

AUTUMN 2018

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ADVANCING HVAC&R NATURALLY

A U S T R A L I A & N Z

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CELEBRATING THE PIONEERS

— Editor's Note by Andrew Williams

Tim Edwards, the former president of the Australian Refrigeration Association, was well known in the HVAC&R industry as a passionate advocate of the role played by natural refrigerants in delivering a more sustainable future.

As we mourn his passing, it is worth taking stock of the progress that has already been made to put our sector on a more environmentally sustainable footing.

This issue of *Accelerate Australia & NZ* focuses on pioneering companies who have helped to make the business case for natural refrigerants as alternatives to HFCs. Check out our cover story for profiles of these 15 Movers & Shakers ([p. 22](#)).

Amid rising energy costs in Australia, ALDI understands the energy-efficiency benefits of opting for natural refrigerants. It is currently adopting CO₂ transcritical systems in supermarkets in Australia ([p. 18](#)).

AIRAH's Refrigeration 2018 conference showcased progress made in installing and developing natural refrigerant-based technologies in Australia. Our event report highlights the need for more training and education to help NatRefs to fulfil their market potential ([p. 44](#)).

The market prospects for natural refrigerant systems in Australia and New Zealand are picking up as more end users become aware of the need to phase down HFCs under domestic and international regulation. On 7 May, our ATMOSphere Australia conference will bring together end users, contractors, suppliers and policymakers to discuss current trends for natural refrigerants in the region. [Check out the programme on page 40.](#)

Low-charge ammonia systems are becoming increasingly competitive and popular as design improves and new players enter the market. Scantec Refrigeration Technologies has recently installed its largest such system to date ([p. 54](#)).

Meanwhile, HVAC&R system and component supplier Heatcraft is seeking to play a leading role in accelerating Australia's transition away from HFCs towards natural refrigerants ([p. 62](#)).

Beyond these shores, progress is being made in bringing natural refrigerants to new parts of the world. METRO China – part of German retail giant METRO AG – has installed the Chinese retail sector's first CO₂ transcritical system, in a METRO wholesale store in Beijing ([p. 28](#)).

Alan Lin from METRO China was among the presenters at our first ever ATMOSphere conference in the country, held in Beijing on 9-11 April. The event sought to assess the market prospects for wider uptake of natural refrigerants in China. [Read our report on page 50.](#)

Award-winning professor, researcher and entrepreneur Pega Hrnjak is a familiar face to those who follow natural refrigerants. In our interview, he sheds light on his quest to optimise the use of natural refrigerants in myriad HVAC&R applications ([p. 66](#)).

Features on propane air conditioning in an Italian supermarket ([p. 32](#)) and on ultra low-charge ammonia for cold storage in the US ([p. 36](#)) are among the other stories waiting for you in this edition.

The coming weeks will be exciting ones for supporters of natural refrigerants in Australia and New Zealand. I look forward to joining in the conversation at ATMOSphere Australia and at ARBS!



Andrew Williams
Editor

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ACCELERATE

ADVANCING HVAC&R NATURALLY

A U S T R A L I A & N Z

About *Accelerate Australia & New Zealand*

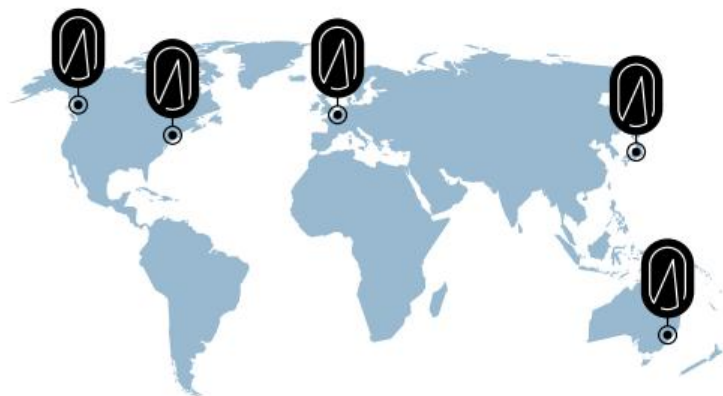
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#GoNatRefs



MAY-JUL

07.05**ATMOsphere Australia 2018
Sydney, Australia**

ATMOsphere Australia 2018 returns to Sydney and will bring together more HVAC&R industry leaders from Australia and New Zealand to discuss the region's latest natural refrigerant developments.



www.atmo.org/australia2018



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**08-10.05****ARBS 2018
Sydney, Australia**

The Air Conditioning, Refrigeration & Building Services Exhibition (ARBS) is Australia's premier exhibition for Air Conditioning, Refrigeration & Building Services.



<http://arbs.com.au>



@arbsexpo #arbs2018

08-11.05**Australian Energy Week 2018
Melbourne, Australia**

Australian Energy Week is the annual meeting place for stakeholders of all levels from the entire energy supply chain.



www.energyweek.com.au



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09-11.05**Data Center Expo
Tokyo, Japan**

Data Center Expo brings together solutions related to the energy-efficient operation of data centres including building energy management systems and cooling systems such as air-conditioning systems and fans.



<https://bit.ly/2qJ41fB>

14-16.05**4th China International
Refrigerating Vehicles and
Shanghai Freezing Equip-
ment & Cold-Chain Logistics
Technology Exhibition (CCLE
CHINA) 2018
Shanghai, China**

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www.coldchainfair.com/cold/en/

16-18.05**China International Cold Chain
Expo (ICCE) 2018
Shanghai, China**

The China International Cold Chain Expo (ICCE) is one of China's largest exhibitions displaying cold chain solutions for transportation, warehousing, processing, distribution and delivery.



<https://bit.ly/2vuh3DA>



MAY—JUL

22-24.05

China International Trade Fair for Heating, Ventilation, Air-Conditioning, Sanitation & Home Comfort Systems (ISH China & CIHE) 2018
Beijing, China

This is one of China's leading trade fairs gathering the world's leading brands within the HVAC and plumbing industry.



<https://bit.ly/2HbFBm0>

12-14.06

ATMOsphere America 2018
California, USA

ATMOsphere America 2018 will be held at the Hyatt Regency hotel in Long Beach, CA, bringing together 450+ experts, policymakers and end users to discuss the latest developments in the HVAC&R industry.



www.atmo.org/america2018



@ATMOEvents #ATMOAmerica

12-15.06

International Food Machinery & Technology Exhibition (FOOMA) Japan 2018
Tokyo, Japan

The International Food Machinery & Technology Exhibition (FOOMA JAPAN) is a comprehensive trade show for food machinery and food processing technologies.



www.foomajapan.jp/english

12-15.06

Consumer Goods Forum Global Summit
Singapore

The Consumer Goods Forum's annual Global Summit brings together retailers, manufacturers and service providers to discuss future business trends, network and share knowledge and best-practices for overcoming today's most pressing challenges.



<https://bit.ly/2qKOkog>



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11-13.07

Sustainable Development Conference 2018
Bangkok, Thailand

The 6th Annual Sustainable Development Conference focuses on green technology, renewable energy and environmental protection, gathering business leaders, scholars and government officials.



www.sdconference.org



AUSTRALIA & NZ IN BRIEF

New Zealand firm opens online NatRef training course

Gauge Refrigeration Management launched a new online course geared towards natural refrigerant safety training, called 'The Natural Refrigerant Academy', in New Zealand in February.

The company, which regularly conducts safety training for businesses throughout New Zealand, has identified some common difficulties faced by clients.

"The number one difficulty for end users was pinning all their staff down to be in the same place at the same time," said Padraic Durham, Gauge Refrigeration Management. "[Secondly], businesses predominantly provide the in-depth training for key engineering and safety workers."

By taking advantage of cloud-based learning management systems, Durham hopes the course will make proper training more accessible for all users of natural refrigerant-based refrigeration systems.

"The online ammonia induction [course] allows for a cost-effective and rapid solution for both of these issues – more importantly, access for everyone who should know about the hazard; from the cleaners to the CEO," said Durham.

"New Zealand has clear regulations that require businesses to provide training for workers around hazardous substances, so being able to provide proof of comprehension through the online portal is a great advantage," he added.

The course is currently focused on ammonia-based refrigeration systems and is targeted towards site workers, contractors and visitors.

In the future, Durham hopes to include courses on all natural refrigerants. "Our experience is predominantly ammonia, although there are many similarities in managing all natural refrigerants," said Durham. ■ DY

Digital smart card licensing solutions launched in Australia

In an effort to help support the continued upskilling of Australia's HVAC&R technicians in view of the HFC phasedown, new digital licensing solutions are emerging that are modernising the trade while at the same time encouraging the use of qualified technicians in the industry.

The Australian Refrigeration Council (ARC), Australia's official licensing body, has announced it will be releasing an 'ARC smart card' solution in the coming months.

"The new 'smart card' technology would be used in conjunction with a free phone app," said an ARC representative. "The smart card will aim to identify technicians as being licensed, enable improved functionality, and provide convenience and access to valuable technical resources."

The smart card release follows ongoing ARC initiatives that aim to promote proper training and support for technicians working with natural refrigerants.

The ARC Green Scheme Accreditation is a voluntary accreditation programme intended to provide an upskilling pathway for RAC technicians in Australia who work with natural refrigerants (hydrocarbons, CO₂ and ammonia) and other low-GWP alternatives.

Additionally, in March, the Australian Refrigeration Mechanics Association (ARMA), in collaboration with the Australian Refrigeration Association (ARA), launched a new digital licensing solution called the ARMA Refrigeration & Air Conditioning Smart Card.

"In support of Australia's international agreements to reduce greenhouse gas emissions, the ARMA Smart Card benefits include raising consumer awareness and ensuring appropriately skilled tradespeople are carrying out the work," said ARMA on its website. ■ DY

Australian firm fined \$12,600 for f-gas imports

In January, the Australian Department of the Environment and Energy fined a New South Wales-based dealer \$12,600 for importing vehicles with air-conditioning units containing an unnamed synthetic refrigerant gas with a global warming potential (GWP) of 1,430.

R134a, an HFC, is commonly used for mobile air conditioning in cars and larger vehicles. It has a GWP of 1,430.

The importer of the vehicles received the fine for not having an appropriate licence to import cars with air conditioners containing f-gases.

The Department of the Environment and Energy noted in a press release that the firm had "incurred significant warehousing costs and business delays" for not possessing an import licence for this equipment.

Australia began phasing down HFCs this year under its updated Ozone Protection and Synthetic Greenhouse Gas Management Act.

A licence or exemption is required to import equipment containing high-GWP and ozone-depleting-potential (ODP) refrigerants.

The Australian government recommends that importers and customs brokers check the legislation on importing or exporting goods containing synthetic refrigerant gases that affect the environment.

It also stresses that this legislation applies to gases that are contained within equipment and not just the importation of the gases themselves.

They also note adequate time should be allowed to apply for a licence or exemption, which can take up to 60 days.

The maximum penalty for each import offence is \$2,100,000. ■ CM

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ARBS 2018

8-10 May 2018 ICC Sydney, Darling Harbour

AUSTRALIA & NZ IN BRIEF

Beijer Ref acquires Heatcraft Australia

The Swedish company, by acquiring Sydney-based Heatcraft Australia Pty Ltd., has now doubled its sales in the Asia-Pacific region.

Heatcraft, owned by Lennox International Inc., is one of the largest refrigeration wholesalers in Australia and New Zealand. It has a strong background in CO₂ and manufactures CO₂ unit coolers, condensers, racks, condensing units and refrigeration systems.

It also works in China and Singapore where it supplies refrigeration equipment, refrigerants and spare parts to customers all over Asia. Sales are made through a large distribution network with over 65 branches.

In addition to wholesale operations, Heatcraft has a manufacturing unit in Wuxi, China, where the heat exchangers and cooling units included in the deal are produced. The acquisition also includes just over 5% of the shares in Thai compressor manufacturer Kulthorn Kirby, which makes R290 and R600a compressors for commercial and household refrigeration units.

"We expect that Australia in particular will comply with the European directives to phase out environmentally hazardous refrigerants," said Per Bertland, CEO of Beijer Ref. "With the acquisition of Heatcraft, we are even better positioned in the market for green technology which we believe will grow significantly."

Heatcraft employs more than 300 employees and sales in 2017 amounted to approximately SEK 1.1 billion (170,500,000 AUD).

The business will initially be continued in its existing form and under the brand Heatcraft. The completion of the agreement is scheduled for April 2018. ■ CM

Info sessions on HFC phasedown

The Australian Department of Environment and Energy has announced that there will be additional HFC phasedown information sessions held later this year to inform the industry on what the legislation means for the refrigeration and air-conditioning sector.

At the beginning of this year, the Department held information sessions on the east coast in Sydney, Melbourne and Brisbane.

April's sessions were held in Chatswood (NSW), Sydney Airport, Melbourne and Geelong.

In May, there will be a singular info session in Perth on the 18th. In June there will be sessions held in Adelaide (1st), Townsville (14th), the Gold Coast and Brisbane (both on the 15th). The additional info sessions will conclude in Darwin on 18 July (TBC).

The Department of Environment and Energy stated that the info sessions "will discuss what the hydrofluorocarbon (HFC) phasedown means for HFC users, including equipment owners and technicians, and other changes to the Ozone Protection and Synthetic Greenhouse Gas Program to reduce emissions and increase efficiency".

The HFC phasedown, announced by the Government in June 2016, began this year with first reduction steps taken on 1 January 2018.

The info sessions are free to attend and can be registered for here: <https://www.eventbrite.com.au/o/the-department-of-the-environment-and-energy-15490163402>. ■ CM

AIRAH to hold ammonia workshops

The industrial ammonia courses will be held by AIRAH (the Australian Institute of Refrigeration, Air Conditioning and Heating) in May and August.

The first course on industrial ammonia plant operations will last for three days and is "designed for plant operators who need to be aware of the potential hazards associated with ammonia and a sound knowledge of how an industrial ammonia plant is operated," according to AIRAH.

The course involves both theoretical and practical components and takes place from 21-23 May and 20-22 August 2018.

It will also discuss legal requirements on installing ammonia systems.

A one-day course on ammonia emergency responses will equip those who attend with the skills to deal with a leak.

It will take place on 24 May and 23 August, looking at "control measures for liquid and vapour leaks [and] practical demonstration of a vapour leak," AIRAH states.

It is also possible to request a half-day training course on ammonia safety awareness at a facility, which can be held at any time during the year.

It includes an introduction to ammonia refrigerant legislation, Australian standards, safety, and risk management.

For more information on these courses and how to apply see here: http://www.airah.org.au/Content_Files/Education/Ammonia-courses/2018/Ammonia_2018.pdf. ■ CM

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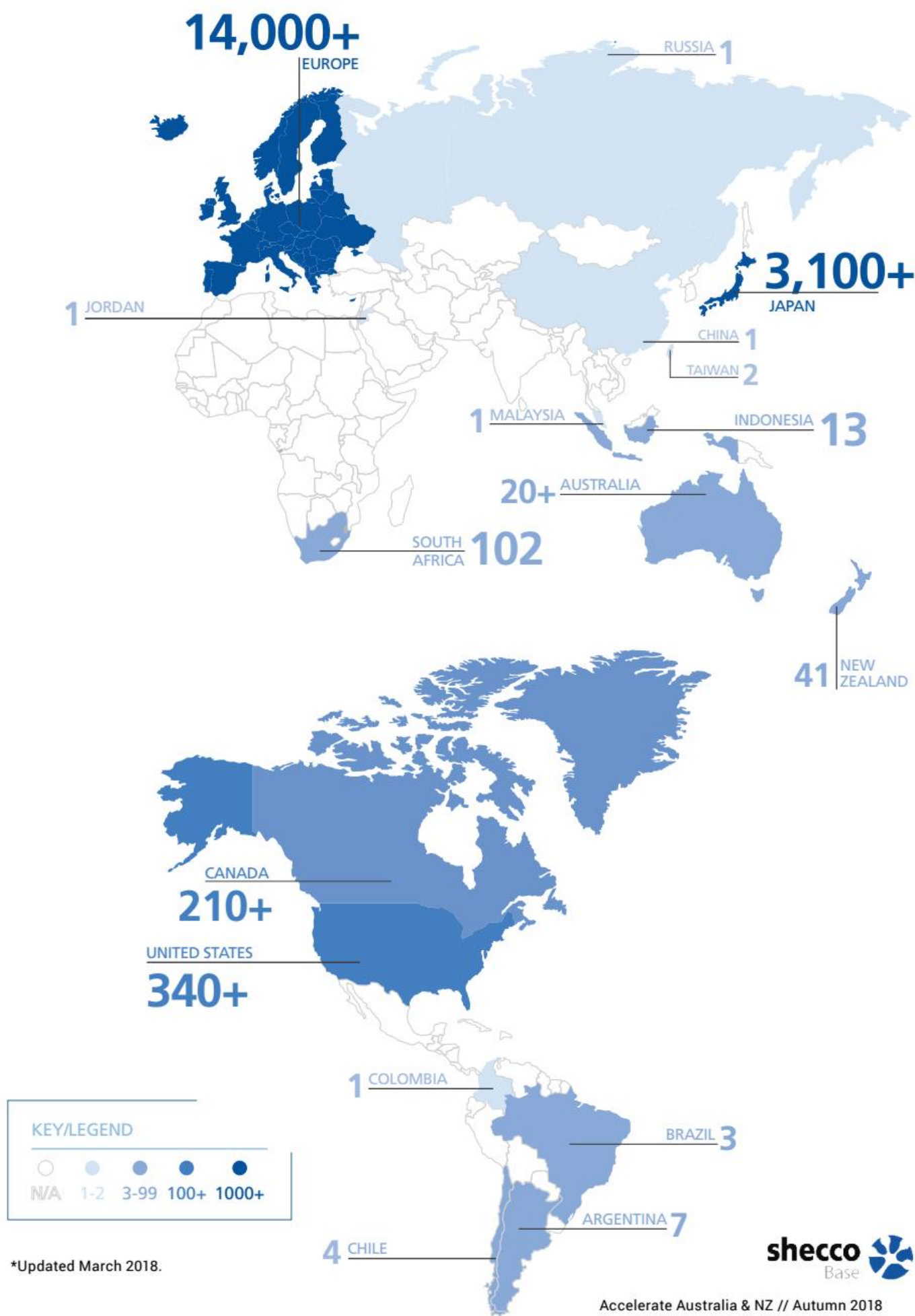
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Tim Edwards: A NatRef Legacy



On

16 February 2018, Tim Edwards, former president of the Australian Refrigeration Association (ARA) and a leading figure in Australia's HVAC&R industry, passed away.

During his tenure at ARA, he was well known in the industry as a passionate advocate of the role that natural refrigerants can play in delivering a more sustainable future, both in Australia and beyond.

"I first met Tim during the Gustav Lorentzen conference in Sydney back in 2010. I last saw him in Melbourne in December. Over these seven years I have had constant exchanges with Tim about the future of our industry and the role that natural refrigerants can play. These exchanges have been invaluable," says shecco CEO Marc Chasserot.

Describing himself as Canadian by birth and Australian by choice, Edwards worked for ARA for six years. He was also managing director of consulting group Strategic Initiatives, where he specialised in energy efficiency, refrigeration and environmental economics.

Edwards stepped down as ARA president in early 2017. His successor, Ian Tuena of CA Group Services, is another keen supporter of natural refrigerants in Australia.

"Ian, I just don't get it," says Tuena, recalling what Edwards once told him.

"We have the solution in natural refrigerants, but no-one wants to listen. No-one sees the wonderful opportunity laid out before them. I can accept that there are some circumstances where the natural solution can be difficult, but overall, the benefit outweighs the risk and we can engineer the majority of the risks out. Why is it so hard? I think human greed overrides good decisions and the sad thing is, it's the next generation who will pay dearly for that greed."

"These are the words Tim said to me as we were sitting together in the parkland near Mrs. Macquarie's Chair in Sydney some years ago. This is what drove Tim Edwards. His desire to provide a better future for the next generation. He was passionate about it. It was this passion that upset

the 'establishment'. He told it as it was and never took a backward step. He was prepared to confront and challenge and call out what he believed was poor policy and misinformation. It was this attitude that earned him a reputation for being confrontational – a reputation I believe to be unfounded. Why, you may ask? Because what Tim Edwards taught me was, if you have no passion and belief in the cause you are fighting for, then you have no cause to fight for."

"I am passionate about the HVAC&R industry. It is a sad reflection that as the train pulled into the station called Australia, on January 1st of this year, carrying the start of the HFC phasedown, the bulk of the industry still does not realise that, not only have we embarked on the single biggest change since 1935, but we are also ill-trained, ill-equipped and ill-informed for that change. We have a lot of work to do in retraining and raising the skill set to handle the refrigerants of the future. It is a real pity that those who could have made good decisions and prepared the industry for the inevitable failed to see the vision that Tim Edwards saw many years ago," says Tuena.

Edwards' background included 10 years in consumer products with General Foods and PepsiCo, and 10 years in transport with DHL and Qantas. His environmental consulting experience included work with non-profit Good Environmental Choice Australia (GECA), and periods as director of Ecoflex Australia and as sustainability manager at the Building Products Innovation Council.

The owner of KAV Consulting, Klaas Visser – another leading figure in Australia's HVAC&R industry – recognised Tim's wider appreciation of environmental sustainability.

"Tim Edwards was totally committed to trying to affect mitigation of the impact of climate change on all life forms on this planet over a long period of time in a number of capacities," says Visser.

"Tim had an all-comprehensive understanding, and appreciation, of the problems and implications of anthropogenic global warming, and its dire consequences. Other than Gustav Lorentzen (GL), I have during my 50-year-plus career rarely met a

man applying his great intelligence, with high integrity and energetic persistence, to making a real difference to the prospective liveability on this planet with admirable modesty and without expecting rewards."

"Like GL, Tim did not suffer fools gladly and the fools were often made aware of this. Formidable Tim has left large, hard-to-fill shoes. Although we occasionally had our differences, I am a better man for having known Tim and the world is a lesser place without him. RIP Tim, we will miss you."

Kim Limburg, chief executive officer of the Australian Refrigeration Mechanics Association and a close friend of Tim's, offered her thoughts as well.

"Tim Edwards – where does one truly start with describing someone as strong, passionate, ethical and dedicated to putting natural refrigerants on the map here in Australia as Tim?" says Limburg.

"My first contact with Tim was when he called me and I recall thinking, who is this guy? He can't be for real, surely? He's telling the truth about the industry and the barriers preventing groups such as ARA and ARMA from participating and implementing much-needed change in the HVAC&R industry. Surely, this guy with a Canadian accent can't be real?"

"The first few calls were with Tim gauging my 'backbone'. I recall saying 'Tim, be blunt. Just say it how it is.' And so began our very blunt relationship and we both loved it. I often refer to Tim as Iron Man – a will that bends to no-one. Anyone that knows Tim would agree how apt and befitting this description of Tim is."

"Tim bulldozed his way through to the top because he saw no-one was giving the natural refrigerant team here in Australia a look-in with industry consultation. If he was assertive towards you, it was a necessity because you either weren't listening, making poor choices for the industry, or putting barriers up against an industry wanting to move forward. Tim fought alongside me for the rights for refrigeration and air-conditioning tradespeople to be represented. He cared for all the right reasons and never wavered in his fight for justice. And as a loving husband, father and grandfather, Tim's passion was endless."



Tim Edwards, former president, Australian Refrigeration Association

"It was a privilege to stand side-by-side with Tim as his colleague and his loss weighs heavy on our hearts. I find solace in knowing the incredible contributions Tim achieved putting natural refrigerants and safety for tradespeople at the forefront of discussions. Tim funded and helped ARMA and ARA design the Mates Rates for Fridgys App, free to all. And when diagnosed with illness he was quick to ensure a strong leader stepped up to replace him as president of ARA, Ian Tuena. And boy did Ian step up. He literally hit the ground running and has shown his leadership is just as strong as Tim's – leaving Tim with the knowledge that he was leaving ARA – his legacy – in very capable hands."

"In December, I was able to catch up with Tim in Melbourne and knowing how important ARA is to Tim, I could see how relieved he was that Ian had stepped up. Tim has left a legacy that we as an industry must continue to support. My friend, my colleague, you are deeply missed and we thank you for your commitment to this industry. We will always remember you and shine an everlasting light on you and your achievements. Rest in peace my friend." ■



Typical first aisle in an ALDI store

ALDI BANKING ON NATURAL REFRIGERANTS IN AUSTRALIA

As energy costs continue to rise in Australia, German-based retailer ALDI is seeking to grow its share of Australia's supermarket sector through product differentiation and environmental sustainability. *Accelerate Australia & NZ* reports.

— By Devin Yoshimoto & Caroline Rham

Since ALDI opened its first store in Australia in 2001, the company has been growing steadily, claiming an increasing share of Australia's supermarket sector.

To date, ALDI Australia has opened more than 500 stores, along with eight distribution centres, spanning every state.

The company is part of Germany-based ALDI South (Süd), which is a leading adopter of natural refrigerant technology in both Europe and the United States.

In addition to Australia and the U.S., ALDI South operates in six countries in Europe (Austria, Hungary, Ireland, Slovenia, Switzerland and the UK), boasting a total of more than 5,000 stores.

The use of natural refrigerants plays a key role in ALDI South's global initiative to reduce greenhouse gas emissions by 30% by 2020 (compared to a 2012 baseline).

Accelerate Australia & NZ spoke to Marcus Meier, property director for ALDI Derrimut, about the company's experience with natural refrigerants so far and its path forward.

ANTICIPATING THE FUTURE

ALDI Australia's parent company, ALDI South, has been very proactive in adopting natural refrigerant technology both in Europe and via its subsidiary in the United States.

In Germany, the company is now installing transcritical CO₂ systems in all new stores.

In the UK last August, ALDI announced plans to convert all its stores to CO₂-based refrigeration systems. By the end of 2018, up to 100 outlets will be equipped with natural refrigerant-based systems at an investment of some AUD 35 million (€22m).

In the United States, the company is currently the number one user of transcritical CO₂ refrigeration systems in the U.S. supermarket industry,

counting more than 100 stores – with more on the way.

"ALDI as a company anticipated this technology transition 10 years ago and made it its goal to move to low-GWP solutions," says Meier, who is responsible for ALDI Australia's refrigeration development activities.

ALDI in Australia soon followed this trend. The company has been installing cascade CO₂/R134a refrigeration systems since 2012, in around 300 Australian stores.

Meier explains that investing in new technologies, including CO₂-based natural refrigerant systems, to phase out the use of R404A from stores plays a key role in achieving ALDI's sustainability goals.

"We have already achieved a 10-15% energy reduction and are expecting more," says Meier.

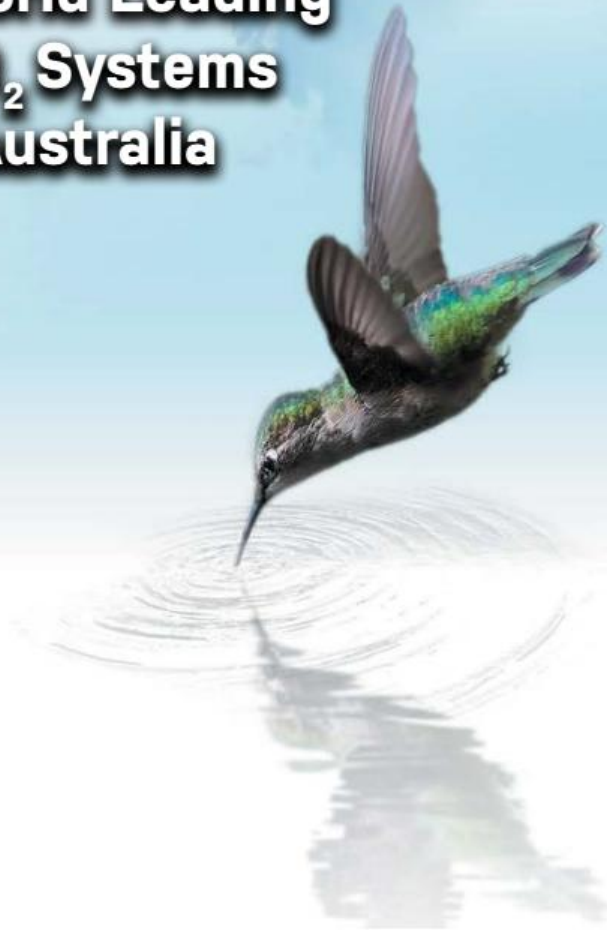
Additionally, ALDI includes the reduction and recycling of waste and the use of solar panels as a part of its sustainability strategy.

GOING TRANSCRITICAL

In 2007, the company began to look at transcritical CO₂ systems. This did not come without its challenges, however, as the technology was still in its early stages of development back then.

"Some of the challenges we faced with transcritical CO₂ at the time were, one, the size of the system and two, its efficiency issues in high-ambient temperatures," says Meier.

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by Hillphoenix

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1 / CO₂ condenser with adiabatic pads

2 / R290 freezer cabinets

"The footprint of the transcritical CO₂ system at the time was huge, but now you can put one on a pallet. Additionally, at the time, no supplier knew how to deal with the effect of high ambient temperatures on the system."

This, however, did not discourage Meier as he took his cue from what was happening with the development and rollout of transcritical CO₂ systems from his colleagues in Europe and the United States.

He knew it was only a matter of time before these systems would get cheaper and advanced enough to be implemented in Australia.

"We used what was happening with ALDI in Europe as a reference," he says.

Though Meier is now based in Melbourne, he has over 19 years of experience with ALDI in areas of operations and property management.

According to Meier, ALDI Australia's first transcritical CO₂ system installation was done for a store in Victoria in 2015. The system incorporated the use of a sub-cooler to cool the gas cooler outlet.

The system is still in operation today after some fine-tuning.

Additionally, ALDI Australia now has five stores using transcritical CO₂ and a sixth underway, which are considered "test stores" where the company is evaluating different transcritical technologies in various climate zones around the country.

The retailer's last transcritical CO₂ installation was done last year and uses parallel compression and adiabatic pads. This site is delivering an annual energy saving of 10% compared to similar cascade stores.

Meier and his team are using these test stores to evaluate the performance of the systems under varying circumstances, with analysis results expected "sometime near the end of 2018 and the beginning of 2019".

The target is to achieve high energy efficiency and reliability, and to minimise the use of water, which is also an issue in a drought-prone country such as Australia.



1 /



2 /

Though the company is continuing to roll out transcritical CO₂ systems, Meier admits that the lack of trained and experienced technicians for these technologies is a bottleneck.

"Even if you have the technology, you will be limited in rolling it out everywhere," says Meier.

"There are no technicians in the more remote country areas and this is slowing down the overall transition to natural refrigerant-based systems in Australia," he argues.

While this remains a challenge in the industry as a whole as the country continues to come to grips with the HFC phasedown which began in January, Meier remains committed to playing an active role in raising awareness of natural-refrigerant technology and the barriers it faces in Australia.

This is why ALDI Australia will be speaking at this year's ATMOsphere Australia 2018 event in Sydney.

"We want to be sharing our findings and knowledge and convincing people that natural refrigerants are the right way for the future," Meier says. ■ DY & CR

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15 MOVERS & SHAKERS

Welcome to *Accelerate Australia & NZ*'s first list of Movers & Shakers working with natural refrigerants – 15 organisations that have played a critical role in advancing the adoption of NatRefs in Australia and New Zealand.

— By Devin Yoshimoto & Caroline Rham

The first issue of *Accelerate Australia & NZ* was published in autumn 2016. The nine issues of the magazine have sought to highlight the most important companies and organisations behind the adoption of natural refrigerant technology in Australia and New Zealand.

The following pages shine a light on 15 of these organisations that deserve recognition for their efforts to promote natural refrigerants, as Australia and New Zealand's HVAC&R industry takes steps to phase down HFCs in this new era.

This initial list covers not just 2018, but the years leading up to it as well.

Please note that we have not ranked the 15 organisations on the list. They are all considered of equal status, each in their own unique fashion.



AJ Baker & Sons

KEY HIGHLIGHT:

Managing transcritical CO₂ in warm ambient temperatures.

AJ Baker Refrigeration has been involved in the design and installation of transcritical CO₂ supermarket projects for five years. Since the first project in 2013, the company has been involved with 14 installations in Australia. This is with both multinational clients and independent supermarket owners. We partner with the Epta Group, and by utilising their European expertise and our company's skills, we have been able to apply the technology to Australian conditions. We see that transcritical CO₂ is the way forward for the supermarket industry in this country, with the impact of the European phasedown of HFCs, and the reduction of HFC import quotas in Australia.



Danfoss Australia

KEY HIGHLIGHT:

Contributing to the need for more CO₂ training.

Danfoss has championed the use of natural refrigerant technology worldwide. Recognising the need to improve training, the firm has brought its global training initiatives to the shores of Australia and New Zealand. Last year, the company brought its Mobile CO₂ Training Unit to the region; a live refrigeration system staffed by regional CO₂ champions. To date, Danfoss has held 32 training sessions, training a total of 411 industry professionals in Sydney, Melbourne and Auckland.



Bitzer Australia

KEY HIGHLIGHT:

Supporting the growth and development of CO₂ systems in Australia.

Bitzer has long been an active leader of natural refrigerant technology adoption in Australia, achieving a number of firsts in the country: Australia's first direct exchange low-temperature cascade CO₂ installation (Lite & Easy), first CO₂ liquid recirculation supermarket (Coles Gisborne, VIC); and first cascade CO₂ hybrid supermarket (Woolworths Harbour Town, SA). Most recently, Bitzer added another feather to its cap: Coles Coburg's CO₂ transcritical combined cooling plant, featuring a refrigeration and air-conditioning package, helped the store achieve a 4-star (plus) Green Star rating.

Today, Bitzer continues to back CO₂ as the refrigerant of the future and supports natural refrigerants through its technical roadshow seminars and comprehensive product ranges for CO₂ and ammonia.



GEA Refrigeration Australia

KEY HIGHLIGHT:

Key supplier of CO₂ and ammonia compressors to Australia's industrial and commercial sectors.

GEA, a German compressor manufacturer, has supplied compressors to contractors in Australia for a long time. The firm's compressors are at the heart of industrial ammonia plants, as well as commercial cascade and transcritical CO₂ systems.

In 2016, GEA supplied a number of its Blu series of ammonia chillers to food and beverage processing projects. The company continues to be a key supplier of CO₂ and ammonia compressors to the industrial and commercial sectors. It recently released its air-cooled hydrocarbon water chiller for convenience stores and small supermarkets in Australia.



Hussmann Oceania

KEY HIGHLIGHT:

More than 30 transcritical systems in operation in New Zealand, with more to come.

The systems manufacturer has long experience working with subcritical CO₂ systems in the warm climates of Australia and New Zealand. Now it has a growing number of transcritical projects too. Hussmann currently has 31 transcritical CO₂ rack systems installed and operating in New Zealand (with a combined total cooling capacity of around 7,500 kW). It has been working with the technology for some time, having commissioned its first transcritical CO₂ rack in the country in June 2013.



OVER A
HUNDRED
YEARS OF
WORKING
WITH NATURAL
REFRIGERANTS.



Gordon Brothers Industries

KEY HIGHLIGHT:

Over a hundred years of working with natural refrigerants.

Gordon Brothers has worked with natural refrigerants, predominantly ammonia, throughout its 100+ year history. In the past 20 years, the company has also begun working with CO₂, further increasing its natural refrigerant offering to the Australian market.

In October 2017, Gordon Brothers helped the Stone & Wood Brewing Company to install an ammonia-based refrigeration system at its newly expanded brewery in Murwillumbah; reducing the company's overall dollar per kilowatt spend. Today, the company continues to push natural refrigerant solutions forward and its training sessions help to upskill the wider HVAC&R industry.



KAV Consulting

KEY HIGHLIGHT:

Driving CO₂ system innovation.

Klaas Visser, owner of KAV Consulting, has long been a pioneer of the design and creation of natural refrigerant-based HVAC&R systems, dating back to a close relationship with his friend and mentor Gustav Lorentzen.

These days, Visser is continuing to build up his knowledge by innovating with CO₂ technology, achieving a series of 'world firsts'. Visser commissioned the world's first multi-function two-stage transcritical CO₂ refrigeration system with parallel compression (MF2STCCO₂RSPC), which has now been operating for seven years. In 2018, Visser announced the commissioning of the second MF2STCCO₂RSPC, this time using the world's first hybrid CO₂ evaporative condensers.



Mayekawa Australia

KEY HIGHLIGHT:

Pushing for natural refrigerant heat pump adoption.

Mayekawa is known worldwide for its natural refrigerant solutions incorporating the use of water, air, CO₂, ammonia and hydrocarbons. As the price of natural gas and electricity continues to rise in Australia, the company reports growing demand for natural refrigerant-based heat pumps in the food-processing sector.

Today, the company is working on a project where hot air, supplied by the CO₂-based Unimo heat pump, is used to dry and crystallise salt flakes that are then sold to restaurants around Australia. Additionally, the company hopes to soon secure a project requiring the use of hot water heat pumps in a suburban shopping centre in western Sydney.



Mitsubishi Heavy Industries Air Conditioners Australia

KEY HIGHLIGHT:

Introduction of CO₂ heat pumps.

Natural refrigerant system adoption is finding its way into every corner of Australia's HVAC&R industry, including heat pumps. Growing demand for MHIAA's Q-ton CO₂ air-to-water heat pump unit indicates a trend towards energy-efficient and environmentally friendly such solutions in Australia.

The Q-ton, which launched at ATMOSphere Australia 2017, has already sold 18 units in Australia in a period of eight months. The unit is demonstrating the potential for CO₂ heat pumps to be an effective and efficient alternative to traditional systems in a wide variety of applications and diverse climates, wherever heat is needed.



Natural Refrigerants Company

KEY HIGHLIGHT:

Driving fully integrated transcritical CO₂ systems in Australia.

The Natural Refrigerants Company, led by Jonathon Hare and Ian Tuena, has certainly lived up to its name. The company is responsible for installing and commissioning the first fully integrated transcritical CO₂ systems in Australia including freezing, chilling, air conditioning and hot water heating. The company has also played an active role in promoting training in the industry by designing, building and installing a CO₂/NH₃ training rack system for the prominent TAFE institution. Today, the company is continuing this effort by working together with regional TAFE training institutions to develop and promote hands-on training courses with natural refrigerants.



Scantec Refrigeration Technologies

KEY HIGHLIGHT:

Driving the development and adoption of low-charge ammonia technology.

For more than two decades, Scantec has been leading the development and installation of low-charge ammonia systems throughout Australia. From the installation of Australia's first central-type, dual-stage, low-charge ammonia DX system in the early 1990s to the installation of its largest central-type, low-charge ammonia system in Australia to date in February this year, the company has achieved significant improvements in system design and technology – reducing the ammonia inventory while maximising energy efficiency for its customers. In 2018 the company will continue to innovate, launching its 'secondary loop LOGAS hot gas defrost system'. The concept should reduce the ammonia inventory of its central-type systems even further, by an estimated 40%.



Coles

KEY HIGHLIGHT:

Pioneering fully integrated CO₂ transcritical systems in retail.

Coles has been a key adopter of CO₂ systems in Australia's supermarket sector. It took its first leap into CO₂ transcritical in 2015, with an HVAC-integrated store in North Coburg, Melbourne. The store has since outperformed expectations. The management was hoping for energy reductions of 10%, but since the store opened in August 2015, the refrigeration system has delivered impressive efficiency improvements of 15% (up to 22% during the cooler months), compared to its baseline CO₂/R134a systems. The retailer is also using hydrocarbons in some store showcases.

Today, Coles continues to work towards further spreading knowledge and awareness of natural refrigerant technologies throughout the retail industry in Australia.



Drakes Supermarkets

KEY HIGHLIGHT:

Committing to CO₂ transcritical.

As a leading independent retailer, Drakes Supermarkets acknowledges its role in leading other independent retailers in the adoption of energy-efficient and environmentally sustainable technology. This year Drakes has opened three new transcritical CO₂-based supermarkets in Goodwood Road, Wayville (SA), Stebonheath Road, Penfield (SA) and Ardrossen Road, Caboolture (QLD). It expects CO₂ transcritical to save upwards of 20-25% on running costs compared to stores fitted with traditional HFC-based systems. The company has since committed to the technology due to its energy-saving potential.



Foodstuffs North Island

KEY HIGHLIGHT:

Leading CO₂ retail implementation in New Zealand.

New Zealand's largest food retailer, Foodstuffs (NZ) Ltd., is demonstrating natural-refrigerant leadership. Taking a proactive approach to sustainability, the firm is adopting CO₂ systems at an impressive rate. Currently, the company has 11 subcritical cascade CO₂ and 24 transcritical CO₂ supermarkets in operation.

The current roadmap provides for the completion of 13 new transcritical builds and major retrofits in the next 18 months. Once these are completed, Foodstuffs will leap from 25% to 33% of its refrigeration portfolio based on CO₂. The company has set a corporate target of achieving 100% CO₂ refrigeration by the time New Zealand must meet its HFC phasedown targets under the Kigali Amendment to the Montreal Protocol.



Woolworths

KEY HIGHLIGHT:

Nurturing Australia's local natural refrigerant ecosystem.

Recognising the limitations of transcritical CO₂ technology in Australia's challenging climate has not stopped Woolworths from adopting the technology. The company's Corporate Sustainability Strategy identifies transcritical CO₂ technology as a key enabler of a sustainable future.

Woolworths' pilot transcritical CO₂ system, installed at Greenway Village, has been a technological success. The pilot system saw the company create a local ecosystem of technology partners ready to replicate this first installation's success, broadening understanding of CO₂ transcritical in Australian industry as a whole. Woolworths will open two more large CO₂ transcritical stores this year, each one pushing the technology envelope still further. ■ DY & CR

BLUE-SKY THINKING: CHINESE RETAIL'S FIRST TRANSCRITICAL CO₂ SYSTEM

The installation of China's first transcritical CO₂ system in the retail sector, in a METRO wholesale store in Beijing, is just the first step in a journey that will see the German multinational fit transcritical systems in all its new Chinese stores by 2025.

– By Devin Yoshimoto, Jan Dusek & Yingwei Tao

It was a beautiful day in Beijing.

One week before the grand opening of METRO China's new Beijing Lishuiqiao wholesale store in January, *Accelerate China* could not help but notice the clear blue skies and fresh, crisp air.

Despite Beijing's international reputation as a city with high levels of pollution, the situation is now changing. The Chinese government is continuing its aggressive push to curb pollution and put the country on a more environmentally sustainable footing.

Industry leadership is vital in this regard. By installing the Chinese retail sector's first transcritical CO₂ refrigeration system, METRO China hopes to demonstrate the potential of natural refrigerant-based HVAC&R systems to benefit both businesses and the environment.

Accelerate China toured the store with key members of the METRO China team – led by Head of Facility Management Alan Lin – alongside Shanghai Fute Refrigeration & Electrical Engineering Co., Ltd. (Fute), responsible for the overall integration of the system ranging from initial design and component imports to system maintenance and staff training, to learn more.

A MAJOR MILESTONE

METRO China's parent company, Germany-based METRO AG, is a world-leading international wholesale and food retail company that has built a global reputation as a committed player in environmental protection efforts.

The company'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.



Alan Lin, Head of Facility Management, METRO China.

Photography by
Yingwei Tao.



In place since 2013, the F-Gas Exit Program aims to phase out f-gases in all METRO stores worldwide by 2030, replacing them with natural refrigerant systems where it is technically and economically feasible to do so.

At the inaugural ATMOSphere Asia conference, organised by Accelerate publisher shecco and held in September 2017 in Bangkok, Thailand, Olaf Schulze – METRO AG's director of energy management – updated attendees on the programme's progress.

"As of mid-2017, we have replaced f-gas-based systems with natural refrigerant-based systems in more than 120 of our existing stores," said Schulze.

"Additionally, every year, we are installing around 30 subcritical or transcritical CO₂ systems in new stores worldwide. In China, to date, we have installed 28 subcritical CO₂ systems."

At ATMOSphere Asia, Schulze also took the opportunity to make a major announcement. "In the next few months, in the northern part of China, we will be installing the country's very first transcritical CO₂ system to be used in the retail sector," said Schulze.

Fast-forward to today, and for the team in METRO China, this first installation of a transcritical CO₂ system represents a key milestone as they continue with their f-gas phasedown.

2020: 'THE END OF R22'

"2020 will be the end of R22 for us," says Lin, who oversees METRO China's installations.

Lin explains that R22 installations are already banned in new stores and that they will be completely replaced by CO₂-based systems in 2020. "We have just finalised the designs for our cascade systems, at the end of last year," he says.

"So this year we are continuing to go step by step towards preparing for our 2020 target with our first transcritical CO₂ system," says Lin.

"It is planned that starting in 2025, all our new stores in China will be equipped with transcritical CO₂."

PREPARING FOR TRANSCRITICAL

Preparations for METRO China's first transcritical CO₂ system began around two years ago, when the team started an intensive internal research and discussion process.

METRO China worked closely with colleagues at METRO headquarters in Düsseldorf, Germany to discuss and address the most important issues: the first of which was China's high ambient temperatures.

"In China, most urban areas have different temperature ranges," says Lin. "Yet during summer, 80% of the cities will reach over 35°C."

Glass door freezer showcases



To find out whether transcritical CO₂ technology would be viable in China's climate, Lin and his team flew to Europe last year to inspect at first hand the latest transcritical CO₂ systems already in operation.

"We learned some real cases, like in Spain, where temperatures in some cities reach over 40°C," says Lin.

"When we saw that the transcritical CO₂ systems were functioning there, we thought to ourselves, 'OK, we can go this way', and got the confidence to move forward."

While in Europe, Lin and his team also took the time to visit other areas and learn about the technology's latest advancements by speaking to the facility managers directly.

"We saw the actual cases and had discussions with the maintenance contractors to ask specific questions like, 'when exactly do they conduct maintenance?' or 'what are the biggest differences between transcritical CO₂ systems and other systems?'" Lin says.

Gaining an initial understanding of the technology and witnessing the systems at first hand was very important during the initial planning phase, he explains.

"It was a good thing for us to first take these past two years, with the support of our colleagues at our headquarters in Germany, to develop this understanding."

A second issue the team faced was the lack of local maintenance service providers in China.

"This was the biggest challenge," admits Lin.

"For system components like the compressors and condensers, it would be OK to have them imported. But we thought the cabinets were the most important things."

Lin highlighted the example of something going wrong with the refrigerated cabinets on the sales floor.

"If something were to break in the sales area, you can't imagine what kind of things would happen. Then if we needed to change some specific part, we'd have to send an order to Europe and wait two months – no chance," Lin says.

Only once the METRO China team had found the cabinets, the component suppliers, and the maintenance staff to service them within the local Chinese market did they decide to move forward.

CHINESE RETAIL'S FIRST TRANSCRITICAL CO₂ SYSTEM

For this pilot transcritical CO₂ project in Beijing Lishuiqiao, METRO China decided to use a booster system – a configuration of transcritical CO₂ systems that is now widely used in the market.

"For the first store, we are taking the safe way. Our goal is to first gain a better understanding of how the transcritical system works for ourselves," says Lin.

"We'd like to find out how suitable it is for China's environment and how it can be improved."

The system itself consists of two separate transcritical booster racks, provided by Italy-based CO₂ system manufacturer SCM Frigo.

With a total cooling capacity of 334 kW, the centralised system supplies the cooling requirements for the entire store, including its fresh sales areas, freezer room, cold room, and prep room.

The system integration company selected for the project was Shanghai Fute Refrigeration & Electrical Engineering Co., Ltd. (Fute), a locally based company with several years of experience working with CO₂ systems in the Chinese market.

Commissioning was completed in December 2017, and the store celebrated its grand opening on 17 January 2018.

■ DY, JD & YT

System specifications

METRO Beijing Lishuiqiao

Address:
Beijing Lishuiqiao
No. 3 Chaoyang District Anli Road
100107

Shopping area: 4,100m²

Fresh sales area: 1,350m²

Freezer room, cold room, and prep room area: 420m²

One MAJA icemaker

One low- and medium-temperature rack with parallel compression, two-stage gas cooling, and heat reclaim

Low-temperature capacity: 93.50 kW

Medium-temperature capacity: 55.97 kW

One high-temperature rack with parallel compression, two-stage gas cooling, and heat reclaim

High-temperature capacity: 184.08 kW

Transcritical CO₂ booster racks



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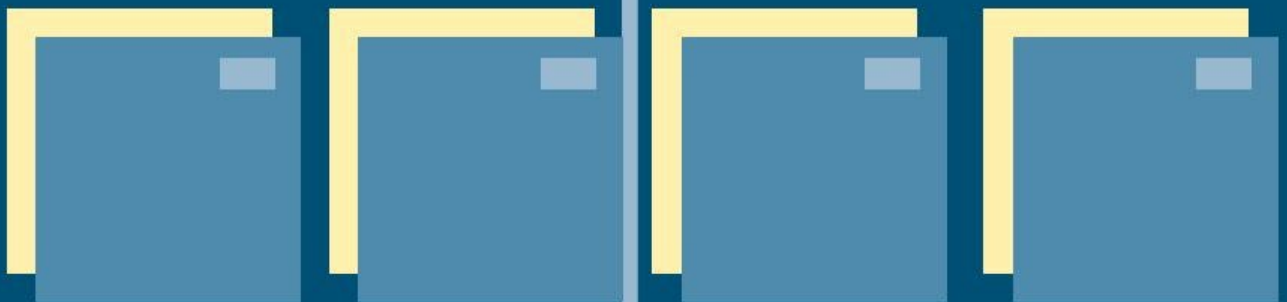


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PROPANE AIR CONDITIONS METRO STORE

A METRO Cash and Carry store in Padova, Italy boasts a transcritical CO₂ system to cool the produce and propane chillers cooling the customers.

– By Charlotte McLaughlin



Germany's METRO AG, an international wholesaler with operations in Italy and across Europe, Asia and Northern Africa, has long been committed to natural refrigerants through its F-Gas Exit Program.

METRO AG – also known as the METRO Group – operates over 2,000 stores in 29 countries – including more than 700 METRO stores and 284 Real hypermarkets (2016 figures). In addition to METRO/MAKRO Cash and Carry stores and Real hypermarkets, its sales divisions include Media Markt and Saturn, its commercial electronics stores.

A cornerstone of METRO AG's emissions reduction strategy, the F-Gas Exit Program will see the firm phase out f-gases by 2030, replacing them with natural refrigerants in all store locations worldwide – where it is technically feasible and economically reasonable to do so.

"We're on track in our programme. Every year we're executing it a little bit more," Olaf Schulze, director, energy management, METRO AG, told *Accelerate Italy*.

The policy in Europe is to fit every new and remodelled METRO Cash and Carry store with a CO₂ transcritical system. "Country-by-country, we're changing stores – usually from R404A to CO₂ transcritical systems," says Schulze.

Some 140 METRO Cash and Carry stores already use CO₂. 60 of these are CO₂ transcritical (2017 figures).

METRO AG has also opened a Cash and Carry store with a CO₂ transcritical system in China (see previous article on page 28).

Though CO₂ transcritical systems are the retailer's primary means of meeting its f-gas commitments, METRO is using other natural refrigerants like ammonia and hydrocarbons to meet its climate goals.

Natural refrigerants are doing just that in Italy, in a METRO Cash and Carry store in Padova. Opened in 1997, it was retrofitted in 2016 with natural refrigerant systems.

"The project developed in Padova is an important part of METRO's [F-Gas Exit] Program from HFCs to natural refrigerants," METRO Italia Cash and Carry's energy manager, Roberto Scarano, told *Accelerate Italy*.

The Padova METRO Cash and Carry store opened in 1997. At the end of the existing equipment's lifecycle, METRO changed it to a new transcritical CO₂ system in 2016. The store's net sales area is around 5,800 m².

The transcritical CO₂ system cools all the store's display cabinets and cold storage facilities. "The cooling system is composed [of] two CO₂ racks: one [...] low and medium temperature with parallel compression and booster system. The other cooling [rack] [is set for] neutral temperature [also using] parallel compression," Scarano explains.

	R290	vs	R410A
Cooling Capacity	255 kW		253 kW
Charge	10 kg x circuit		17 kg x circuit
EER	2.98		2.86
GWP	3		2088
Leakage rate: 3%			
Direct CO ₂ eq.	0.0036 ton.		4.2595 ton.
Direct Savings: 99.9% ton. CO ₂ eq.			
Source: Euroklimat, Presentation at ATMOSphere Europe 2017, Berlin, Germany.			

Air conditioning with propane

What makes this store so unique? Two propane chillers, from Italian manufacturer Euroklimat, serve two different purposes: first, providing “cooling power to [the] subcooling system after the [CO₂ transcritical] gas cooler,” and two, air conditioning the store during the hot Italian summer, he says.

The propane chillers are part of an indirect system that provides the air conditioning and the subcooling. No refrigerant is circulated in the store.

“This solution increases the efficiency of the cooling system. We also optimise the equipment installed and the spaces used, because these chillers have a double function,” he says.

Together the chillers provide a cooling capacity of 510 kW, according to Euroklimat’s product developer, Giulia Fava, who spoke at ATMOSphere Europe in Berlin, Germany about the project in September 2017.

Steps must be taken to ensure that the chillers comply with local safety standards. “You need a provision from the fire department and you need to conduct an in-depth analysis” to install this type of equipment, Fava said.

The analysis recommended that METRO install a safety grid around the propane chillers in the Padova store, within which only authorised people can venture.

The chillers also have compressors and pressure switches that comply with the EU directive on controlling explosive equipment (known as ATEX), and a gas detector for leakage purposes.

The propane chillers translate into lower emissions and greater energy efficiency compared to an R410A chiller (see graphic), according to Euroklimat.

Natural refrigerants like CO₂ and propane, with a global-warming potential (GWP) of one and three respectively, offer significantly less CO₂-equivalent (CO₂e) emissions and the equipment has higher energy efficiency ratios (EER) compared to HFC equipment.

Even with the UK Institute of Refrigeration’s (IOR) EU-wide estimated average leak rate of 3%, HFC-based equipment in the Padova store would release 4.2595 tons of CO₂e. Propane chillers by contrast would only emit 0.0036 tons of CO₂e.

This translates into a direct saving, in terms of CO₂e, of 99.9% per ton in the propane system.

“In the whole store in Padova, there are only natural refrigerants,” says Scarano.

METRO Italia Cash and Carry will replace HFCs with CO₂ transcritical in one further store in 2018, bringing the total to seven at the end of the current fiscal year. ■ CM



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KPAC GENERAL'S GREAT LEAP FORWARD

New KPAC General facility in South Gate, Calif.



The California cold-storage operator replaced an antiquated R22 system at an old facility with an ultra-low-charge ammonia packaged system at a new state-of-the-art facility. *Accelerate America* reports.

— By Michael Garry

Like many small businesses, cold-storage operator KPAC General started modestly. It began by leasing a building in Bell Gardens, near Los Angeles, California, in the late 1980s, where it installed a patchwork refrigeration system that harnessed a variety of different used components, according to Ronnie Ceballos, KPAC's vice-president and general manager.

Upon that foundation, Ceballos, an accountant, and his late brother John, who had previously run a trucking concern, provided 50°F (10°C) storage for a cheese company in Chino, California.

They later took in grapes and stone fruits from a Chilean importer. From that point, the business grew significantly.

In 2007, the Ceballos brothers sold their company, then called General Cold Storage, to KPAC (Konoike-Pacific), a Japanese operator that today also owns two cold-storage facilities in Wilmington, California, near the Port of Long Beach.

Inevitably, the Bell Gardens facility, with its 14-package refrigeration system that used R22, "started to deteriorate and was not efficient," said Ceballos. "We decided to build our own facility from the ground up," buying property in 2014.

That building, a state-of-the-art cold-storage warehouse located close to Bell Gardens in South Gate, California (south of downtown Los Angeles), had its grand opening in July 2017, though it did not start full operation till January of this year.

Of course, in opening a new cold-storage facility, Ceballos had to answer the \$64,000 (actually much more than that) question: what refrigeration system



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1 / Ronnie Ceballos,
KPAC General

2 / Two of eight NXTCOLD
rooftop units with mini water
towers

Photography by:
Megan Miller

should we install? The answer turned out to be ultra-low-charge ammonia packaged units from NXTCOLD, a Los Angeles-based start-up that is now made and distributed in the U.S. by Conyers, Georgia-based OEM Hillphoenix.

Eight rooftop ('penthouse') NXTCOLD units were installed, two above the freezer, one above each of the convertible rooms and two above the dock area. Why did Ceballos select NXTCOLD for this critical piece of his business? For a number of reasons, he said – but most importantly, because he sees it as "the way of the future".

LOW-CHARGE – A KEY POINT

Having used R22 at its Bell Gardens warehouse, Ceballos was intent on moving away from not only R22 (which is being phased out as an ozone-depleting gas) but also other man-made high-GWP refrigerants like HFCs. While the U.S. Environmental Protection Agency is currently restrained from regulating HFCs, California is planning an aggressive phasedown programme in line with that prescribed by the Kigali Amendment to the Montreal Protocol that calls for a global phasedown of HFCs.

"There's a move to get rid of man-made refrigerants," noted Ceballos. "So why not take a look at natural refrigerants?"

Two other KPAC facilities the company has in Wilmington, California, in the Los Angeles Harbor region, employ a natural refrigerant – ammonia – in a traditional engine room, with a large-charge overfeed design.

But Ceballos was attracted to the idea of using packaged low-charge units located on the rooftop rather than in an engine room. "Not requiring an engine room in itself was huge," he said. "You don't need all the piping through the warehouse, and all the ammonia pushed through by large compressors."

He also liked using the area that would have gone to an engine room for "revenue-producing storage space". The relative simplicity of the NXTCOLD units – and the fact that the refrigeration is distributed among eight units – was also a plus for Ceballos. "If you have an issue with one, you don't have to be concerned about the whole facility."

Moreover, the NXTCOLD units have redundant features to provide an operational cushion. The four units for the convertible rooms each have two compressors, though they can operate with just one if the other is not working. The freezer and dock areas are each served by two units, though one can handle the load if necessary. The distributed nature of the NXTCOLD system makes it easy to add additional units in the event of an expansion.



Ceballos compared it to "going to Home Depot and buying a window air conditioner for a room in your house". Each rooftop NXTCOLD unit at the South Gate facility was installed with an accompanying mini water tower. Ceballos considered a central water tower but decided it was better to customise each unit with its own water tower.

Ceballos was also impressed by the minimal amount of ammonia used in the packaged units. "At KPAC's other two facilities, there's probably 1,000 to 1,200 gallons (3,785 to 4,543 litres) of ammonia," he said.

At South Gate, the total charge ranges from 30 to 47 gallons (114 to 178 litres). "We're talking a huge reduction in the amount of ammonia, so we fly under the radar for regulatory compliance." In California, 500 lbs. (0.2 tonnes) of ammonia triggers a high level of government scrutiny, compared to 10,000 lbs. (4.5 tonnes) at the federal level.

"We didn't want to have a plaque that says, 'The last conventional refrigeration system in California'," he said. "We wanted to go in a new direction, and [low-charge ammonia] looked like the way to go – the way of the future."

■ MG

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ATMOsphere Australia 2018

DATE: 7 MAY 2018

LOCATION: LUNA PARK, SYDNEY



The market for natural refrigerant systems in Australia and New Zealand is hotting up as more end users become aware of the HFC phasedown, electricity costs continue to rise, and technology suppliers further drive down costs and establish positions in the market.

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PROGRAMME

08:00 / Breakfast

09:00 / Welcome and Introduction

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09:20 / Technology Leadership Round Table

*Heatcraft Australia, Mayekawa, Scantec,
Mitsubishi Heavy Industries Air-Conditioners Australia (MHIAA),
Danfoss, Advansor, Arneg and Embraco*

10:40 / Networking Break

11:10 / Policy Session

*Australian Government Department of the Environment
New Zealand Ministry for the Environment*

11:50 / Networking Lunch

*Sponsored by Mayekawa, Scantec, MHIAA, Danfoss,
Advansor, Arneg and Embraco*

13:15 / Future of the Industry End User Panel

*Nestlé, Costco, Aldi Stores, IGA Wentworth Point,
Drakes Supermarkets, Coles Supermarkets,
Woolworths and Countdown*

14:45 / Networking Break

15:15 / Parallel Sessions

TECHNOLOGY CASE STUDIES: PART I

*Heatcraft, Scantec, Embraco, SCM Frigo,
and Natural Refrigerants Company*

TRAINING

*Australian Refrigeration Association (ARA),
Australian Refrigeration Mechanics Association (ARMA),
Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH),
Australian Refrigeration Council (ARC) and Danfoss*

16:45 / Networking Break

17:00 / Parallel Sessions

TECHNOLOGY CASE STUDIES: PART II

*Arneg Oceania, CAREL, AJ Baker & Sons,
Commercial Refrigeration Services (CRS) and KAV Consulting*

HEAT PUMP WORKSHOP

*Australian Alliance for Energy Productivity (A2EP) (co-chair),
Mayekawa, MHIAA and Johnson Controls International*

18:30 / Networking Dinner Reception

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AIRAH Refrigeration 2018 showcases NatRef innovation

AIRAH's Refrigeration 2018 conference highlighted the continued progress being made with the installation and development of natural refrigerant technologies, particularly in the commercial sector, while also highlighting the need for more training and education to support the uptake of new technology. *Accelerate Australia & NZ* reports from Sydney.

– By Devin Yoshimoto

AIRAH's Refrigeration 2018 conference was held on 26-27 March at the Novotel Sydney Brighton Beach hotel, where the country's HVAC&R leaders gathered once again to discuss the industry's progress and challenges in 2018.

With Australia's HFC phasedown officially underway, discussions over the two days centred on progress being made with the development of natural refrigerant systems around the country, the need for increased efforts in training and education, and input from European industry.

The true cost of 'ultra low-GWP' refrigerants

Prof. Dr. Armin Hafner of the Norwegian University of Science and Technology delivered the keynote address on the morning of day one.

Prof. Hafner made the case for "why we need a fast phase-in of natural refrigerant working fluids," and why new ultra low-GWP synthetic refrigerants and their blends – which Hafner referred to as "unsaturated HFCs" – were not a sustainable solution.

"Now, we have the option of using natural [refrigerants], which is a long-term solution. And initial investment is no longer so much higher than traditional [refrigerants], so this is not an argument anymore," said Hafner.

"These new ultra low-GWP refrigerants, even if some people have given them a new name, they are still [HFCs]. It's just that they have this weak double-bond," Prof. Hafner explained, referring to the fact that these new refrigerants are organic compounds that still contain hydrogen, fluorine, and carbon atoms.

Additionally, Hafner argued for measuring the environmental impact of a refrigerant using its Life Cycle Climate Performance (LCCP) value, rather than simply its GWP, which only measures "the ability of the fluid to absorb infrared radiation and its lifetime in the atmosphere".

"These [new synthetic refrigerants] have a 10-day lifetime in the atmosphere," said Prof. Hafner. "On a hundred-year perspective, you see, they have found the golden egg. The lifetime in the atmosphere is so short, so by definition, the GWP is very small."

"However, you should look at the whole Life Cycle Climate Performance of a system, from cradle-to-grave," he said.

Prof. Hafner explained that the industry should look at the entire life cycle, including refrigerant manufacturing, usage, and end-of-life aspects.

"We are not looking at these aspects, these molecules are much more complicated to produce than the old stuff now. They have a very low GWP value, but the environmental aspects are unknown or kept secret."

Transcritical CO₂ making headway in Australia's warm climate

As the true cost of these new ultra low-GWP refrigerants is just beginning to be investigated, those leading the industry in Australia are making significant progress with natural refrigerants.

One of the key issues discussed at the conference was the ability for transcritical CO₂ systems to run reliably and efficiently in Australia's warm climate.

Julian Hudson, managing director of Australia-based system supplier Glacim Cooling Technologies, addressed this issue in his presentation discussing tests conducted using an integrated dew point cooling system to help control the operating temperature of CO₂ systems in high ambient conditions without increasing system complexity.

"Glacim's approach is to tackle the root cause of the problem – high ambient air temperatures," said Hudson.

According to his presentation, "results showed that integrating dew point cooling with CO₂ systems significantly increases the COP value by up to 79%".

In addition, Mike Baker, managing director for Perth-based system supplier AJ Baker & Sons, demonstrated the various methods the company was using to operate transcritical CO₂ systems in Australia's warm climate.

As Baker has contended in the past, the biggest challenge deals with controlling the gas cooler outlet temperature. The main methods to overcome this challenge include the use of adiabatic sprays, evaporative pre-cooling, mechanical sub-cooling, and parallel compression.

Through the use of these methods, AJ Baker is now up to 14 installations of transcritical CO₂ systems in several states with varying climate conditions.

"We're seeing that these systems can run in warmer climates," said Baker during his presentation.

The company is now installing new transcritical systems at a rate of 3-4 every six months.

"We are realising transcritical energy savings – compared to cascade CO₂/HFC systems – in Australia, no matter what state we put this in," said Baker. "This has allowed us to influence the end users and retailers who are the real people we need to convince."

"We've got to get them to say, 'yes that is more energy efficient to do, and I want to do this for the long term.'"

Baker also hinted at plans to integrate air conditioning, saying, "we're looking at doing some air conditioning work with a client in the future, so we can put everything together – refrigeration with low and medium temperature, as well as HVAC."

"We want to try to bring everything together under the one umbrella. It's important."

Dario Ferlin, sustainability engineer at Woolworths, highlighted the data benchmarking the retailer has been doing with its first transcritical CO₂ system, installed last winter.

"During the coldest days of the year, the energy efficiency of the transcritical system outperformed that of our current standard specification R134a/CO₂ systems to the extent of around 15%," said Ferlin.





1 /

Measurements were taken over Australia's last winter season, July to September 2017, through to the hottest season lasting into early 2018, with temperatures that reached 45°C.

Ferlin attributes the energy efficiency benefits to the use of adiabatic cooling.

"We've got adiabatic coolers on the gas coolers," said Ferlin. "There is no way around this. Transcritical systems in warm climates require adiabatic cooling."

Woolworths opened its first transcritical CO₂ store – in Colebee, New South Wales – on 16 May 2017. ([See cover story, winter 2017 issue.](#))

Though Ferlin noted that the pilot transcritical system was "up to 10% less efficient (than their current specification R134a/CO₂ system) during the warmest days of the year, and just as efficient on the hottest days of the year," he emphasised the fact that this is the retailer's first transcritical installation.

1 / Commercial refrigeration sector panel discussion

2 / Wolfgang Zaremski, president, Association of German Refrigeration and Air Conditioning Companies

"Our pilot transcritical system is just that. It is a pilot. It's our first crack at it," said Ferlin.

"Its primary objective was to enable the store to trade. We weren't chasing the gold standard in terms of energy efficiency. We wanted something which was reliable, robust, cost-effective as much as can be, and repeatable. Something which would create the framework for future iterations of transcritical systems, not only for Woolworths but for the industry."

Ferlin believes the projected annualised data suggests that this first transcritical system's energy efficiency figures would fall in line with its R134a/CO₂ systems.

"Only a few weeks ago, we did a significant reconfiguration of the parallel compressors and we expect to see some significant energy improvements," Ferlin explained.

"So, there's a lot of room for improvement for transcritical systems. That's the take-home message."

Caroline Rham, business development manager for *Accelerate Australia & NZ* publisher shecco, updated the audience with the latest figures on the number of transcritical CO₂ stores around the world.

"Europe is leading the world in the number of transcritical CO₂ stores with more than 14,000 systems," said Rham. "The U.S. is growing but only slowly in comparison."

"What is interesting is that we are seeing more development in the southern hemisphere. South Africa, Australia and New Zealand are really starting to pay attention and take up these new natural refrigerant technologies."

European industry sheds light on f-gas regulation

Wolfgang Zaremski, president of VDKF or the Association of German Refrigeration and Air Conditioning Companies – a leading German trade association for the HVAC&R and heat pump industry – provided input and perspective on how industry in Europe is dealing with aggressive HFC phasedown schedules.

Zaremski explained the effect the EU F-Gas Regulation has had on the price of HFCs, especially in 2018 when the HFC quota was reduced by 37% – the biggest reduction so far.

"R410A and R404A prices are going up a lot," Zaremski said.

He explained that the biggest impact would be felt by the small and medium-sized contractor businesses that represent the largest portion of the market.

"The only winners are the chemical industry," he stated. "The losers are the small and medium-sized contractors and the European economy."

As the proliferation of natural refrigerant-based systems continues to increase in Europe, Zaremski stressed the importance of improving the training of technicians to handle new refrigerants.



Alexander Cohr Pachai, Johnson Controls, addresses Refrigeration 2018.

Educating end users, training new talent

Though the importance of training in Europe was also discussed, the issue was again highlighted with respect to Australia's industry during the commercial refrigeration sector panel session, where some of the country's leading HVAC&R suppliers took to the stage.

Several key challenges were identified, including how to improve training for industry technicians and how to better educate and inform end users about new technology.

Several of the panellists agreed that technicians in the field were in the best position to speak to and educate end users with regard to training.

"Our customers are 90% tradesmen and 10% salesmen," said Rafi Chenzian of leading Australian wholesaler Actrol.

"It's hard for us to get them to seminars like this for them to up skill. For them to convince their end user that this refrigerant is right for them, that's another task."

In addition to addressing the need to upskill today's technicians, panellists discussed how to do a better job of preparing the next generation and attracting new talent to the industry.

"I think there are a lot of talented young kids coming through school," said Woolworths' Ferlin.

"Part of the problem is, how do we get the talent interested in our industry."

The panel comprised wholesalers and suppliers, who concluded that the responsibility for training and education lies with the entire industry working collectively to solve this issue.

As the sun set on AIRAH's Refrigeration 2018 conference, attendees left feeling invigorated and re-focused on the opportunity for improvement and technological innovation within Australia's HVAC&R sector in the year that lies ahead.

"I think the key takeaway for much of the audience is that they have now understood that natural [refrigerants] are a real option," said Prof. Hafner.

"We have seen very good examples from first pilot installations of transcritical CO₂ systems, nice ammonia systems here. This is just the beginning because due to f-gas regulations and the Kigali global phasedown, we will see that natural [refrigerants] will have an increasing market, even in Australia, very soon." ■ DY

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CHINA TARGETS NATREFS FOR 'BRIGHTER FUTURE'

The Chinese government will continue to promote natural refrigerants as alternatives to HCFCs and HFCs. But technology suppliers warn that training and local availability of components must be improved if their market potential is to be fulfilled. *Accelerate* reports from ATMOsphere China in Beijing.

– By Andrew Williams & Devin Yoshimoto

Natural refrigerants are well placed to gain momentum in the Chinese HVAC&R market as the country prepares to leapfrog from HCFCs to solutions based on ammonia, CO₂ and hydrocarbons in the context of the global HFC phasedown, heard participants in April's ATMOsphere China conference in Beijing.

"China has an opportunity to jump straight from HCFCs to natural refrigerants," said Mauro De Barba, senior product marketing manager at Eliwell by Schneider Electric.

The conference – the first ATMOsphere event to be held in China; organised by *Accelerate* publisher shecco – took place on 9-11 April 2018 at the Sheraton Grand Beijing Dongcheng Hotel in the Chinese capital.

"China is rapidly adopting natural refrigerant solutions," said De Barba.

Yet as technology suppliers sell more natural refrigerant-based systems to the Chinese market, panellists stressed the need to improve training and local availability of components to allow these solutions to fulfil their market potential.

"Natural refrigerant technologies are complex, so support and training will be key to increasing their uptake," De Barba said.

Torben Funder-Kristensen, head of public and industry affairs at Danfoss, also expects natural refrigerants to play a greater role in China in the future.

"Technology development of applications using natural refrigerants is gaining momentum here," he said.

Government promoting NatRef uptake

The Chinese government is accelerating its efforts to implement the Kigali Amendment to the Montreal Protocol on phasing down HFCs and is promoting natural refrigerant alternatives by developing new standards.

"All the controlled substances under the Kigali Amendment will be phased out by 2045," Zhong Zhifeng, vice-chief of Division III in the Chinese Ministry of Environmental Protection – Foreign Economic Cooperation Office (MEP-FECO), told the Sheraton audience. "These HFC applications will be 100% eliminated."

"In normal industries, we will never use HFCs," said Zhifeng.

"We have a very clear direction forward: we're developing alternatives," he said, before citing "special industries" working with flammable refrigerants as exceptions where the evolution may take longer.

1 / Zhong Zhifeng, MEP-FECO, Government of China

2 / Wenhua Wang, China Chain Store & Franchise Association

Photography by: Ben Beech

Going forward, Zhifeng expects to see quick progress in the room air-conditioning segment in particular, with a 45% reduction in HCFC consumption by 2020. 1 /

China to revise domestic standards

China is building up production capacity for natural refrigerant technologies, and in the room air-conditioning sector, "we're improving the standards system for alternative refrigerants," Zhifeng said.

"Our current domestic standards are not helpful for promoting alternatives," he admitted. "We're revising standards to improve safety levels and promote natural refrigerants, which are the future market trend."

André Paz Rosa, senior R&D manager (Asia Pacific) at Embraco, identified safety concerns, lack of knowledge among light commercial refrigeration equipment manufacturers, and the fact that the Chinese government is yet to put in place an HFC phase-out plan as the biggest obstacles to wider uptake of hydrocarbons in China.

Nidec's Ricardo Maciel (president of the light commercial division at the compressor manufacturer) cited the high level of investment required to convert compressor production lines from HCFCs and HFCs to hydrocarbons as another obstacle to their wider uptake in China.

Yet a likely global increase in the hydrocarbon charge limit to 500g, the putting in place of HFC phase-out regulations worldwide, and tighter new energy efficiency standards in China will all boost the market for hydrocarbons in the Chinese market, according to Pedro Olalla, sales director, Huayi Compressor Barcelona. 2 /

Fresh food trend driving China retail

Representatives of top Chinese HVAC&R industry associations took to the ATMosphere stage, showing a united front in pushing China's industrial, commercial and consumer sectors towards a sustainable future with natural refrigerants.

Representing the China Chain Store & Franchise Association, Wenhua (Wendy) Wang said the organisation was actively encouraging its members to be more energy efficient through the use of new technology, including natural refrigerants.

However, Wang cited several significant barriers that lie ahead before more natural refrigerant uptake can be realised.



"In China, supermarkets are located in areas with dense populations; that's why safety regulations are strict," she said. "We need the government to form these safety standards and help boost confidence in the market."

Representing the China Household Electrical Appliances Association, Vice-President Lei Wang discussed the widespread use of R600a in China's household refrigerators and the industry's commitment to the use of R290 in room air-conditioning units as long-term solutions for their members to achieve energy efficiency.

"In the air-conditioning sector, we have come to realise that R290 will be the ultimate and final solution for us because it will meet our environmental sustainability requirements, and the efficiency is very high," said Wang.

State-of-the-art NH₃ making inroads into China market

State-of-the-art ammonia systems, meanwhile, are making inroads into the Chinese industrial refrigeration market. Ammonia has attracted a degree of attention among the Chinese public and government since two fatal accidents occurred in 2013. This, in turn, has resulted in strict regulation of the refrigerant in the Chinese market, said Jin Ma, representing the Chinese Association of Refrigeration (CAR).

CAR is creating and enforcing design and operational standards that guarantee safety when working with ammonia systems. "Based on my observation in the past few years, we can obviously see that cascade NH₃/CO₂ large-scale refrigeration systems will become the mainstream," said Ma.

"We now have 100-200 sets of these systems that have come up in the last few years. This will be the future trend."

End users such as Nestlé and Shandong Meijia are adopting state-of-the-art ammonia systems for industrial refrigeration, helping to broaden understanding and acceptance of the technology in China.

Swiss multinational Nestlé began replacing its CFC and HCFC systems with natural refrigerants in 1986. Today, its commitment to adopting natural refrigerants for HVAC&R applications wherever possible is helping to bring the technology to new parts of the world.

In China specifically – Nestlé's second-largest market – the firm uses packaged ammonia chillers in many of its refrigeration plants, Daiqian Zhang, from Nestlé China Ltd., told the event.

Ammonia chillers provide chilled water for process cooling and for humidity and temperature control in hygienic zones, for example, while larger ammonia systems are used for freezing ice cream.

Nestlé has installed ammonia refrigeration systems in its Hong Kong, Shuangcheng, Tianjin and Guangzhou factories, and packaged ammonia chillers at sites in Qingdao, Shanghai, Tianjin and Taizhou.

The success of these installations is helping Nestlé to convince local governments unfamiliar with ammonia that this natural refrigerant can be used safely, Zhang said.

The Shandong Meijia Group Co. Ltd., a leading Chinese seafood and frozen food processing company, opted for an ammonia-CO₂ cascade system in its Keyuan factory.

Xiaohua Guo, the group's executive vice-president, outlined four "tangible benefits" of the new system: increased safety, increased energy efficiency, environmentally friendly operation, and the use of automatic or remote controls reducing the need for manual labour.

The Chinese market, then, looks poised to continue to adopt natural refrigerants across their full range of application. ■ AW & DY

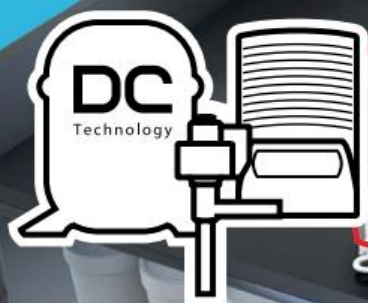


Xiaohua Guo, Shandong Meijia Group

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PUSHING THE LOW-CHARGE ENVELOPE

Low-charge ammonia systems are becoming increasingly competitive with HFC-based systems and traditional ammonia options as design improves and more players enter the market around the world. Scantec Refrigeration Technologies has recently installed its largest low-charge ammonia system to date, showing just how adaptable and efficient these systems can be. *Accelerate Australia & NZ* reports.

— By Devin Yoshimoto & Caroline Rham

TOP

One of six evaporators in freezer room.

RIGHT

Engine room with four SABROE SMC 116L reciprocating compressors in dual-stage compression configuration.

Photography by:

Marty Pouwelse Photography



The use of low-charge ammonia systems is continuing to gain popularity around the world. Their energy efficiency and inherent safety benefits are driving this trend.

System manufacturers worldwide are also continuing to iterate and improve on low-charge ammonia systems in applications ranging from refrigerated warehouses to air conditioning and even supermarkets.

This, in turn, is driving competition and decreasing costs, making them increasingly viable options for business owners looking to move away from HFCs, increase employee safety, minimise governmental regulation, and save on energy costs.

One of the pioneers of low-charge ammonia technology in Australia is Scantec Refrigeration Technologies, which has been developing and installing low-charge ammonia systems since the early 1990s – refining design, improving efficiency, and reducing ammonia charges the whole way.

Among the company's latest low-charge ammonia installations is its largest system to date, showing just how competitive and adaptable this type of system is becoming in comparison to traditional ammonia and HFC-based systems.

Accelerate Australia & NZ spoke to Scantec's managing director, Stefan Jensen, to get the details.

ACHIEVING ENERGY EFFICIENCY AND SAFETY WITH LOW-CHARGE AMMONIA

In February of this year, Scantec successfully commissioned its largest low-charge ammonia system in Australia.

The system was done for a newly-built cold storage facility in Brisbane and its total NH_3 inventory is 750 kg, providing cooling for a total refrigerated volume of 114,000 m^3 .

Several types of low-charge ammonia system exist in the market today. Scantec's new system is a centralised system, referring to the fact that it runs off of a central plant rather than being a pre-packaged or decentralised system consisting of several separate units.

For a centralised system of this size, Jensen explains, it is remarkable how energy efficient it is, especially compared to a comparable HCFC-based system that the company worked on a decade prior.

"A little over a decade ago, Scantec was awarded a contract for the conversion of a large refrigerated warehouse in Sydney from R22 to NH_3 ," says Jensen.

The metric commonly used for measuring energy efficiency is SEC or specific energy consumption. For this previous project, annual SEC prior to the conversion was 100 $\text{kWh}/\text{m}^3\cdot\text{a}$.

Accelerate Australia & NZ has confirmed with Scantec actual SEC values that have been measured for the system's running period from February to April 2018.

"We're currently seeing a yearly SEC value of 17.9 $\text{kWh}/\text{m}^3\cdot\text{a}$," says Jensen.

"This value includes the facility's use of blast freezing, which typically doubles the refrigeration capacity required on the low-temperature side."

Jensen notes that, "it is important to understand that all other things being equal, SEC values reduce with increasing refrigerated volume".

"This means SEC values are not directly comparable without also referencing refrigerated volume in each particular case."



1/ Evaporative condenser

2/ 304 stainless steel NH₃
dry expansion valve station

The previous 100 kWh/m³*a value does, however, put into perspective the amount of energy savings that can be realised when converting Freon-based systems to low-charge ammonia systems.

The value of installing the low-charge ammonia, therefore, was clear to the end user for this project, whose main goals were achieving high energy efficiency and reducing the NH₃ inventory.

"Not only is the overall NH₃ inventory low (750 kg), but the operating NH₃ inventories of the individual freezer evaporators are also exceptionally low," Jensen remarks.

Inherent in the design of the low-charge ammonia system is reduced risk of ammonia exposure in the event of a leak.

"The largest freezer room (approximately 50,000 m³) is fitted with six evaporators with a unit capacity of approximately 80 kW," Jensen explains.

"Each evaporator has an operating NH₃ inventory of 0.7 kg at the design point. Release of the operating NH₃ inventory from one evaporator is therefore unlikely to cause an NH₃ concentration greater than 25 ppm."

CONTINUING THE DISCUSSION ON DEFINING LOW-CHARGE AMMONIA

Currently, there is no standard definition of what exactly constitutes a low-charge ammonia system.

Some argued that this is hindering the development of the technology as well as the awareness of the benefits of such systems among end users, but Jensen suggests that the technology can be defined in three main ways.

"There are three fundamental types of low-charge NH₃ system," Jensen explains.

"Packages for chilling liquid (down to 0.03 kg NH₃/kW), unitary equipment (down to 0.018 kg NH₃/kW), and central plants (0.3-1.2 kg NH₃/kW or 4-5 times less than liquid overfeed)."

Jensen acknowledges, however, that there is currently "no clear definition of what low-charge NH₃ is by using the absolute charge metric in kg of NH₃ or the specific inventory in kg of NH₃/kW".

As low-charge ammonia technology matures and manufacturing costs continue to go down, one thing is certain: an increasing number of end users in Australia and New Zealand – and around the world – will have more options for moving away from HFCs.

■ DY & CR



1/



2/

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Assessing HFOs' environmental impact

A report released by the Norwegian Environment Agency in December 2017 looked at the impact of these low-GWP refrigerants.

– By Michael Garry & Andrew Williams

HFOs or hydrofluoroolefins are unsaturated organic compounds composed of hydrogen, fluorine and carbon, which are looked on as low-global warming potential (GWP) alternatives to hydrofluorocarbons (HFCs).

One drawback of HFOs is that they produce an atmospheric by-product called trifluoroacetic acid or TFA.

A report commissioned by the Norwegian Environment Agency on the environmental impact of TFA called for a number of “knowledge gaps” to be addressed in order to determine TFA's ultimate effect on the environment.

Released in December, the report – entitled ‘*Study on environmental and health effects of HFO refrigerants*’ – is based on a review of the academic and ‘grey’ literature on the topic, as well as consultation with stakeholders, including an HFO manufacturer, a reclaimer of HFO refrigerants, academic experts, a non-governmental organisation and a refrigeration industry association.



The report, prepared by UK-based Risk and Policy Analysts, noted that the current consensus among academic experts is that, "TFA will have a negligible effect on the environment". However, it also identified "knowledge gaps" that must be filled to support that conclusion, including studies on the cycle of TFA in the atmosphere and hydrosphere, the amount of TFA used globally, and other potential sources of TFA in the environment.

HFOs' environmental risks will grow with use, the report said, adding that phasing out HFOs and other measures will reduce those risks.

Notably, the report said the risks presented by TFA – a highly durable chemical – increase if emissions of HFOs such as R1234yf increase. "[TFA] is very persistent and concentrations of TFA will only be expected to increase," it said.

As a result, the report suggests taking preemptive measures with regard to HFOs.

"Phasing out HFOs (and consequently TFA), or emission reduction strategies along with best-practice measures that help ensure efficient capturing of HFO/TFA during recycling operations, will help reduce the risk to human and environmental health."

The largest risk to human health, the study added, "is likely to be close to areas of production facilities and urban areas where it is used in devices for personal and domestic use".

HFO CONSUMPTION PROJECTIONS

The study reported on existing HFO consumption projections until 2050, and modelled two scenarios from 2051 to 2100, one having a consumption freeze and the other a phase-out. Peak emissions of HFOs and other low-GWP refrigerants could exceed 500,000 metric tons per year by 2050, it said.

The HFO R1234yf has an atmospheric lifetime of about six days, after which it degrades completely into TFA, the report said. In the atmosphere, TFA is partitioned into droplets of cloud, rain and fog, "with wet precipitation assumed to be the major source of TFA in the biosphere," it added.

TFA is found in a wide range of water bodies, including rivers, streams, lakes and wetlands, with the highest concentrations on terminal water bodies such as salt lakes, playas and oceans. In freshwaters, TFA is thought to be solely human-made (anthropogenic). It also enters soils on its way to aquatic environments. Of tested aquatic organisms, only the alga *Raphidocellis subcapitata* "displayed sensitivity to TFA," said the study.

TFA has been shown to cause some toxicity in plants and soil organisms, the report said. But no studies have been reported on concentrations of TFA in crops for human consumption, both raw and processed foods, it noted.

In a study on toxicity of TFA, the study reported that the ECHA (European Chemicals Agency) critiqued studies on pre-natal development toxicity in a rat or rabbit.

"ECHA considers that there is not sufficient weight of evidence from several independent sources of information which would allow to assume/conclude that the substance does not have a particular dangerous property, i.e., reproductive toxicity," the report said.

A request for comment on the study was sent to HFO makers Honeywell and Chemours. Honeywell did not respond and Chemours declined to comment.

According to the website of the EFCTC (European Fluorocarbons Technical Committee), of which Honeywell and Chemours are members, "over 200 metric tons of TFA are present naturally in coastal and deep-ocean seawater. HFCs and HFOs will add only 0.1% to the amounts already naturally present".

“Phasing out HFOs (and consequently TFA), or emission reduction strategies along with best practice measures that help ensure efficient capturing of HFO/TFA during recycling operations, will help reduce the risk to human and environmental health.”

– Norwegian Environment Agency

Greenpeace responds to HFO study

Responding to the report, Janos Maté, a senior consultant in the political business unit of environmental NGO Greenpeace, said: “There is no credible reason for governments to accept at face value industry’s claims regarding the safety and technological benefits of HFOs.”

Maté said the study’s key conclusions reflect some of the concerns that Greenpeace has been raising over the years:

- ▶ There is insufficient knowledge on the tolerable thresholds of TFA accumulation in the environment. What level of HFO use will result in catastrophic levels of TFA accumulation? What is the TFA accumulation tolerance level of nature?
- ▶ The peak production and emission levels of HFO refrigerants and other TFA-producing compounds are unknown.
- ▶ Industry is creating HFO/HFC blends. These blended compounds are marketed as HFOs, with their implied low-GWP rating. In actuality the GWP of HFO blends is relatively high compared to the GWPs of natural refrigerants. The GWP of most HFO blends ranges between 150 to 1,800, while the GWP of natural refrigerants is zero for ammonia, one for carbon dioxide, five for propane and less than 20 for isobutane.

“While the chemical companies have earned massive profits from the sale of these products, and from the transition from one generation of fluorocarbons to the next, they have failed to contribute towards solving the

global crises their products have caused. The costs of cleaning up have been left to the public purse,” Maté said.

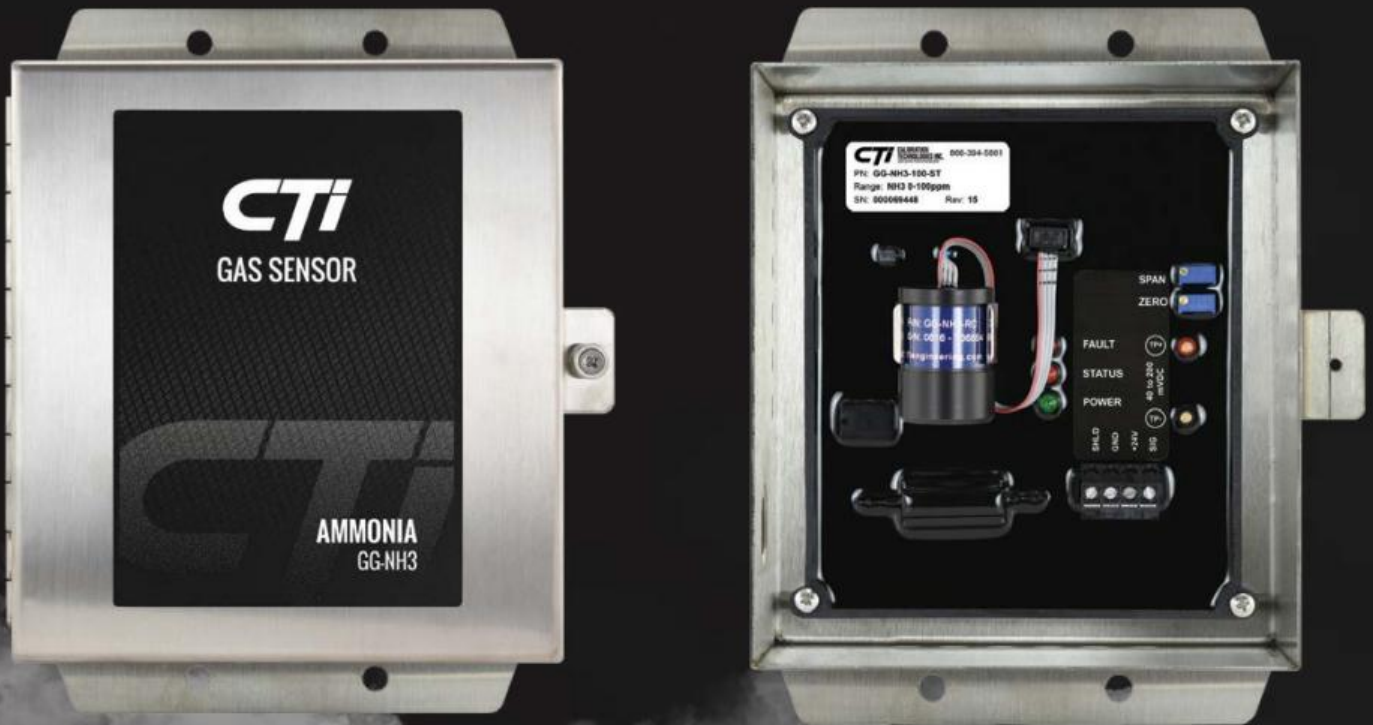
“Who will pay the mitigation costs should the large-scale production of HFOs result in yet another global crisis?” he added.

Based on these concerns, Greenpeace called on governments to take the following measures:

- ▶ Set production quotas on HFOs to curtail industry in its commercial aspirations for these products.
- ▶ Immediately ban the use of HFOs as aerosols.
- ▶ Require industry to commit to paying for all mitigation costs, through a liability contract, should the large-scale production of HFOs in the future result in severe damage to the environment.
- ▶ List HFOs in the Annex of Controlled Substances of the Kigali Amendment to the Montreal Protocol on HFCs. Including HFOs in the Annex will enable accurate accounting of the volume of HFOs being produced and consumed, the amount of TFA being released into the environment, and enable reporting and licensing to help prevent the illegal trade of HFCs mislabelled as HFOs.
- ▶ Vigorously support the uptake of cooling technologies using natural substances by enacting modern-day standards and policies that reflect the current state of technology; and by providing financial incentives to encourage their further development and rapid uptake. ■ MG & AW

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HEATCRAFT POISED TO LEAD NATREF UPTAKE IN AUSTRALIA

As a leading supplier and wholesaler of HVAC&R systems and components, Heatcraft is aiming to play a leading role in accelerating Australia's transition away from HFCs towards wider uptake of natural refrigerant technology. Driving down technology costs, supporting technician training, and raising awareness among end users are central to the firm's plans in this regard.

– By Devin Yoshimoto & Caroline Rham

Accelerate Australia & NZ spoke to Heatcraft Australia's director of marketing, Roger Pecnik, who detailed the company's outlook on these issues and the market for natural refrigerant systems in Australia. (Edited for length and clarity).

// Can you tell us about Heatcraft's strategy regarding natural refrigerant-based technologies? What natural refrigerant systems and components do you currently offer?

Pecnik: We see naturals as a key part of our business going forward. It is inevitable with the HFC phasedown and pressure on

synthetic gases that the market will demand natural refrigerant-based technologies.

As an industry leader in equipment and wholesale, our position is both to continue to develop the technologies and more importantly guide our customers through the change.

We are able to offer a range of systems including CO₂ transcritical racks, our Multiwave (our plug and play CO₂ condenser and rack in a box) and our 3 kW to 10 kW E-Compact CO₂ condensing unit.

LEFT

Heatcraft team in front of eCOBoost transcritical CO₂ booster rack system manufactured at Milperra production facility.

// Can you tell us a little bit more about Heatcraft's local production of CO₂ systems?

Pecnik: Heatcraft's local production of our CO₂ and transcritical CO₂ systems is based in Milperra, NSW.

Our Milperra site has been in operation since 1961 and is supported with local engineering, manufacturing and product development teams that drive our high-quality product output.

// You have recently announced the sale of a transcritical CO₂ booster system to be installed in NSW in 2018. Is this Heatcraft Australia's first transcritical CO₂ booster system in Australia? What are you expecting from this first installation?

Pecnik: We are proud to announce that this was the first sale. Heatcraft, under the Kirby brand, has a tradition of quality and reliability and it is always our position never to test products on our customers.

We were explicit in ensuring the technology would be ready and tested before any customer project. We are expecting a system that meets our customer's design expectations and exceeds their installation and commissioning requirements.

// We've all heard about the importance of educating the market and individual end users about total cost of ownership, especially now that the HFC phasedown has gone into effect in Australia. What role do you believe Heatcraft plays in this education process?

Pecnik: Heatcraft as a leading wholesaler and CO₂ equipment supplier has a key role in educating the market.

We see that there are several aspects to education including total cost of ownership, energy usage, carbon gas emissions and familiarity with the new technology.

Education is done through leadership as we seek to understand the individual needs of our customers and to develop solutions for their specific needs. We have an Australia-wide network of field engineers that are able to partner with our customers to educate and offer a range of natural refrigerant solutions.

// How does Heatcraft educate customers and technicians on natural refrigerant technologies? Do you hold training sessions or seminars?

Pecnik: Yes, Heatcraft is able to run seminars but most importantly, our branch and sales staff are trained on new refrigerant technologies.

We find that technicians don't have the time to sit in formal training sessions, but gain more insight from individual training as they are in our branches to purchase products for specific projects.

We also offer toolbox talks for larger contractors but feedback from business owners has been resounding – they need their techs to be working on-site and to minimise time in branches.

Our training model is to offer individual training while technicians are in branches, minimising their down time. Heatcraft has invested significantly

in ensuring our sales and branch teams can educate customers and field technicians.

// In which market sector (supermarkets, convenience stores, food manufacturing/food service) does Heatcraft see the most potential for natural refrigerant uptake in Australia over the next couple of years?

Pecnik: We see supermarkets as the key market sector. Capital costs, energy costs and greenhouse gas emissions are all significant in this segment, making it attractive for end users to review and adopt new technologies.

We see the complementary segments such as liquor and convenience as the next to adopt, where the same end users influence decision-making. Heatcraft has a strong partnership with supermarket end users and we jointly work with these end users to meet their design and installation needs.

// For Heatcraft, what will be the biggest challenge over the next few years in terms of growing sales for natural refrigerant solutions?

Pecnik: We are well placed to lead our customers through the change with our Field Engineering team. We have access to the latest CO₂ technology and we have a nationwide network of sales teams and branches.

Our biggest challenge will be the continued drive to reduce the cost of capital to make the technologies more attractive to decision-makers.

Any new technology and importantly technology that is customised to end users' needs will incur increased costs – the positive for the customer is that they get exactly what they want and the ability to review construction with shorter lead times.

We are already working hard to standardise and look for cost-saving opportunities to make these new technologies even more attractive. This will be a continued partnership with our suppliers, customers and end users. ■ DY & CR

REMOVING BARRIERS TO HYDROCARBONS

In a move that should boost the market penetration of hydrocarbons in Europe's HVAC&R sector, the EU-funded LIFE FRONT project seeks to help create a level-playing field for flammable natural refrigerants within standards.

– By Anti Gkizelis

Current international and European standards set safety requirements on hydrocarbons that do not allow their potential to be fully exploited. Limits on the maximum allowable charges of hydrocarbons anchored in industry standards were not established on the basis of scientific assessment and the assumptions do not reflect the realities in the field.

In a bid to remove these barriers, the EU-funded project '*Flammable Refrigerant Options for Natural Technologies – Improved standards & product design for their safe use (FRONT)*', aims to establish calculation methods for charge limits that reflect these realities and improve system design to address flammability risks. The objective of the project, which runs from mid-2017 to mid-2020, is to encourage and increase wider availability of climate-friendly alternatives to fluorinated gases.

The team behind the project is led by shecco and includes five other partners – AHT Cooling Systems GmbH, ait-deutschland, NIBE, ECOS and HEAT. To map and analyse existing relevant European and international standards, the project partners conducted a literature review, which will be made available to the public later in the project.

The project consortium is now working on a market study to evaluate the availability of non-fluorinated flammable refrigerant products and the impact of standards on market uptake of these products. The literature review and market study should be published as a public report by the end of August 2018.

COMMON BARRIERS

The review of current standards demonstrates that the primary barriers to flammable refrigerants in safety standards are mainly related to refrigerant charge limits, which limit the ability of systems to provide the desired cooling capacity.

These charge limits take shape as:

- ▶ Charge size limits applied to air conditioners, heat pumps and dehumidifiers when in 'human comfort' conditions
- ▶ Charge restrictions for HVAC&R systems below ground
- ▶ 150g limit for systems installed regardless of room size
- ▶ Charge size limitation for large systems

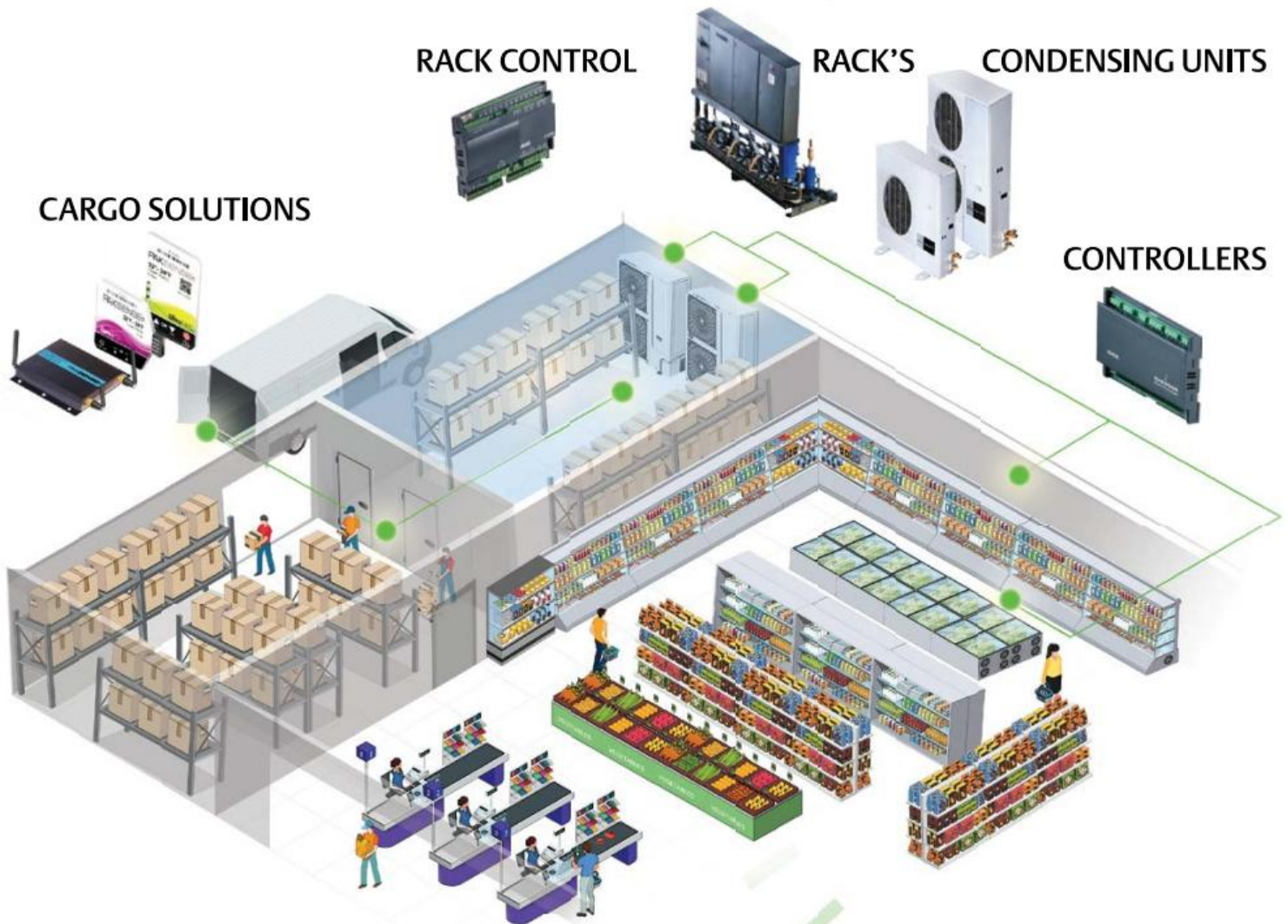
The project seeks to identify risk mitigation measures to address the identified barriers to wider uptake of flammable refrigerants and increase the permitted refrigerant charge. The review has determined that the following risk mitigation measures are of use:

- ▶ Improved system tightness
- ▶ Systems with integral airflow
- ▶ Charge leak test method
- ▶ Housing design
- ▶ Sources of ignition test method

To reflect the commercial dimension of the standards barriers, an EU-wide survey was launched recently to directly exploit the results of the literature review by investigating the impact of current (restrictive) standards on the European RACHP industry and its customers. The goal of the study is to map available technology and product groups using hydrocarbon refrigerants, their expected future availability, and the impact of standards on such market development. ■ AG

Interested parties can watch a public webinar presenting the LIFE FRONT project's objectives and outlining work completed so far. The project is also seeking to assemble a Standards Action Group (SAG) of academics, trade bodies and non-profits interested in helping to develop EU standards on flammable refrigerants. Watch the webinar on: lifefront.eu

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PEGA'S QUEST

Award-winning professor, researcher and entrepreneur Pega Hrnjak continues to search for ways to optimise the use of natural refrigerants in myriad HVAC&R applications.

– By Michael Garry

When Predrag Hrnjak – known universally as Pega – was a visiting scholar at the Technical University of Denmark in the early 1980s, he took a trip to the Norwegian Institute of Technology in Trondheim, Norway, where he met Gustav Lorentzen.

Lorentzen, already a renowned thermodynamics scientist, would secure his place in history in the late 1980s by rediscovering how CO₂ could be used effectively as a refrigerant in cooling and heating.

"I saw him at his desk meeting with a student," Hrnjak recalled recently in an interview with *Accelerate America* at Creative Thermal Solutions (CTS), his research and consulting business in Urbana, Illinois. "He radiated strength, knowledge and charisma. Later, when I talked to him, he strengthened the initial impression he made. In a relatively short time, he left a deep impression. It was clear why they called him Iron Gustav."





LEFT

Pega Hrnjak with transcritical CO₂ system for high-ambient conditions.

Hrnjak, a charismatic and deeply knowledgeable figure himself, would also go on to leave an indelible mark on the global HVAC&R industry, helping to advance the CO₂ revolution that Lorentzen and his last Ph.D. student Jostein Pettersen set in motion, and making significant contributions in many other applications as well.

Born in Belgrade, Yugoslavia (now Serbia), Hrnjak received a doctorate from the University of Belgrade, where he taught for many years. He resettled in the United States in 1993, becoming research professor at the University of Illinois at Urbana-Champaign, as well as co-director and then director of the University's Air Conditioning and Refrigeration Center. He founded CTS in 2003.

In 2011, his accomplishments were recognised at the International Congress of Refrigeration in Prague, Czech Republic, where he fittingly received the prestigious Gustav Lorentzen Prize, one of many awards he has received. "That award reminded me of the man who influenced not only me but the entire world," he said. (Lorentzen passed away in 1995.)

Ammonia is another natural refrigerant for which Hrnjak has made major contributions, particularly in the development of microchannel heat exchangers that dramatically reduce its charge. This charge reduction technology, which he originally designed in the 1990s, has helped bring about the recent growth of low-charge systems and packaged units in industrial refrigeration, including an 'ultra-low-charge' system made by CTS itself.

CTS has grown from a small house and Quonset-style lab to a five-building campus, including 49 temperature- and humidity-controlled environmental test rooms and a 120-seat conference room. It employs 42 full-time employees – more than half with advanced degrees – including engineers, physicists, brazing

experts, metallurgists, machinists, and refrigeration, mechanical and electrical technicians.

Known globally as a hub for HVAC&R research, CTS is a kind of engineering playground, where Hrnjak and his crew can explore the fundamentals of heat transfer in creating their own innovations while at the same time helping clients optimise their HVAC&R systems. From 50% to 60% of its projects involve natural refrigerants.

"Whether natural refrigerants will take all applications in refrigeration, air conditioning and heat pumps – that remains to be seen," said Hrnjak. "But I'm absolutely certain that their growth is getting stronger and their operation is getting dramatically better – efficient and inexpensive. We will see more natural refrigerants in every segment."

CTS's clients span several industries, from automotive and residential to food retail and industrial refrigeration. CTS has also worked on power generation, military, aircraft and space applications. For the military, CTS created a refrigerated vest that could keep soldiers from overheating in the desert.

Hrnjak sees CTS as a bridge from the more theoretical work he does at the University of Illinois to real-world projects that can be commercialised. "The objective from the beginning was to make prototypes and new systems, evaluate them, and present these new technologies with results in real conditions," he said.

CTS prides itself on being "unbiased and independent," he said. This, for example, enables CTS to be called upon to help in standards development. After working on several SAE International (Society of Automotive Engineers) standards, CTS is currently working on a hot-gas defrost project for AHRI that "will result in a standard that's the same as an ongoing project for ASHRAE," he said.

With multiple projects across industries and applications, CTS is able to take advantage of the cross-fertilisation of ideas. "This is our great opportunity," said Hrnjak. "[Other places] stay in their own silo."

Build a system around the refrigerant

Hrnjak likes to cite one of Lorentzen's guiding principles – that it's better to build a system around a refrigerant, rather than just drop a refrigerant into a system. "A good mechanical engineer can build a system to enhance the properties of the refrigerant," he said.

In explaining this philosophy, Hrnjak distinguishes between the thermodynamic and thermophysical properties of a refrigerant. The former are the basic properties exhibited in the simple Reversed Rankine (or Evans-Perkins) cycle, the basis for the vapour compression systems used in most refrigeration, air conditioning and heat pump solutions.

By contrast, thermophysical properties, often neglected in evaluations, are those that define how a refrigerant behaves in components of the cycle – like its heat transfer and pressure drop in the heat exchanger – which can be optimised through good engineering.

"People typically look at just the thermodynamic cycle," said Hrnjak. "They often forget the heat transfer and pressure drop, or the efficiency of the compressor. All of

that is engineering, rather than thermodynamics, and can make a significant difference in conclusions."

CO₂, with its low critical point (88°F/31°C and 1,071 psi), is an example of a refrigerant for which systems can be designed to maximise its thermophysical properties and take advantage of its non-flammability and GWP of one; this is what Lorentzen realised and what Hrnjak has helped to refine. "You need to make something different with CO₂ and then it works much better than when you just drop it in the existing system," he said.

In the automotive sphere, Hrnjak developed some of the early CO₂ mobile air-conditioning systems in the mid-1990s.

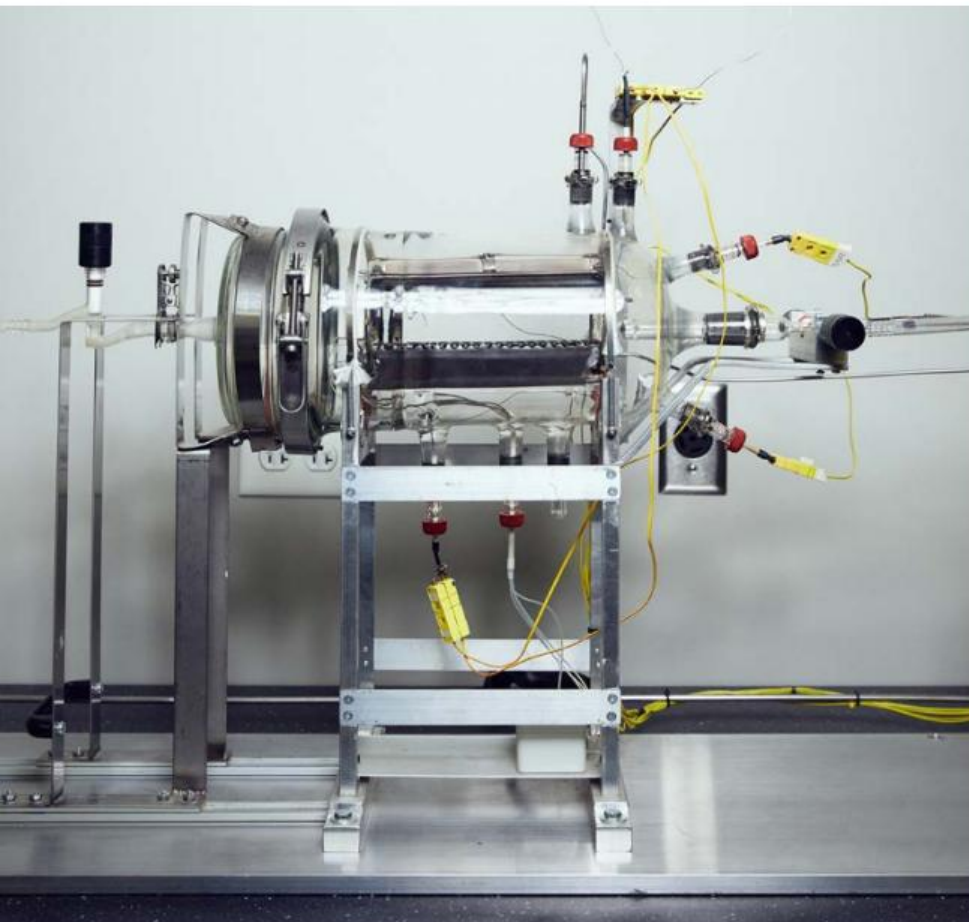
In a 'CTS museum' section of one of his labs, he displays the first Denso CO₂ compressor made around 1994, as well as the first CO₂ evaporator and gas cooler for cars. Over the past year, German automaker Daimler has started commercially equipping some car models with CO₂ air conditioning.

Following a prototype built in 1997 (and described in a publication in 2000), CTS devised a CO₂ heat pump producing both cooling and heating for the emerging electric car industry. The company is currently working on minimising noise from automotive air conditioning.

Just as he was inspired by Lorentzen and carried on his mission, Hrnjak has a message for the colleagues and students who will succeed him.

"Try to go beyond the tracks that have been running for many years. Think about inexpensive, good ways to improve efficiency and capacity and reduce cost with creative, innovative approaches. Don't be shy of that." ■ MG

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