chief technology officer for Sphere Solutions (the holding company for Sphere Asia, a recently formed joint venture to bring CO_2 water-to-water heat pump technology to the Southeast Asian region), described the massive opportunity to reduce energy costs in the hotel industry.

"Looking at the hotel industry in Singapore overall [...] there are currently about 200+ hotels – a lot of them still using boilers. Predominantly, 95% of these hotels use chilled water for air-conditioning systems," said Groenewald.

Using inefficient boiler technology for hot water – in a high-ambient temperature region with a continuous need for air conditioning – means that close to 72% of the total energy consumption in a given hotel in Singapore is for HVAC and heating, Groenewald explained.

Technology such as Sphere Asia's CO_2-based water-to-water heat pump helps reduce costs by eliminating energy waste in the system.

"The water supply and return to your chillers is used as the heat source instead of the ambient air. The hot water is your predominant factor, replacing either gas boilers or electrical or any other means of heating," said Groenewald. "The benefit of this is that you are utilising waste. Typically, you are looking at COPs of around seven to eight combined, when you are chilling water and heating water at the same time."

The CO_2 heat pump system – which can also be used in the food manufacturing and processing sectors – also reduces water use.

"If you reduce the capacity of your chiller, you obviously reduce the use of water to condense your chiller plant," said Groenewald.

"There's water saving involved and an energy saving involved in utilising these systems," he said.

Growing uptake of propane-based (R290) room air conditioning (RAC) systems was also showcased during the '*NatRef Solutions for Asia*' panel.

India-based Godrej announced that it had sold 600,000 R290-based RAC systems to date. Most of these sales are in India, but units are beginning to be sold in Southeast Asia.

"Our manufacturing capacity for [hydrocarbon RAC units] is 180,000 units per annum. Today we have around 600,000 units in the field, without any accidents that can be attributed to hydrocarbons," said Abhijit Acharekar, general manager for R&D at Godrej.

Acharekar attributes this success to Godrej's well-trained technician workforce. "Hydrocarbons for us are not just

> “HYDROCARBONS FOR US ARE NOT JUST THE FUTURE – THEY ARE THE PRESENT, BECAUSE WE HAVE ALREADY SOLD 600,000 UNITS.”
>
> – Abhijit Acharekar, general manager R&D, Godrej

Ray Soraya, CEO, Kiat Ananda Cold Storage addresses ATMOsphere Asia 2018.

Photography by: Angie Tao

the future — they are the present, because we have already sold 600,000 units," he said. "Our focus now is on training technicians."

Godrej runs a vocational training school in India, where it has documented training procedures for each refrigerant. For a nominal fee, the company offers practical training and certification to technicians in India and neighbouring countries, as well as to the government, said Acharekar.

The importance of training

Conference participants identified training technicians to safely use hydrocarbons as a primary requirement for boosting uptake of these natural refrigerants in Southeast Asia.

Philipp Munzinger from GIZ Proklima International – a German international cooperation and implementation agency – talked about ongoing training, standards, and capacity-building programmes in the region.

One of these is the Green Chillers NAMA project, which handled the installation of R290 chillers at pharmaceutical company Phapros in Indonesia.

"If we want to use hydrocarbons or other natural refrigerants, we have to deal with [their] high pressure [or] flammability," said Herlin Herlianika, a technical expert for the Green Chillers NAMA project. “Every country should prepare for this capacity development, especially for technicians," he said.

GIZ Proklima’s Munzinger said: "Hydrocarbons have huge potential in Asia, especially in Southeast Asia. A comprehensive approach can help overcome […] the lack of trained technicians."

As demand for HVAC&R solutions in Southeast Asia’s warm climate increases and the entry into force of the Kigali Amendment draws nearer, the region has an opportunity to leapfrog HCFCs and go directly to environmentally friendly natural refrigerant-based technologies.

“We request from you as private companies to provide us with alternative technologies at a time when developing countries are ready to implement the Kigali Amendment," said Bitul Zulhasni from the Indonesian Ministry of Environment and Forestry, calling on industry to provide natural refrigerant-based HVAC&R solutions.

Participants left the conference looking forward to the next ATMOsphere Asia conference which is scheduled to be held in Bangkok, Thailand, on 24 September 2019. ■ DY

> “IT IS OUR VALUES THAT ARE DRIVING THESE CHANGES – IT'S WHAT YOU BELIEVE.”
>
> – Ray Soraya, CEO, Kiat Ananda Cold Storage

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NATREF INNOVATORS TAKE TO GUSTAV LORENTZEN STAGE

Industry experts explain the effectiveness of CO_2, ammonia and hydrocarbons as refrigerants at event named for CO_2 pioneer. *Accelerate Australia & NZ* reports from Valencia.

— By Andrew Williams & Dario Belluomini

ABOVE

The Gustav Lorentzen welcome drinks were held at the City of Arts and Sciences, Valencia.

Between 1988 and 1991, Norwegian researcher Gustav Lorentzen showed how the long-dormant refrigerant CO_2 could be used again as an effective working fluid. At the biannual conference named in his honour, industry experts carry on Lorentzen's work with reports on CO_2 and other natural refrigerants.

CO_2 technology for warm climates was one of the key themes of the 13th IIR Gustav Lorentzen Conference on Natural Refrigerants, held at the Polytechnic University of Valencia, Spain, on 18-20 June.

For example, technology innovations such as ejectors, evaporative condensers, energy storage, parallel compression and heat recovery are helping to broaden the market for CO_2 as a refrigerant across climate zones, according to Armin Hafner, a professor at the Norwegian Institute of Science and Technology (NTNU).

BOOSTING SUPERMARKET EFFICIENCY IN WARM CLIMATES

CO_2-based technology can provide efficient heating and cooling in Spanish supermarkets despite the country's warm climate, according to a conference paper authored by Hafner, his NTNU colleague Paride Gullo and Krzysztof Banasiak (SINTEF).

The paper investigates the energy-efficiency performance of two alternative systems serving the refrigeration, air-conditioning and space-heating needs of a supermarket. One uses R134a in the high-temperature circuit and CO_2 in the low-temperature circuit, together with an HFO R1234ze reversible heat pump. The other one is a CO_2 transcritical system.

To take into account the characteristics of Spain's warm climate, the researchers collected data for six major cities. Average outdoor temperatures in the sample range from 9.9°C in Burgos and 21.1°C in Tenerife (other cities included in the analysis are Madrid, Barcelona, Valencia and Seville).

In heating mode (between -5°C and +15°C), the CO_2-only solution proved to have a COP 83% higher than the R1234ze-based system. In air-conditioning mode (between +25°C and +40°C), the results are not as positive, given the substantial cooling demand.

As for annual energy consumption, the CO_2 systems offer energy savings between 1% (Tenerife) and 33.2% (Burgos) compared to systems using HFCs.

Moreover, Hafner said: "Today it is possible to integrate heating and cooling into CO_2 transcritical systems to eliminate all applications of HFCs in supermarkets."

However, with more OEMs developing new technologies to improve efficiency in warmer climates, system design is becoming more complex. Training and support for installers and contractors, therefore, will be crucial in ensuring the continued success of CO_2 as a refrigerant as it takes on a greater market share, Hafner said.

"People are getting to know CO_2 systems, knowledge is being transferred, and that is very good," Hafner said.

He cited data from sheccoBase – the market development arm of shecco, publisher of *Accelerate Australia & NZ* – indicating that there are already over 16,000 supermarkets in Europe fitted with CO_2 transcritical systems.

Echoing Lorentzen, Hafner took aim at the latest generation of synthetic refrigerants: "It does not seem very logical to try to replace HFCs with another family of related halocarbons, HFOs, which are equally foreign to nature."

"TODAY IT IS POSSIBLE TO INTEGRATE HEATING AND COOLING INTO CO_2 TRANSCRITICAL SYSTEMS TO ELIMINATE ALL APPLICATIONS OF HFCS IN SUPERMARKETS."

– Armin Hafner, NTNU

"IT'S A VERY EXCITING TIME TO BE OFFERING LOW-CHARGE AMMONIA SYSTEMS."

– Andy Pearson, Star Refrigeration

AMMONIA'S REINVENTION

The growing adoption of low-charge ammonia systems marks the "rediscovery" and "reinvention" of this most long-lived of natural refrigerants, Andy Pearson, group managing director of UK-based Star Refrigeration, told *Accelerate Australia & NZ* at the conference.

"The take-up is extremely rapid, there's a huge level of interest," he said. "It's a very exciting time to be offering low-charge ammonia systems."

He attributed this development to "a huge leap forward in terms of reliability, efficiency and safety". "All three of them are important, and with low-charge ammonia, you get all three in a single package," he said.

While Star is focusing on low-charge systems for its existing industrial applications, Pearson noted that, "the door is also open to wider use of ammonia, for example in building services, or in chillers in ice rinks".

Ammonia came out on top as a refrigerant for heat pumps in a paper presented at Gustav Lorentzen by Kashif Nawaz, Moonis Ally Raza and Omar Abdelaziz of the Oak Ridge National Laboratory, Tennessee.

The researchers assessed the performance of selected HFCs (R134a and R410A), ammonia and propane in four different heat pump systems. These range from a simple configuration made up of four components to more sophisticated ones using flash tanks.

For all systems, the evaporating (10°C) and condensing (40°C) temperatures were fixed to produce comparable results and allow for an efficient compression process.

In terms of COP, researchers found ammonia to have the highest efficiency in all cases. The difference with R134a was particularly striking. Ammonia was also found to have the lowest mass flow rate among the selected refrigerants.

Together with their optimal volumetric capacity, NH_3-based systems were also found to be more efficient and more compact than their HFC-based counterparts under analysis.

Thanks to its comparatively smaller mass flow rate, ammonia also has the smallest overall environmental irreversibility. By contrast, when using HFCs in thermodynamic processes such as heating and cooling, it is significantly more difficult to restore the environment to its own initial conditions.

HYDROCARBONS: BEST FOR LIGHT COMMERCIAL

The properties of hydrocarbons make them the best-performing refrigerants for light commercial applications, said Cláudio Melo, a professor at the Polo research lab, Federal University of Santa Catarina, Florianópolis, Brazil.

"Hydrocarbons have equal or better heat transfer performance and lower pressure drop compared to R22 and R134a," Melo said in a keynote Gustav Lorentzen presentation.

In addition, "hydrocarbons mix very well with mineral oils both in the liquid and vapour phases," he said. "The hygroscopic synthetic oils used with HFCs can thus be avoided."

Melo pointed out that most of the materials used in HFC refrigeration systems could also be employed for hydrocarbons. These include neoprene, Viton, nitrile rubber and nylon.

There is also a strong business case for adopting hydrocarbons over HFCs, Melo said, starting with cost. "Hydrocarbons such as isobutane and propane are substantially less expensive than HFCs," he said.

Moreover, a refrigeration system designed for hydrocarbons will typically need "50-60% less refrigerant by mass when charged with hydrocarbons," Melo said.

In addition, "the energy efficiency of hydrocarbon units is frequently claimed to be up to 30-40% better than comparable HFC units," he said.

"5% to 10% of this improvement can be accredited to better thermodynamic and transport properties," Melo said. "The rest is most likely due to component modifications such as improved compressor or heat exchanger design, as well as variable speed drives."

All this innovation with natural refrigerants, then, should help to improve their HVAC&R performance as companies begin to develop the next generation of technology. ■ AW & DB

ATMO sphere Business Case for Natural Refrigerants

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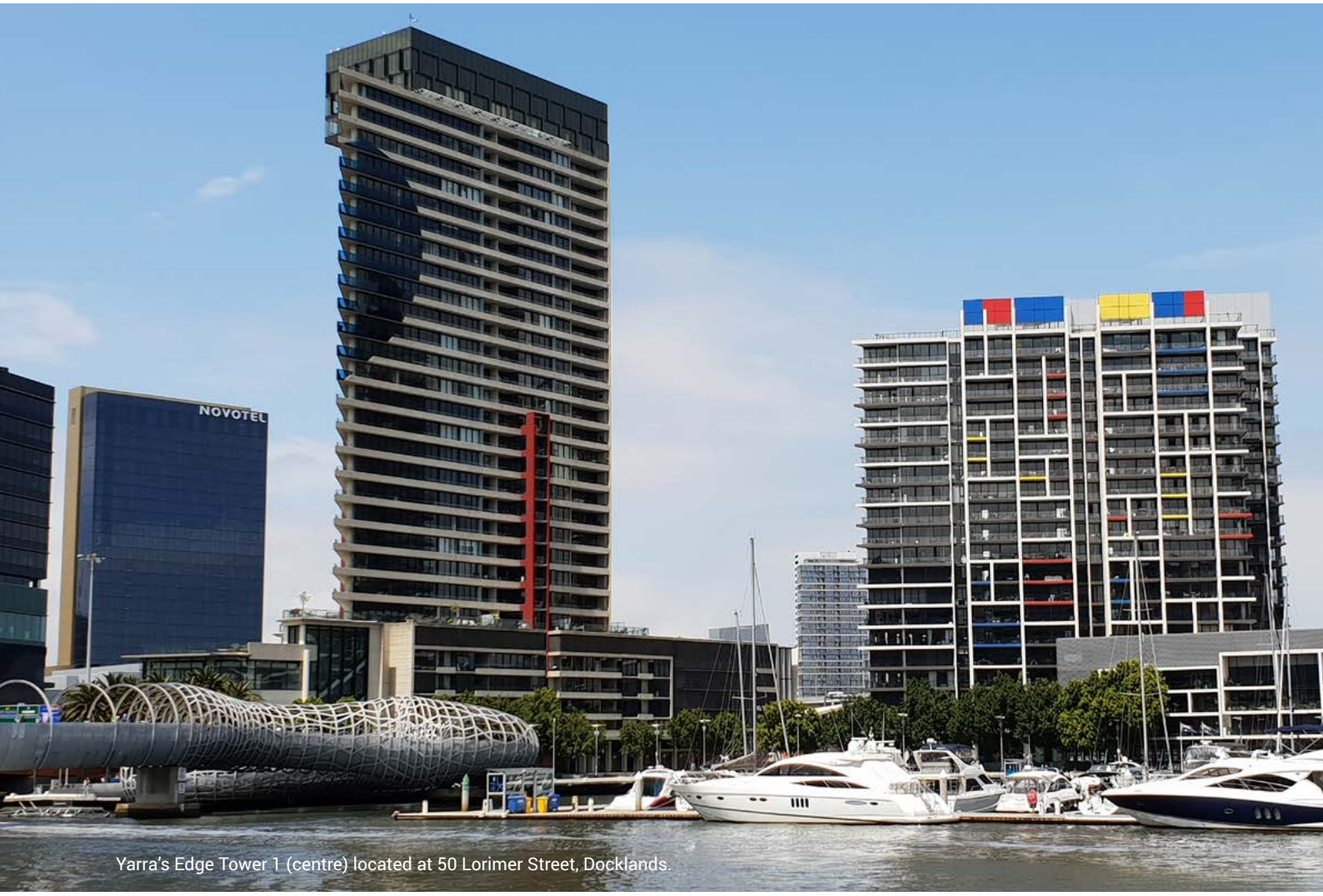
SUPPLYING DOMESTIC HOT WATER WITH CO_2 HEAT PUMPS

As gas prices in Australia continue to rise, so too is interest in CO_2 heat pump technology – with local technology suppliers ready to meet that demand. Installing a CO_2 heat pump at a residential complex in Melbourne is reducing hot water boiler gas consumption by 25-30%. *Accelerate Australia & NZ* reports.

– By Devin Yoshimoto



Yarra's Edge Tower 1 (centre) located at 50 Lorimer Street, Docklands.

Photography by: Automatic Heating Global Pty Ltd

Itomic Eco-Cute 15kW High Temperature CO_2 Heat Pump

In August 2018, Melbourne-based Automatic Heating Global commissioned a CO_2 hot water heat pump at a residential apartment building in Melbourne's Central Business District (CBD).

The CBD installation is just one of several CO_2 heat pump projects the company has planned in the near future.

"This is one of several CO_2 heat pump projects we currently have underway in Australia and New Zealand," Automatic Heating Global's Business Development Manager Terry Plaisted told *Accelerate Australia & NZ*.

Interest in CO_2 heat pumps, according to Automatic Heating Global, is being driven by recognition of their various benefits over traditional boiler technology, including: reduced dependence on fossil fuels, improved energy efficiency (especially in cold climates), and reduced overall environmental impact.

Energy efficiency of heat pumps and CO_2

Simply put, CO_2 heat pumps supply hot water by employing the refrigeration cycle in reverse – extracting heat from either the ambient air, from the ground, or from another water source, and using it to heat and store water for use in a wide range of industrial, commercial and residential applications.

Heat pumps are significantly more efficient compared to conventional technology such as electric, gas or oil boilers.

Automatic Heating Global's CO_2 heat pump boasts an average COP of 3.9, achieving close to four kilowatts of heating capacity for every kilowatt of energy input.

CO_2 is also a vastly superior heat transfer substance compared to synthetic refrigerants, when operating in cold ambient temperatures, or when supplying high temperature water (~90°C).

These benefits were among the main messages communicated by Automatic Heating Global, Mitsubishi Heavy Industries and Mayekawa, all of which exhibited CO_2-based heat pump technology at this year's ARBS exhibition of HVAC&R technologies in May (see '*NatRefs buzzing in Australia at ARBS 2018*', *Accelerate Australia & NZ*, winter 2018).

During a presentation made at ARBS, Automatic Heating Global's business development manager, Lachlan Shemilt, explained how rising gas prices and an increasing focus on environmental sustainability in Australia initially pushed the company to investigate and invest in natural refrigerant-based heat pumps.

"It all started when we had some requests from customers for non-gas sites," said Shemilt.

"Though we're a supplier of heating equipment – predominantly gas-fired boilers – in Australia and New Zealand, we had some sites where it was non-gas and some requests from customers for non-gas applications and high water temperatures," he explained.

"Our extensive research led us to partner with a leading Japanese manufacturer, Nihon Itomic, which has a solid foundation and a long history in water heating innovation and technology. After testing some EcoCute CO_2 heat pumps in our factory, we verified their exceptional performance and ideal application for high-temperature domestic hot water," he said.

Shemilt explained that when the company did some initial return-on-investment calculations, the CO_2 heat pump's performance advantages over LP gas boilers were very significant.

During the initial testing phase, Automatic Heating Global saw an "operating cost of about 75% less than an LP gas boiler," said Shemilt.

Taking advantage of off-peak power

Fast-forward a couple of months later to July, and Plaisted explained that this CO_2 heat pump installation in Melbourne was motivated by reducing dependence on fossil fuels, and by energy savings achieved through efficient hot water production.

"Our client had a need to replace their hot water system and was also looking for opportunities to reduce their gas consumption," said Plaisted.

At this particular Melbourne residential complex, the client decided to go with "a hybrid solution by using a combination of high efficiency gas boilers and a CO_2 heat pump, after reviewing the savings demonstrated and seeing that a COP of 3.9 was available," Plaisted said.

"Up to 30% of the daily hot water load can be produced and stored at night during off peak times. This reduces CO_2 emissions by running the heat pump instead of the gas boilers. We also expect to see a 25-30% reduction in gas consumption," he added.

Asked what Automatic Heating Global had learned from the process, Plaisted said, "we established from this installation that the efficiency of domestic hot water systems can be increased by using a combination of modern gas condensing boilers and CO_2 heat pumps".

In view of the ability of CO_2 heat pump technology to deliver a number of environmental and economic advantages to developers, building managers and end users, the company is confident in the opportunities going forward.

"Demand for CO_2 heat pumps has increased significantly this year, and we will no doubt see more and more inquiries in the future," concluded Plaisted. ■ DY

> *"Demand for CO_2 heat pumps has increased significantly this year, and we will no doubt see more and more inquiries in the future."*
>
> – Terry Plaisted, Automatic Heating Global

CO_2 heat pump system specifications

Installation location: *Yarra's Edge Tower 1, Lorimer Street, Docklands, Melbourne, Victoria*

- Apartment building: 175 apartments, 32 floors
- Application: Domestic hot water
- Make: Nihon Itomic
- Model: CHP-15HF
- Hot water supply: 270 litres per hour @ 50°C rise
- Heating capacity: 15 kW
- Inlet water temperature: 30°C
- Outlet water temperature: 80°C
- Average COP: 3.9
- Ambient temperature specified operating range: -25° to +40°C
- Total peak demand water supply: 10,000 litres per hour (including gas boiler)

AMMONIA 21

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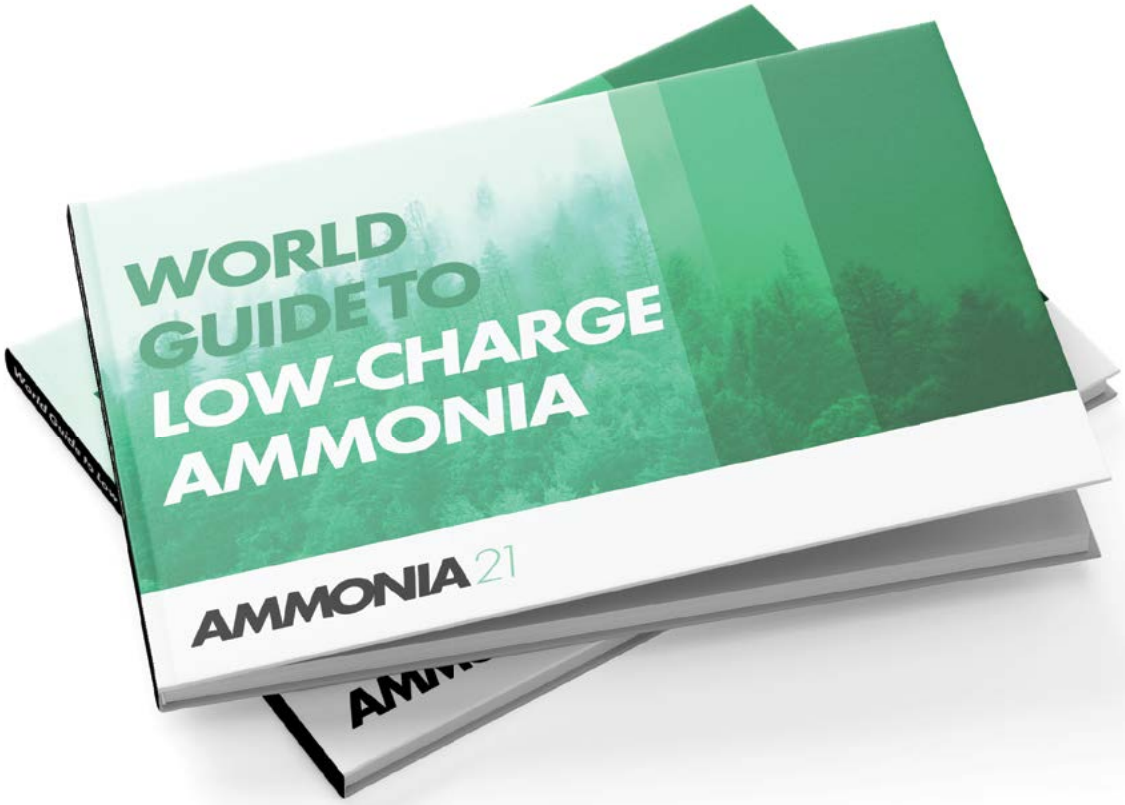

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INDUSTRIAL REFRIGERATION: A COMPETITIVE MARKET

Competition between natural refrigerants in industrial refrigeration is growing. The low-charge trend is attracting new customers to ammonia, while new technology is bringing CO_2 to higher capacities. All this innovation is helping industry to phase down synthetic refrigerants and improve energy efficiency. *Accelerate Australia & NZ* reports.

– By Devin Yoshimoto

RIGHT
ScanPAC engine room for Scantec central-style, low-charge NH_3 plant in Mackay, North Queensland.

Photography by: Marty Pouwelse Photography

Ammonia's superior performance as a heat transfer substance, compared to synthetic refrigerants, for use in large industrial-sized refrigeration plants is already well known.

"Ammonia has a low boiling point [...] and a high latent heat of vaporisation eight times higher than R12 and six times higher than R134a," says HVAC&R industry body ASHRAE in its position paper on ammonia (NH_3) as a refrigerant.

This is one reason why ammonia is the only natural refrigerant that has been consistently in use since the emergence of modern refrigeration technology in the mid-1800s.

According to the International Institute of Ammonia Refrigeration (IIAR), NH_3 was first used as a refrigerant in the 1850s, in France.

Yet as demand for industrial refrigeration grew, so did the amount of ammonia used in refrigeration systems.

As Terry L. Chapp of the International Association of Refrigerated Warehouses put it in a 2014 white paper, "for decades, refrigeration was regarded by many as simply the cost of doing business and the dictum was often, 'just make sure it's cold'".

"With this perspective as a backdrop, both facilities and refrigeration systems grew dramatically in size. Accompanying the growth of the refrigeration system was a consequent growth in the ammonia charge of the facility," Chapp wrote.

Worldwide, the HFC phasedown taking place under the Kigali Amendment to the Montreal Protocol – as well as the drive to save costs by improving energy efficiency – is triggering renewed interest in natural refrigerant-based systems for industrial refrigeration.

The rise of low-charge ammonia systems – and the proliferation of transcritical CO_2 systems – is therefore timely as Australia's industrial refrigeration sector begins to adopt energy-efficient alternatives to HFCs.

Riding the low-charge ammonia wave

Smaller amounts of ammonia are now being used without compromising on energy efficiency.

In October, for example, Scantec Refrigeration Technologies commissioned a central-type, two-stage and low-charge ammonia system in Mackay, North Queensland.

The ammonia plant serves a cold storage and food service distribution facility and is notably, "the smallest low-charge central system designed and constructed by Scantec so far," according to the firm's managing director, Stefan Jensen.

The system's low- and medium-temperature design capacities are both approximately 50 kW respectively, with a total ammonia charge of some 500 kg.

Competition between natural refrigerants in this area is growing. "The capacity range is well and truly within the area previously reserved for HFC-based solutions and is now occupied by a large number of transcritical CO_2 solution providers," says Jensen.

The Mackay installation replaced an R404A system that was over a decade old, "comprising multiple air-cooled, single compression stage, multiplexed condensing units, and electric defrost," Jensen says.

"It is believed to be the first 'real' HFC-based system being replaced with a small-scale, low-charge NH_3 system in Australia – and possibly anywhere," he notes.

Currently the system is still in an early phase of operation. At the time of going to be press, adjustments were to be made after receiving just over a month's worth of operational data.

Jensen expects actual energy performance data to soon become available in order to compare the new low-charge NH_3 system to the previously installed R404A one.

This "will enable a simple 'before' vs. 'after' comparison because the plant owner remains the same and the activities conducted in the warehouse remain unchanged before and after the conversion," Jensen says.

"The plant is located in tropical North Queensland, where transcritical CO_2-based solutions will struggle to deliver acceptable energy efficiencies regardless of the number of energy-efficiency measures that are added," he says.

Jensen expects to be able to analyse the recorded energy consumption figures sometime next year.

Reducing the ammonia charge in this way, combined with the superior energy efficiency of these systems compared to their HFC-based counterparts, is driving interest and innovation in new ammonia systems, according to Jensen.

Advansor's first CO_2 transcritical rack in Australia in Keysborough, Melbourne, for a United Food Express cold storage warehouse.

Describing Scantec's own central-style, low-charge ammonia systems at this year's ATMOsphere Asia conference, held by *Accelerate* publisher shecco in Singapore in September, Jensen said, "the ammonia charge in the freezer evaporators is so low that in the event of one evaporator emptying itself completely, the ammonia concentration in the freezer can never ever exceed 100 ppm – which is way, way below the IDLH value". IDLH refers to the concentration above which the ammonia becomes 'Immediately Dangerous to Life or Health'.

Arguing that their energy efficiency is driving uptake of these systems, Jensen says, "low-charge ammonia is by far superior to HFCs, transcritical CO_2, single-staged economised ammonia with liquid overfeed, or any other concept. This is based on energy performance records that have been measured in a real-life warehouse".

CO_2 scaling up

As for CO_2, many companies see significant market opportunities for this natural refrigerant to be used more widely in industrial applications, thanks both to the generally lower cost of CO_2 systems compared to their comparable ammonia counterparts, and their ability to provide significant amounts of heat reclaim.

In November 2017, Danish system manufacturer Advansor's first transcritical CO_2 rack in Australia was commissioned at a United Food Express cold storage warehouse in Melbourne (see p. 62, *Accelerate Australia & NZ*, summer 2018 edition).

Local contractor Lucas Refrigeration worked with United Food Express to replace the firm's old R404A system with an all CO_2-based system.

The Natural Refrigerants Company, which represents Advansor in Australia, sees more opportunities for large-scale installations of transcritical CO_2 systems in the country.

"Due to the 'semi-industrial, semi-commercial' nature of CO_2 systems, they come at a reduced initial cost compared to equivalent NH_3 systems," says Jonathon Hare, a refrigeration engineer at the Natural Refrigerants Company.

Hare argues that, "although early evaluations show that a standard, air-cooled, parallel compression CO_2 system uses more energy than the equivalent evaporatively condensed NH_3 system, due to the offset of the [lower] initial cost, the lifecycle costs are much the same, if not less for the CO_2 system".

"The other factor is the availability of massive amounts of high-temperature heat reclaim. In industrial applications, there are many instances where this is a huge win for the end user in terms of their specific processes," he says.

Hare argues that as technology innovation increases, CO_2 systems will achieve ever larger capacities and reach a wider range of applications.

"Currently CO_2 industrial systems often simply use commercial equipment for an industrial project, such as a cold storage distribution centre," he says.

"They still include the likes of air-cooled gas coolers, electric defrost, and such like in the design," he adds.

Hare believes, "this skews the energy comparisons when stacked up against NH_3, which is inevitably evaporatively condensed, with hot gas defrost, etc.".

> *We can very easily see a future where the same contractors competing for supermarket installations and service contracts are doing the same at our distribution centres. And I don't think that future is far away.*
>
> – Woolworths Sustainable Innovations Engineer, Dario Ferlin

"Once these more energy-efficient design concepts are incorporated into CO_2 system design for future industrial or commercial systems, we will have a better gauge on the actual energy performance compared to other refrigerants or systems," he argues.

"Once this difference is better understood, I believe, the adaptation of CO_2 will increase even more in this sector," he says.

All about design

Most technology suppliers would agree that good energy performance always comes back to good system design, as well as technological innovation.

This is especially true in industrial refrigeration, where customers' system and temperature requirements vary significantly from installation to installation, even within the same company.

"As industrial guys traditionally, we know that NH_3 is an amazing refrigerant and will always have huge benefits in several applications," says Hare.

"But it is important to keep in mind that there is no ideal refrigerant, and that a poorly designed system will be inefficient, and perhaps unreliable, no matter the refrigerant used," he adds.

Scantec's Jensen echoes this by saying, "energy performance is all about system design".

"There can be a factor two or even three difference between the annualised energy performances of two systems both employing NH_3 and performing exactly the same refrigeration duties," Jensen says.

The performance of the refrigeration plant installed last year at F. Meyer's cold storage warehouse in Melbourne demonstrates this (see cover story, *Accelerate Australia & NZ*, summer 2017 edition).

Australian firm Strathbrook Industrial Services, led by Ian Wilson, designed and installed the system. Strathbrook focused on design to take full advantage of the strengths of both CO_2 and ammonia – using a CO_2 transcritical system in conjunction with an ammonia chiller – to serve the facility's needs efficiently.

"This system warms the freezer floor and sub-cools the liquid line at the same time," Wilson told *Accelerate Australia & NZ* last year. "So the floor heating is free and the compressor COP goes up at the same time."

Optimal system design is vital, because the energy efficiency of CO_2 drops dramatically when outside temperatures rise above 28°C.

Wilson mitigated this by installing an outdoor ammonia chiller to keep the temperature of the CO_2 below this point all year round, which is important in summer.

"Here, in Australia, it's 30 degrees and above for three or four months a year constantly, so from time to time, the system would have to run supercritical. And when it runs supercritical, the compressor capacity is half and the power consumption is double," Wilson explains.

"It goes from being this really energy efficient thing to something that won't compete with R134a. When you add the chiller outside, that means this plant thinks it's winter all year round, because when it's not winter, the chiller makes it behave like it's winter, meaning it's always super energy efficient," he says.

Tackling costs, improving training

The initial cost of new technologies, especially in the energy sector, is often higher than existing technology, because the new technology takes time to mature in the market.

"Everyone wants a natural refrigerant plant," says Strathbrook's Wilson. "They all want energy savings, but not everybody is prepared to pay for it."

At ATMOsphere Asia 2018, Jensen provided some perspective on the initial capital costs of these new systems based on his experience.

"I'll give you a real-life example of a simple cold store in central New South Wales," Jensen said. "Freon – A$400,000 capital cost. Transcritical CO_2 – $600,000. Ammonia DX – $900,000. These are real numbers."

> *It is important to keep in mind that there is no ideal refrigerant, and that a poorly designed system will be inefficient, and perhaps unreliable, no matter the refrigerant used.*
>
> – Jonathan Hare, Natural Refrigerants Company

F. Meyer cold storage warehouse in Melbourne with CO_2 gas cooler and two ammonia chillers.

"The step from Freon to transcritical CO_2 is real easy because that differential investment of $200,000 is returned in three to four years. The step from transcritical CO_2 to ammonia DX in this scenario is much more difficult, because the difference in capital cost from $600,000 to $900,000 is a ten-year payback in that order. So, we cannot overlook the simple economics," Jensen said. Given that the lifetime of industrial systems is generally 15-25 years, long-term efficiency gains also favour natural refrigerants.

To facilitate wider rollout of natural refrigerant systems, there is also a need for more industry-wide training to support the ongoing maintenance and service needs of new industrial systems – particularly CO_2 transcritical.

"The biggest barriers now for CO_2 are the same industry issues that we talk about every day in Australia," says Hare.

"These are training and licensing. If we pushed harder into natural refrigerant training as a standard for Cert III technicians, licensing to qualified personnel, the industry barriers would be reduced," he argues.

Hare says that the Natural Refrigerants Company is committed to overcoming the training barrier and is encouraged by recent results.

"We've clearly found that once the local technicians are trained, lose the 'fear' and understand the design concepts, they take to transcritical CO_2 systems like ducks to water," Hare says.

In the commercial refrigeration sector, food retail end users like Woolworths are beginning to see more overlap between natural refrigerant technology options available to them for both supermarkets and distribution centres.

"What potential do we see for transcritical CO_2 systems being used in industrial applications in Australia? In short, huge!" says Woolworths' Sustainable Innovations Engineer Dario Ferlin.

"Ammonia certainly has its place, particularly in the northern warmer climate zones. But ammonia also has its challenges. The pool of available ammonia specialists is very limited, whereas the potential to up-skill the commercial refrigeration industry to take on transcritical CO_2 is significant," Ferlin says.

"We can very easily see a future where the same contractors competing for supermarket installations and service contracts are doing the same at our distribution centres. And I don't think that future is far away," he argues.

The proliferation and further development of these new natural refrigerant-based systems indicates that the market-ready alternatives to synthetic refrigerants in industrial refrigeration are out there.

The depth of opinion among manufacturers would indicate that there is no single best natural refrigerant system for every application.

What's clear is that the innovators active in Australia today will continue to push the boundaries of what ammonia and CO_2 can achieve in industrial refrigeration – further improving their competitiveness vs. synthetic refrigerant-based systems. ■ DY

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