

SUMMER 2016

ACCELERATE

ADVANCING HVAC&R NATU

E U R O P E

Spotlight on future
tech at Mostra
Convegno
p.16

Ammonia makes
waves at
Seafood Expo
p. 20

CAREL brings
natrefs to
warmer climates
p.40

Advansor scales
new heights
with CO₂
p.44

PAOLO MARTINI

Refrigeration & HVAC Manager
for International Support
Carrefour Group

p.30

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Editor's note by
Andrew Williams

CROSSING THE CO₂ EQUATOR... AND THE FINAL FRONTIER!

With temperatures mounting and thoughts turning towards summer barbecues, innovators in the HVAC&R industry are also turning their attention to warmer climates – and demonstrating that natural refrigerants offer climate-friendly solutions for all weathers.

New technological innovations are bringing high-efficiency CO₂ refrigeration systems to high ambient temperature regions, an achievement which until recently was considered technically and economically unfeasible. This potentially puts an end to the so-called 'CO₂ equator': the previously accepted geographical limit for cost-effective construction of CO₂ systems in food retail.

Retailers and manufacturers alike are showing how these challenges can be overcome. For Carrefour, one of the largest retailers in the world, refrigeration plays a key role in delivering its environmental sustainability objectives. With excellent results already recorded in warm climates, Paolo Martini, Refrigeration & HVAC Manager for International Support, is the man charged with delivering the Carrefour Group's dramatic transition from HFCs to natural refrigerants (p. 30).

Carrefour is not the only retail giant adopting natural refrigerant technologies to reduce emissions and deliver on climate objectives. Germany's METRO AG has put in place an F-Gas Exit Program for transitioning away from HFCs by 2030, while Belgian retailers Colruyt and Delhaize are also turning to R744, hydrocarbons and ammonia to help reduce their carbon footprints (p. 24).

On the technology side, Italian firm CAREL has joined forces with Carrier to develop and industrialise a range of modulating ejectors designed to increase the energy efficiency

of transcritical CO₂ systems in warmer climates – thereby extending the scope to use CO₂ as a natural refrigerant across the spectrum, from smaller convenience stores to large supermarkets (p. 40).

Danish pioneer Advansor is also working hard to bring CO₂ transcritical technology to new pastures. Celebrating the company's 10 year anniversary, Managing Director Kim G. Christensen identifies three distinct stages to overcoming the CO₂ equator: the R&D phase, the commercialisation phase, and the maintenance phase (p. 44).

Indeed, the sky is no longer the limit in realising the full potential of natural refrigerants! The Dutch National Aerospace Centre is crossing new frontiers by developing a new hydrocarbon heat pump to cool down spacecraft, which – if proven successful – may lead to new applications for natreps back on Earth.

Reports from our recent ATMOsphere Europe conference, held outside Brussels for the first time, in Barcelona, and the latest technology and market updates from other parts of the world complete this summer edition of *Accelerate Europe*.

With more exciting new developments on the way, I'm confident that – together – we will continue to drive wider uptake of natural refrigerant solutions in warmer climates.

I would like to take this opportunity to thank our readers for engaging with us on this journey. Have a pleasant and relaxing summer break. And if you spend your summer holidays in Italy, Spain, or even Brazil, you might be surprised to see that your local supermarket is already using natural refrigerants! @AW

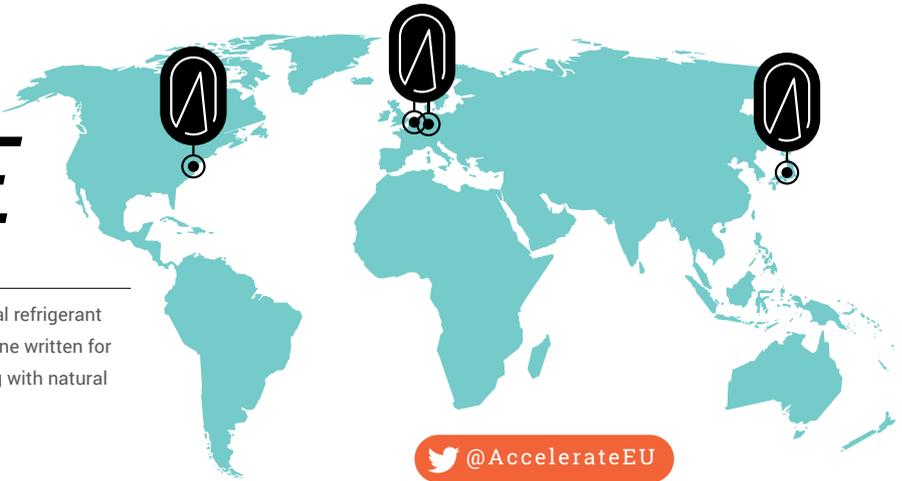
EUROPEAN EDITION ISSUE #3, SUMMER 2016

ACCELERATE

ADVANCING HVAC&R NATURALLY

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

<http://accelerateEU.com>



3

Crossing the CO₂ equator...and the final frontier!

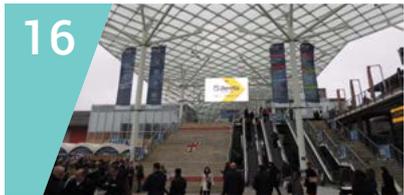
Editor's note by Andrew Williams



8

Guest Column : EU F-Gas Regulation calls for action!

by Barbara Gschrey & Bastian Zeiger



16

Future-proof technologies steal show at Mostra Convegno



10

Event Guide
For June, July,
August 2016



20

Natural refrigerants make waves at Seafood Expo Global



24

Supermarkets showcase natrefs for warmer climates at ATMO Europe

30



Crossing the CO₂ equator: Carrefour leads the march south

For Carrefour, refrigeration plays a key role in delivering environmental sustainability objectives. Recording excellent results in warm climates too, the retail giant is putting natural refrigerants at the heart of its strategy to become HFC-free in the near future.

Paolo Martini
Refrigeration & HVAC Manager
for International Support
Carrefour Group

40



CAREL bringing natrefs to warmer climates

44



Getting to the top with CO₂ alone at Advansor

50



ATMOsphere Australia builds industry momentum

54



Coles putting CO₂ on the map Down Under

58



Ready for takeoff: putting natural refrigerants into space



Natural refrigerants key to China's sustainable growth



Spotlight on new industrial refrigeration systems from Japan



Natural refrigerants take centre stage at European heat pump forum



Industry experts see bright future for ammonia refrigeration



Regulators: Training holds key to greater uptake of natrefs



California policy paving way for natural refrigerants

76
Short takes

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EU F-GAS REGULATION CALLS FOR ACTION!



Barbara Gschrey, General manager, Öko-Recherche



Bastian Zeiger, Project manager, Öko-Recherche

The implementation of Regulation (EU) 517/2014 (the EU F-Gas Regulation) is in full force: the HFC phase-down has been underway since 2015, various important bans for high-GWP HFCs in air conditioning and refrigeration are around the corner, and servicing and containment requirements for fluorinated gases are in effect. As such, the F-Gas Regulation has been providing significant momentum for all available low-GWP alternatives and especially natural refrigerant technologies in a large selection of applications. This trend towards natural refrigerants is great news for the climate, not least because in most cases these new technologies also result in significant energy efficiency improvements.

We at Öko-Recherche, however, see that there is still some work to be done in order to ensure the smooth continued implementation of the EU F-Gas Regulation, especially of the EU HFC phase-down but also of the bans in the near- and medium-term future. Particular areas where action and further innovation are required include:

R744 TECHNOLOGY IN SUPERMARKETS EVERYWHERE?

R744 technology in commercial refrigeration has spread massively across Europe in the past decade. Transcritical CO₂ is now the go-to technology for supermarkets across northern and central Europe and there are a multitude of technological improvements that bring energy efficiency on a par with traditional HFC systems also in southern Europe. Some retailers and other end users are, however, still sceptical about the energy efficiency and cost of such systems in the face of a de facto ban on HFCs in commercial refrigeration systems from 2022 onwards (Annex III, 13). We are currently seeking your input on alternatives to conventional HFC systems in supermarket refrigeration and intend to create an overview of solid pilot projects across southern Europe for the European Commission. Please participate in the survey: <http://www.oekorecherche.de/en/projects-references/supporting-eu-f-gas-policy>.

CHARGE SIZE LIMITATIONS FOR HYDROCARBONS

Currently, the widespread adoption of proven hydrocarbon technology is hampered by unfavourable standards and norms on the EU and international level but also by sub-national safety requirements in building codes. Due to relatively conservative requirements regarding flammability, the use of hydrocarbons is limited to small charge sizes by many manufacturers, which effectively prevent many applications. Case-by-case approvals and risk assessments are possible, as the successful application of R290 semi plug-ins in a large discounter chain in Europe shows. The situation is more complicated with respect to domestic air conditioning with hydrocarbons. We suggest that (potential) manufacturers contribute in the various standardisation bodies to accelerating the review of safety requirements.

TRAINING AND CERTIFICATION FOR HANDLING NATURAL REFRIGERANTS

A concerted effort is necessary to ensure appropriate training of technical personnel in handling flammable, high pressure or toxic refrigerants. In our experience, the lack of such training is often an argument against natural refrigerant solutions for end users. Large manufacturers have noticed this and have set up their own training facilities. Efforts by industry and associations to establish an EU-wide certification for handling natural refrigerants will pave the way for more trust and a faster uptake of these vital technologies. @BG & BZ

Barbara Gschrey is general manager and Bastian Zeiger is project manager at German research and consulting company Öko-Recherche.

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EVENTS GUIDE JUNE 2016

- | | |
|--|--|
| <p>1 1-2 June, Karlsruhe, Germany
WTT-Expo 2016
http://www.wtt-expo.com/en/home/homepage.jsp</p> | <p>8 16-17 June, Verona, Italy
Eurovent annual meeting
http://en.anima.it/news/10666/eurovent-annual-meeting</p> |
| <p>2 7-9 June, Valence, France
SEPAG 2016
http://www.salon-sepag.fr/le-sepag/presentation.html</p> | <p>9 16-17 June, Rome, Italy
Temperatuz 2016
http://www.temperatuz.com/index.html</p> |
| <p>3 7-11 June, Minsk, Belarus
Prodmash Holod Upak Fair for food processing, refrigerating and packaging technologies
http://www.minskexpo.com/</p> | <p>10 21-22 June, London, UK
CLOUD WORLD FORUM 2016
https://cloudanddevopsworld.com/#pane4
twitter : @CloudWSeries</p> |
| <p>4 14 June, Cardiff, UK
Developing Heat Networks in Wales Workshop
https://www.business-events.org.uk/en/events/developing-heat-networks-in-wales-workshop/</p> | <p>11 21-23 June, London, UK
Energy And Environment Expo
http://10times.com/energy-and-environment-expo</p> |
| <p>5 15 June, Brussels, Belgium
Heating and Cooling Strategy: A promise of transformation and decarbonisation-Panel Debate
http://eusew.eu/heat-energy-union-principle-practice</p> | <p>12 21-23 June, Milan, Italy
24th POWER-GEN Europe
http://www.powergeneurope.com/
twitter : #POWEROUROPE @POWERGENEUROPE</p> |
| <p>6 15-16 June, Lille, France
ENVIRONORD 2016
http://www.salon-environord.com/
twitter : @ENVIRONORDLILLE</p> | <p>13 21-23 June, London, UK
FACILITIES SHOW 2016
http://www.facilitiesshow.com/
twitter : #FacShow @Facilities_Show</p> |
| <p>7 15-17 June, Madrid, Spain
GENERA 2016
http://www.ifema.es/genera_06/
twitter : #GENERA2016 @FeriaGenera</p> | <p>14 23-24 June, Schaffhausen, Switzerland
eurammon Symposium 2016
http://www.eurammon.com/node/581</p> |

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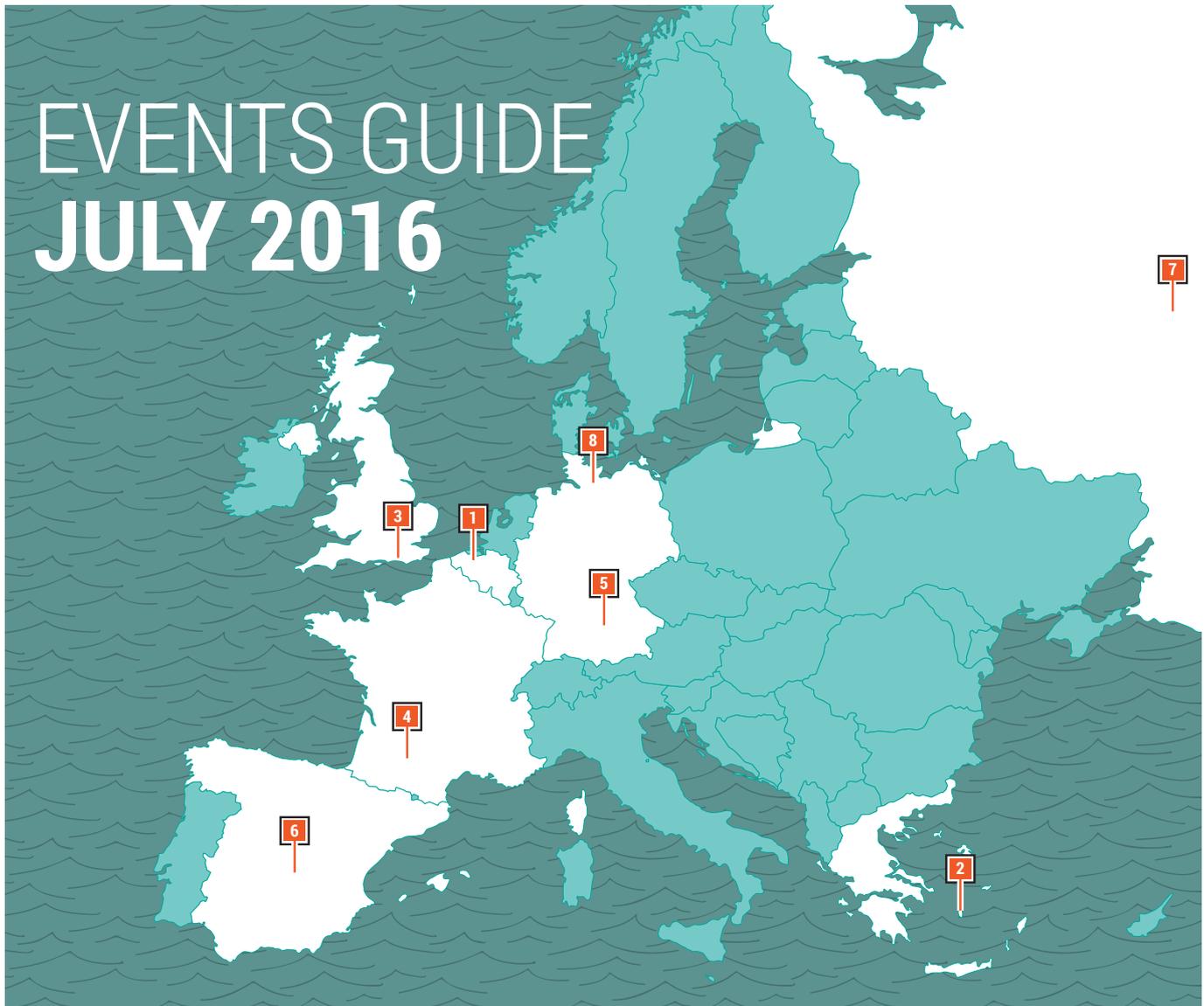
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SETTING THE STANDARD

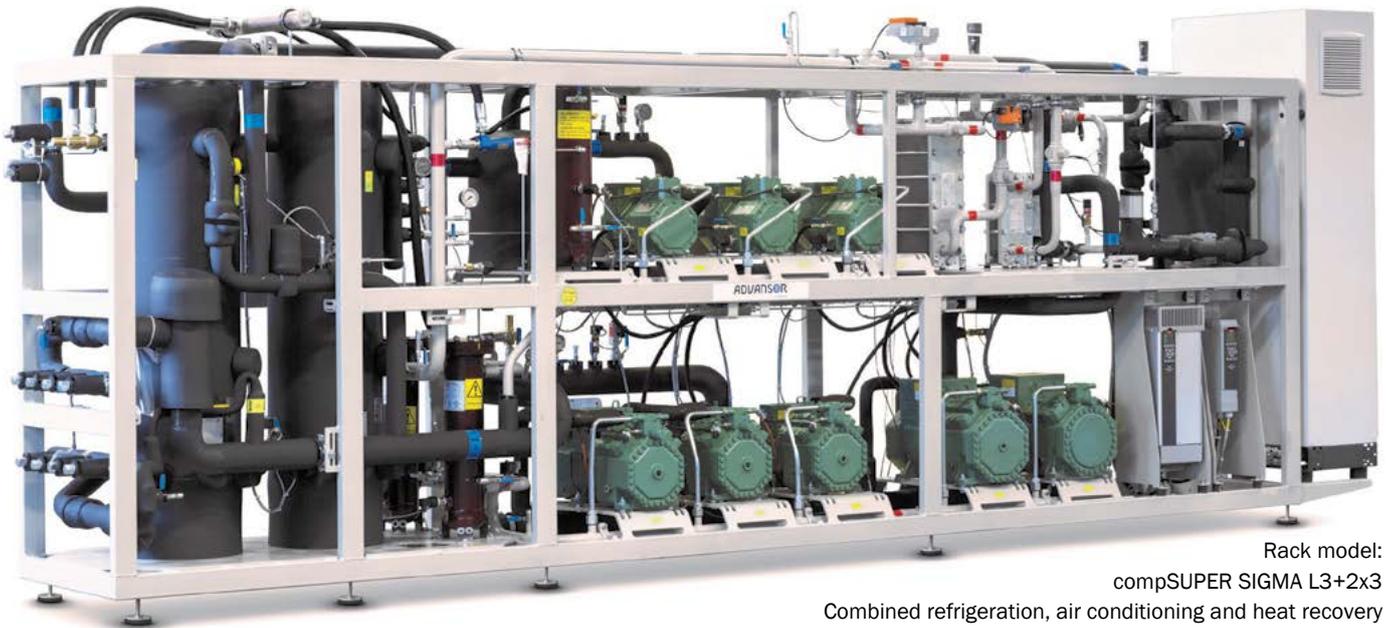


- 1** 3-8 July, Ghent, Belgium
The 14th International Conference of Indoor Air Quality and Climate
<http://www.indoorair2016.org/>
twitter: @IA2016.
- 2** 3-8 July, Mykonos, Greece
13th International Conference on Protection and Restoration of the Environment
<http://pre13.civil.auth.gr/>
twitter: @pre13conf1
- 3** 7-10 July, Brighton, United Kingdom
The European Conference on Sustainability, Energy & the Environment 2016 ECSEE2016
<http://iafor.org/conferences/ecsee2016/>
- 4** 10-14 July, Toulouse, France
iEMSS 2016
<http://www.iemss.org/sites/iemss2016/>

- 5** 11-12 July, Nuremberg, Germany
iSEneC 2016
<https://www.isenec.org/en>
- 6** 11-13 July, Madrid, Spain
IREEC 2016
http://www.warponline.org/viewjc.php?id=c11&page_id=54
- 7** 11-14 July, Ekaterinburg, Russia
INNOPROM
<http://www.innoprom.com/>
- 8** 27-28 July, Luebeck, Germany
8th International Congress of Environmental Research
<http://www.icer16.jerad.org/>

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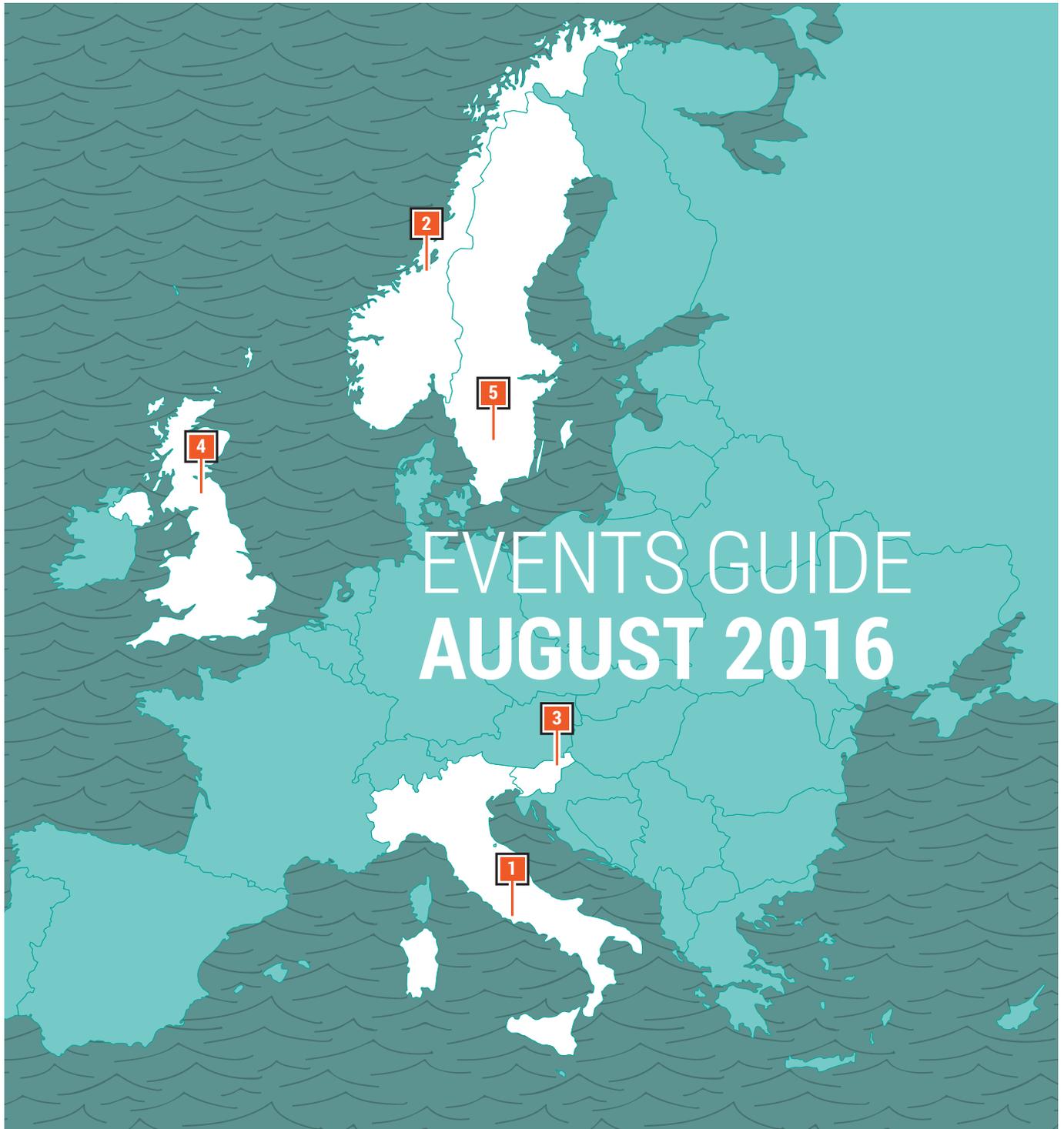
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EVENTS GUIDE AUGUST 2016

1

3-4 August, Rome, Italy
ISERD – 63rd International Conference on Environment and Natural Science (ICENS)
<http://iserd.co/Conference/2016/Italy/ICENS/>

2

16-19 August, Trondheim, Norway
Nor Fishing 2016
<http://www.nor-fishing.no/?lang=en>
twitter : #norfishing #norfishing2016 @NorFishing

3

20-25 August, Gornja Radgona, Slovenia
International Fair of Packaging, Packing Techniques and Logistics
<http://10times.com/sejem-inpak>

4

21-24 August, Edinburgh, Scotland
Gustav Lorentzen Conference on Natural Refrigerants
<http://ior.org.uk/GL2016>

5

24-27 August, Jönköping, Sweden
Elmia Lastbil
<http://www.elmia.se/en/lastbil/>

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Compressors



Condensing Units

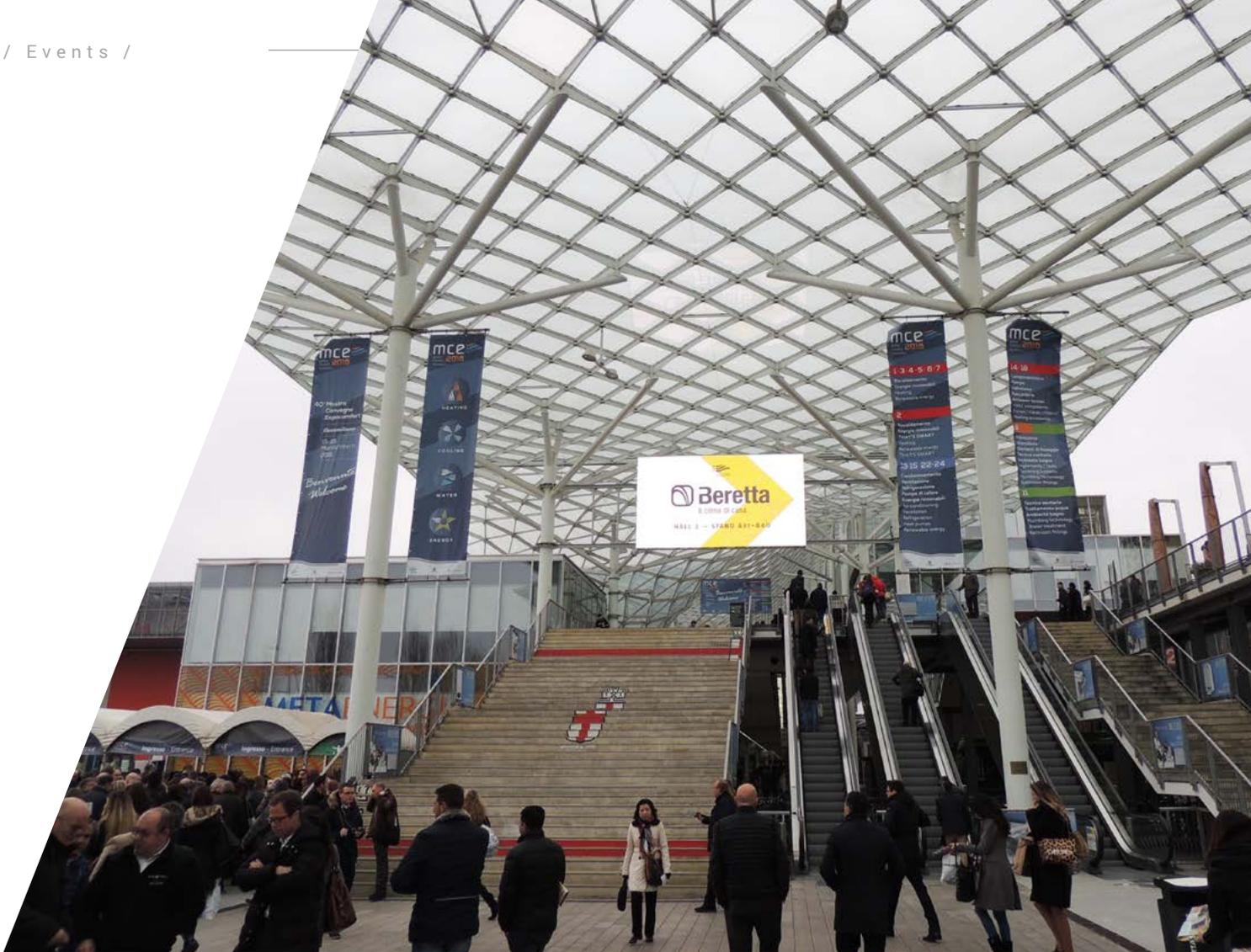


Fullmotion



Sliding Units

embraco POWER IN.
CHANGE ON.



FUTURE-PROOF TECHNOLOGIES STEAL SHOW AT MOSTRA CONVEGNO

Natural refrigerants have a key role to play as replacements for climate-damaging hydrofluorocarbons (HFCs) in the context of the HFC phase-down taking place in Europe under the EU's F-Gas Regulation. Mostra Convegno Expocomfort in March saw manufacturers unveil new technologies for a range of CO₂ and hydrocarbon HVAC&R applications.

– By Andrew Williams

Mostra Convegno Expocomfort (MCE), held in Milan on 15-18 March, saw some 2,100 exhibitors and 155,000 attendees from across the world descend upon the Rho Fiera Milano site to discover new innovations in comfort technology and hear about the latest trends sweeping the HVAC&R industry – including greater uptake of CO₂ refrigeration solutions in warmer ambient temperature regions such as southern Europe.

F-GAS REGULATION BOOSTING DEMAND FOR NATREF SOLUTIONS

With the EU f-gas phase-down in mind, Emerson is putting together a diverse, “future-proof” portfolio to respond to evolving customer demand, says Abhinav Barnwal, Product Manager Refrigeration and Marketing at Emerson Climate Technologies.

The company's refrigeration and comfort technology portfolio is designed to ensure that end users comply with EU rules under the F-Gas Regulation and the Eco-design Directive as well as market requirements for natural refrigerants, energy efficiency improvements and sustainable performance driven by general demand for return on investment.

Emerson was at MCE 2016 to showcase its Copeland brand compressors for CO₂ and propane (R290) applications alongside solutions integrating modulation technology, as well as innovative intelligent electronics for smart and reliable circuit management.

"We have a lot of customers asking for CO₂," particularly in large retail applications where booster or cascade systems make good energy efficiency or financial sense, Barnwal says.

In milder, more favourable northern European climates like the UK, CO₂ transcritical systems are on the rise, observes Barnwal, who also sees growing potential in warmer southern markets as the technology improves.

Indeed, throughout the show it was apparent that new technology innovations are paving the way for increased uptake of CO₂ systems in warmer temperature regions.

"We are seeing increased demand for CO₂ transcritical systems," says Diego Malimpensa, who manages the retail solutions business unit at Italian manufacturer CAREL. He argues that the efficiency of CO₂ transcritical systems in warmer climates will only improve in future as the technology develops.

Among the CAREL technologies on show were management solutions for all refrigerant applications that use CO₂ as either the primary or secondary refrigerant. CAREL's transcritical CO₂ system controllers allow users – such as supermarket managers – to monitor their system remotely from their smartphones. In the event of a problem, maintenance companies can also manage the system remotely, Malimpensa explains.

French firm Carly, meanwhile, was in Milan to showcase equipment for CO₂ transcritical systems at two pressures: 64 bars and 140 bars. Among the components on display were filter driers for stopping humidity and acid, mechanical filters for stopping solid particles, discharge motors, and oil filters adapted for use in CO₂ systems.

Managing Director Cyrille Berthet says that as a component manufacturer, it is not Carly's role to decide which refrigerants will be used in the future – but supermarket applications represent the firm's biggest market for CO₂ equipment today.

Berthet is optimistic that the market for CO₂ refrigeration equipment in Europe will grow as the phase-down of HFCs under the EU's F-Gas Regulation continues to take effect. "We are flexible enough to respond to all requests," he says.

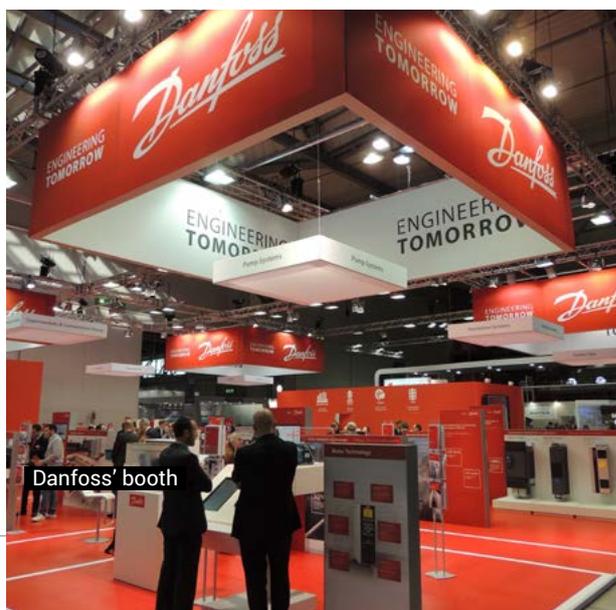
Philippe Duchêne – senior director for sales and marketing at Danish company Danfoss – was in Milan outlining their 'Smart Store' concept, which delivers efficiency improvements of up to 50% in some stores by offering integrated control of refrigeration, HVAC and lighting systems.

As for the company's compressor, condensing unit, valve and ejector technologies for CO₂ refrigeration systems, Duchêne says "the efficiency of our valves and compressors is already very impressive". Having reached optimal component performance, Danfoss is introducing advanced system control and monitoring tools like the VLT Refrigeration Drive FC 103 to deliver further efficiency gains for compressors, condensers, evaporators and pumps.

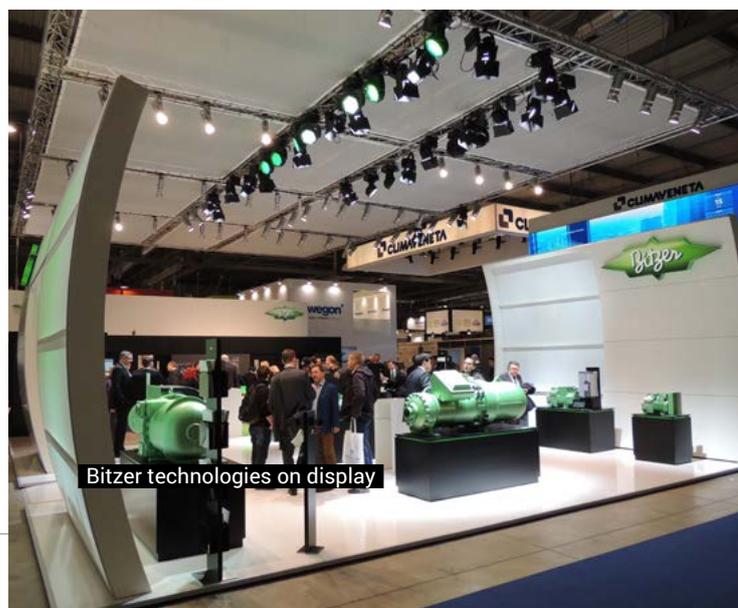
MARKET FOR NATURAL REFRIGERANTS GROWING

Process technology manufacturer GEA presented a new compressor series designed for use with hydrocarbons – the HG44e – alongside its subcritical and transcritical CO₂ compressor range.

continued on p.18



Danfoss' booth



Bitzer technologies on display



Carly's CO₂ portfolio

→ With the HG44e, “the complete platform is optimised from the efficiency side,” explains Manuel Fröschle – manager (application engineering) and product manager (natural refrigerants) at GEA.

Furthering the current trend towards developing new natural refrigerant-based technologies, the HG44e features optimised engine components and special oil filling in order to maximise performance.

With four model sizes, the HG44e hydrocarbons series covers the range of maximum displacements from 41.3 m³/h to 67,0 m³/h.

For hydrocarbons, high solubility poses particular challenges in terms of compressor design. With the HG44e series, “the motor protection tool is located outside, not inside the box. And the drive gear is optimised to handle hydrocarbons,” Fröschle said.

Asked where GEA is seeing the biggest growth in demand for its products, Fröschle says “the big market is definitely supermarkets”. Demand for smaller compressors for use in medium-sized supermarkets and small convenience stores is particularly strong, he explains.

Fröschle sees natural refrigerants as efficient, cost-effective and climate-friendly solutions in the long term, with ammonia likely to remain a key focus of industrial applications.

Also on show at the GEA booth was the compressor model EX-HG88e – the largest GEA compressor that is suitable for use in hazardous environments. GEA is the first and only European manufacturer to offer semi-hermetic compressors for zone 1 and 2 ATEX- and recently also IECEx-certified.

“Over the past three years, we have improved the efficiency and reliability of our complete CO₂ range, as well as improving their running behaviour and extending their operating limits with an increase of condensing and evaporating temperatures in the subcritical CO₂ compressors,” Fröschle says.

As an international technology group, GEA manufactures process technology and components for production processes



Japanese giant Panasonic brings new tech to Europe

in various end-user markets. It is a major supplier to the food processing industry, which generates over 70% of its revenue.

BRINGING CO₂ HOT WATER HEAT PUMPS TO EUROPE

Japanese giant Panasonic’s CO₂ technology portfolio includes a special compressor and heat exchanger with very high efficiency. In Japan, the firm is a top supplier of CO₂ heat pumps for hot water.

“We really want to launch this technology on the European market too. We’re planning to have it but we don’t really have a fixed schedule,” says Sebastian Merino, Manager (Pan-European Technical Support) at Panasonic Appliances Air Conditioning Europe. First, the company wants to get a better understanding of the European market, for example to ascertain how much hot water Europeans tend to use.

Panasonic is another major player predicting that the market for natural refrigerant technologies in Europe will grow as the HFC phase-down takes hold. “That’s why we’re planning to introduce our CO₂ hot water heater pump,” Merino says.

“We think there’s a demand for natural refrigerant solutions. And we can explain to customers that it’s better to have natural refrigerant solutions. They’re not just good for the environment but also for the profile of the customer,” he argues.

K65 IN THE SPOTLIGHT

Meanwhile, Wieland and Conex Bänninger – part of the IBP Group – were at MCE to showcase the K65 tube system for high-pressure applications. K65 is a high-pressure pipe system developed in response to increasing use of CO₂ as a refrigerant – particularly in supermarket applications.

“We see our K65 range of high pressure commercial tube fittings as another big opportunity for increased sales, due to huge growth in the commercial refrigeration market,” says Francesco Mocella, Italian sales director for Conex Bänninger.

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NATURAL REFRIGERANTS MAKE WAVES AT SEAFOOD EXPO GLOBAL

Ammonia has long been used by the seafood industry for ice-making and freezing applications. And in Europe, the phase-down of HFCs under the EU's F-Gas Regulation is widening its use still further, with the sector increasingly turning to ammonia for ice-making applications at sea and on land alike.

– By Andrew Williams



Ziegra's ZBE 150 CoolNat ice machine



DSI's plate freezer

Manufacturers attending Seafood Expo Global – the world's largest seafood trade fair featuring more than 1,700 exhibiting companies from over 75 countries – in Belgian capital Brussels in April were keen to exhibit their natural refrigerant-based plate freezers and ice-making machines.

ICELAND FERTILE GROUND FOR AMMONIA REFRIGERATION

Iceland is particularly fertile ground for ammonia technology in seafood applications. Freyr Friðriksson, general manager of Iceland-based Optimar Kapp, says the company has fitted eight boats with ammonia-based ice-making and cold storage equipment. Their ammonia and CO₂-based equipment makes slurry ice for storing fish on boats.

Frost, another Icelandic manufacturer with factories in Reykjavik and Akureyri, has built many ammonia-based fish processing plants across Iceland with another two in the pipeline. The latest – a highly automatic pelagic processing plant for seafood company Eskja in the eastern port of Eskifjörður – will open in October 2016. The new plant, which will use a two-stage ammonia system, will be capable of achieving up to 1,000 tonnes of production per day.

"It's a tradition in the fishing industry to use ammonia. So people aren't afraid to use it. Almost all the fishing factories in Iceland use ammonia. It's easy. We have also installed a 50-ton ammonia plant in the Faroe Islands," says Sigurður J. Bergsson, Frost's technical manager.

Running ammonia systems at a low charge and taking safety precautions helps to address safety concerns. And measures can be taken to protect cargo from any potential leakages, Bergsson argues. Indeed, boat owners and their insurance companies often demand that such measures are put in place.

In Iceland, Frost has fitted ammonia equipment in three plants and several trawlers belonging to seafood company HB Grandi, in two plants run by Ísfélag Vestmannaeyja, in two plants and several trawlers belonging to Fisk, and one large plant run by Skinney. It is also fitting five trawlers owned by Samherji with ammonia freezing facilities, Bergsson says.

"We mainly do industrial systems. And if it's industrial, it's 95% ammonia, apart from small processing factories in the capital, Reykjavik, where there are only one or two stand-alone freezers – making it too complicated to hook up a big ammonia plant," he explains.

NATREFS RISING WITH THE TIDE...

Christoffer Ulf, area export manager at Danish manufacturer DSI, sees the market for natural refrigerants in the seafood industry growing in Europe.

The company was at the Seafood Expo to showcase their CO₂ and ammonia plate freezers for fish processing, for use both on land and at sea. In the fishing industry, plate freezers are used to freeze fish – whether whole or processed – into blocks. Freezing the fish into blocks allows them to be transported and packaged more easily, and also facilitates their preservation. "When freezing at sea, you get the best quality. Also in terms of bacteriology," explains Ulf.

Ammonia is already well established in the seafood industry. But Ulf sees the market for CO₂ technology picking up speed as initial costs come down. Moreover, he does not consider the limited space available on boats to pose any particular challenges for technology manufacturers. "Our freezers are basically the same for CO₂ and NH₃," he says.

continued on p.22 →

→ ...AND OFFER 'INCONTESTABLE' ADVANTAGES

Describing the advantages of CO₂ freezing in particular as "incontestable", Ulf argues that DSI plate freezers using CO₂ can reduce freezing times by 25-50%, thereby saving on power consumption. Moreover the faster the freezing time, the more effectively the natural freshness of the product is maintained.

"The main advantage of CO₂ freezing for seafood is higher capacity per square metre. A CO₂ freezer can work with an evaporation temperature of -50 degrees Celsius in the plates, giving a significantly faster freezing time," he explains. Ammonia technology, meanwhile, is more familiar to refrigeration companies and can be serviced worldwide, he adds.

What about marketing their products on the basis that they use natural refrigerants? "We market our freezers on the basis that they can be applied to the common refrigerants. As ammonia and CO₂ are the most popular technologies, that's where we're focusing our energy," says Ulf.

SEAPORTS GETTING IN ON THE ACT

Natural refrigerants are also helping entire seaports to reduce their energy costs. Geralt Vels, managing director of Dutch firm Sealane – which runs a major port equipped with state-of-the-art cold storage facilities at Eemshaven – said that the company had decided to adopt ammonia for all cold storage applications in 2014; a transition which was completed last year.

Fast forward to 2016, and the decision to adopt ammonia has allowed Sealane to slash electricity consumption at the port by 15%, Vels said.

Another Dutch company, Recom Ice Systems, is successfully exporting natural refrigerant technology beyond European shores. "We've installed two ammonia flake ice machines

in plants in French Guyana and Suriname," says Managing Director Stef Bouhuijs.

"We also plan to market a CO₂ flake ice machine in Europe in the near future," he says.

German firm Ziegra presented their CO₂ and hydrocarbon ice-making range, with the R290-based ZBE 150 CoolNat model for making chipped flake ice taking centre stage. The machine has a capacity of 150kg and is designed to operate 24/7. Local sales manager Martin Klages says Ziegra is currently developing a new R290 icemaker that will have a charge limit of 250kg.

Meanwhile Frost is looking into broadening its activities with natural refrigerants in Iceland beyond the seafood industry. In January, Frost invited experts from the Danish Technological Institute to Iceland to educate staff on using CO₂ refrigeration technology, for example.

There are not currently any supermarkets running CO₂ refrigeration systems in Iceland but Bergsson believes it is only a matter of time until companies there become more familiar with it. Indeed, plans are afoot for Frost to install a CO₂ system in a Costco supermarket in Iceland in the near future – with Bergsson arguing that Iceland's climate is particularly well suited to running subcritical CO₂ systems in supermarkets.

Indeed, the Frost engineer expects interest in natural refrigerants more generally to increase in Iceland as the country strives to phase down HFCs, similarly to EU countries' efforts to do the same under the terms of the F-Gas Regulation.

As for the seafood sector, he believes that CO₂ technology may be an option for smaller trawlers. Frost is yet to install CO₂ systems on boats itself, but has already done so in conjunction with a Norwegian company. **AW**



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SUPERMARKETS SHOWCASE NATREFS FOR WARMER CLIMATES AT ATMO EUROPE

The 7th annual ATMOsphere Europe conference in April saw key retailers like METRO AG, Delhaize and Sainsbury's demonstrate how natural refrigerants can help them save energy costs and meet their corporate sustainability goals – even in warm climates. *Accelerate Europe* reports from Barcelona.

– By Andrew Williams

For the first time, the annual ATMOsphere Europe conference left its Brussels home to venture to the south of Europe. A record-breaking audience of 350 experts from over 150 companies and 25 countries gathered at the Crowne Plaza Fira Center Hotel in Barcelona on 19-20 April to hear the latest policy, market and technology trends driving the uptake of natural refrigerants in Europe.

With a special focus on southern Europe, the event served to show how new technological innovations are bringing high-efficiency CO₂ refrigeration systems to higher ambient temperature regions than had previously been considered technically and economically feasible. Hydrocarbons, even for large installations, and ammonia, used for warehouses close to stores, completed the range of solutions for commercial refrigeration on show.

FOOD RETAILERS PUTTING NATURAL REFRIGERANTS....

Despite the impressive impact of transcritical CO₂ installations in northern Europe, few people would have bet on an equally bright future for CO₂ in high ambient temperature regions. Yet judging by the success of recent installations showcased at ATMOsphere Europe, the potential for natural refrigerants today seems greater than ever before.

Continuous innovation from technology manufacturers is essential to making the transition away from HFCs work. But equally important to increasing the uptake of natural refrigerants in the food and beverage retail sector is commitment and enthusiasm from the retailers themselves.

"In new and remodelled stores, METRO AG has been using only natural refrigerants – where technically possible – since 2013," says Olaf Schulze, the German retailer's director of facility, energy and resource management.

METRO AG is aiming to reduce its greenhouse gas emissions by 50% by 2030 compared to 2011 levels, primarily by reducing energy demand in stores, introducing green energy sources, and reducing refrigerant leakages. Central to this is the company's F-Gas Exit Program for transitioning away from HFCs by 2030, which was the driving force behind the decision to begin adopting natural refrigerants in 2013.

METRO AG currently operates 40 CO₂ transcritical and 58 CO₂ subcritical stores, with an additional 52 CO₂ stores planned for 2016. "We hope to be able to say next year that we are introducing CO₂ transcritical to China, India and Russia," he says.

Belgian retailer Colruyt, meanwhile, is planning to install hydrocarbon refrigeration systems in many stores. It has already fitted propane (R290) systems in Bio Planet stores in Mons, Hasselt and Jambes, with R290 refrigeration also to be installed in the first Colruyt and OKay-branded supermarkets in 2016. "Our goal is to equip 40 shops per year with a propane refrigeration unit," says Collin Bootsvelde, a project engineer at the Colruyt Group.

...AT THE HEART OF THEIR SUSTAINABILITY STRATEGIES

Delhaize, another Belgian retailer, is putting natural refrigerants at the centre of its strategy to reduce the global warming potential of its stores and slash the company's CO₂ emissions by 20% by 2020 and by 40-70% by 2050. "Delhaize Group is committed to increasing the number of natural refrigerant systems where they are feasible and cost-effective," says David Schalenbourg, director of the Delhaize Group's technical department for Belgium and Luxembourg.

Delhaize's use of natural refrigerants is part of a bigger picture of corporate social responsibility towards its customers. "Our aim is to lead the way, help transform the marketplace and show others what is possible," Schalenbourg declares.

In Belgium, Delhaize currently has eight CO₂ transcritical stores and nine R290 stores, with a further three CO₂ transcritical stores in operation in the US. In Romania, meanwhile, the group operates 93 R290 systems. Ammonia is also a key part of the picture. All the company's refrigerated warehouses use NH₃/CO₂ cascade systems.

Delhaize is currently working to optimise the efficiency of its CO₂ systems, for example by testing new ejector technology. It is also planning to roll out more plug-in R290 systems in its stores, and is testing CO₂ refrigeration equipment for transport.

UK supermarket giant Sainsbury's recently installed its 200th CO₂ refrigeration system, at Abbey Wood in southeast London. Refrigeration Design Manager Paul Arrowsmith says that adopting CO₂ refrigeration has already saved the firm 330,000 tonnes of CO₂ emissions, equivalent to lighting 1.7 million domestic buildings for a year.

Arrowsmith says that fitting a CO₂ refrigeration system at its Olympic Way store in Wembley has reduced average weekly electricity consumption for refrigeration by 37.8%, resulting in a payback period of 14.15 months and annual CO₂ emission savings of 70 tonnes.

continued on p.26 →

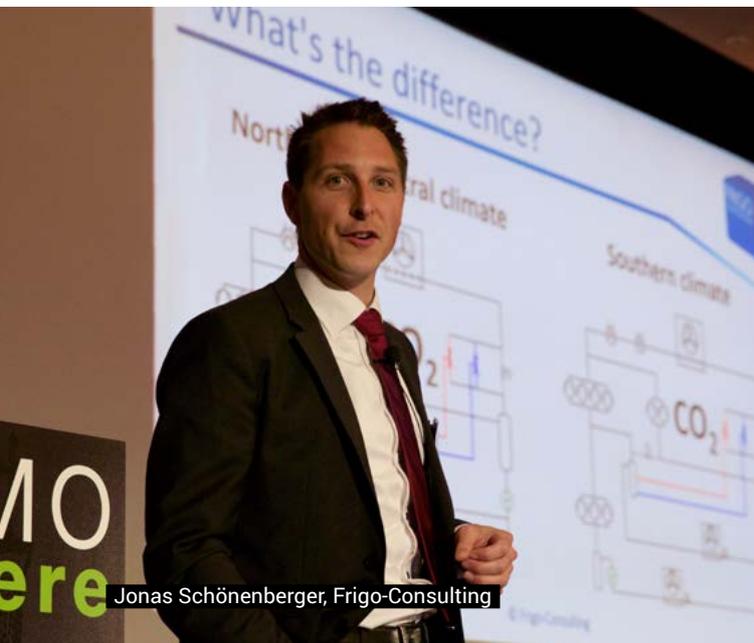


CAREL's Diego Malimpensa



eneX's Sergio Giroto





Jonas Schöenberger, Frigo-Consulting



Sascha Hellmann, Carrier Commercial Refrigeration

→ Harnessed in partnership with other innovations like heat reclaim and destratification fans, he demonstrates how the refrigeration system has become an integral part of a wider sustainability package capable of reducing average weekly electricity consumption by 56.8%.

Indeed, Arrowsmith says the heat reclaim opportunity from CO₂ refrigeration is greater than from HFCs due to the high grade of heat available. He is confident that the Olympic Way blueprint can be applied to other Sainsbury's stores.

Carrefour, meanwhile, has responded to the phase-out of HFCs under the EU's F-Gas Regulation by fitting smaller cabinets and by investing in technological innovations like parallel compression, sub-coolers and ejectors.

Marks & Spencer is aiming to be HFC-free by 2030, and the UK supermarket chain is putting CO₂ at the centre of its strategy for achieving this. M&S' Paul Alway argues that compared to many alternatives CO₂ is cheaper, more efficient, more reliable and future-proof.

INNOVATIVE TECHNOLOGY DELIVERING THE TRANSITION – NORTH AND SOUTH

"CO₂ transcritical systems should operate in the same way whether they are in a northern European climate or a southern one," declares Jonas Schöenberger of Frigo-Consulting.

A combination of liquid ejectors, vapour ejectors and heat exchangers together has led to an efficiency increase of between 15-25% at Swiss retailer Migros' Mythencenter superstore, for example. With site-specific customisation, the Mythencenter demonstrates that CO₂ transcritical systems can be very successful, Schöenberger argues.

"One final barrier limiting the full deployment of CO₂ transcritical systems is the question of efficiency and sustainability in warmer climates," says Diego Malimpensa, Business Unit Manager – Retail Solutions at CAREL Industries S.p.A.

With this in mind, CAREL and Carrier Commercial Refrigeration Europe have joined forces to develop and industrialise a range of modulating ejectors in a bid to put an end to the so-called 'CO₂ equator': the previously accepted geographical limit for cost-effective construction of CO₂ systems in all food retail store formats. "We're now moving from concepts to real industrial sustainability solutions," Malimpensa argues.

Describing a new series of adjustable CO₂ ejectors for commercial refrigeration systems, Sascha Hellmann – project leader for systems development at Carrier Commercial Refrigeration – says the company's transcritical CO₂ system with the CO₂Oltec ejector rack is capable of reducing the average energy consumption of a total refrigeration system by 13%.

"Carrier provides optimised energy solutions with sustainable refrigeration technologies for every food retail store format," says Hellmann, explaining that the CO₂Oltec system's three working modes are suitable for all seasons.

For Mirko Bernabei, technical director at SCM Frigo, integration between cooling, heating and air conditioning is becoming increasingly important for supermarkets, alongside their use of natural refrigerants, as a means of making efficiency gains.

TARGETING SMALLER STORE FORMATS

Japanese company Sanden has seen great success in its native country, installing its 'Sanden CO₂ Technology' range in over 200 stores in Japan. Sanden technology has been successfully deployed for use with remote cabinets, cold rooms, laboratories, and plug-in display cases, among other applications.

Sylvain Gillaux, sales and marketing manager at Sanden International Europe Ltd., told the ATMOSPHERE Europe conference that the company is adapting its Japanese CO₂ technology for the European market amid confirmed interest from European end users.

continued on p.28 →

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→ However, he warns that the image of CO₂ systems in different regions strongly depends on the skill level of installers – not to mention their willingness to work with the technology.

Another Japanese company, Panasonic, has already installed over 2,000 CO₂ systems in Japan. It is also preparing to bring its CO₂ refrigeration systems for smaller format stores to Europe.

Hidekazu Tachibana, from Panasonic's refrigeration and air conditioning business division, was in Barcelona to present the company's CO₂ split refrigeration system for European convenience stores – a new standalone system with a decentralised outdoor condensing unit.

Using a split cycle, adjusting the refrigerant volume, controlling high pressures and fitting electronic expansion valves allow for an optimal refrigerant flow, delivering stable operations as well as significant energy savings, Tachibana argues.

"By choosing a Panasonic solution using a natural refrigerant, you may already be able to meet future European regulations concerning cooling systems today," Tachibana says.

Hydrocarbons are also an option for convenience store applications. Frédéric Guy, technical support engineer at Tecumseh Products Company, argues that adequately containing the refrigerant and reducing the hydrocarbon concentration rate in the event of abnormal running conditions, as well as ensuring regulatory compliance by end users, can address safety concerns.

Optimising components such as compressors, expansion valves and heat exchangers in accordance with refrigerant properties increases their lifetime and therefore reduces the cost of natural refrigerant systems, Guy argues.

EU F-GAS REGULATION BOOSTING NATURAL REFRIGERANT UPTAKE

Danfoss, meanwhile, argued that the EU's F-Gas Regulation is encouraging greater uptake of natural refrigerants for supermarket refrigeration. In Barcelona, Torben Funder-

Kristensen, Danfoss' Head of Public and Industry Affairs, showed how variable capacity ejectors improve the efficiency of CO₂ as a refrigerant in supermarket applications.

Funder-Kristensen outlined how fixed, optimised geometry ejectors operating in parallel can vary the capacity by operating only partially. Ejector efficiency can reach up to 25% even in high ambient temperature conditions, he argues.

Plant design must account for ejector performance characteristics to maximise their efficiency. Compressor capacity must allow for the use of ejectors and the oil return design must be carefully considered, for example. By following these and other simple steps, ejector efficiencies of up to 30% can be achieved, says Funder-Kristensen.

CO₂ can also be used as a refrigerant for direct space heating and cooling applications, reducing energy consumption and related costs still further when used in conjunction with refrigeration and freezing equipment, revealed a case study presented at ATMosphere Europe by Sergio Giroto, president of enEX. He cites lifecycle cost reductions, space saving, and efficiency increases among the advantages of CO₂ for direct heating and cooling applications.

WHAT'S NEXT?

The Barcelona event demonstrates that those who had considered natural refrigerants a niche market for a few applications in northern Europe had better think twice!

The next ATMosphere Europe is scheduled for April 2017 in Berlin.

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CROSSING THE CO₂ EQUATOR: CARREFOUR LEADS THE MARCH SOUTH

For Carrefour, refrigeration plays a key role in delivering environmental sustainability objectives. Recording excellent results in warm climates too, the retail giant is putting natural refrigerants at the heart of its strategy to become HFC-free in the near future.

– By Andrew Williams

C headquartered in Boulogne Billancourt near Paris, France, Carrefour S.A. is a multinational retailer with 12,296 stores in 35 countries across five continents and over 380,000 employees worldwide. With annual sales topping €100 billion, it is one of the largest retail groups in the world.

Carrefour stores are a familiar sight from France to China, ranging from large Hypermarkets to mid-sized Supermarkets and smaller Express convenience stores. Boasting 1,481 Hypermarkets, it ranks among the world's largest hypermarket chains.

With global outreach comes great responsibility. Overall, the Group is aiming to reduce carbon emissions by 40% by 2025 and by 70% by 2050 (compared to 2010 levels). It intends to achieve this by reducing energy consumption, and by reducing CO₂ emissions generated from refrigeration and transportation.

To reduce refrigerant emissions, Carrefour is phasing out HFCs and replacing them with CO₂ for commercial refrigeration. By the end of 2015, it had installed 260 stores with CO₂ technologies in seven countries.

Paolo Martini, Refrigeration & HVAC Manager for International Support at the Carrefour Group, is the man charged with delivering this transition. *Accelerate Europe* met him at his office in the leafy Brussels suburb of Evere to find out how the Carrefour Group is putting natural refrigerants at the heart of its sustainability strategy.





→ **TOWARDS AN HFC-FREE CARREFOUR**

“We’re moving to eliminate HFCs,” Martini says. “This is the goal that we’d like to reach – that’s for sure!” Yet the driving force behind his vision for the retail giant runs deeper still – by adopting natural refrigerants, “you can reduce your CO₂ impact and consume less energy,” he enthuses.

With HFC phase-out deadlines under the EU’s F-Gas Regulation on the horizon, Carrefour’s response to the evolving HVAC&R landscape is marked by two distinct approaches. The first centres on reducing direct emissions from refrigeration, HFC leakages, and other refrigerant gas leakages. The second is to replace HFCs with natural refrigerants.

Indeed, natural refrigerants like CO₂, hydrocarbons and ammonia will all have a key role to play in the context of the HFC phase-down taking place in Europe under the F-Gas Regulation, which since 2015 has been restricting the total amount of HFCs that can be sold in Europe. In 2020, a ban on using certain HFCs in new equipment comes into effect, accompanied by bans on servicing and maintaining existing equipment.

In current standard Carrefour stores, “we’re working on maintenance. We’re implementing what the law and the regulations say, to control refrigerant leakages. We’re working on testing”. “Now we’re also implementing in a good number of stores some smart leakage detection systems. We want to be proactive and to anticipate big HFC leakages,” Martini explains.

The standard Carrefour stores in the future, however, will use natural refrigerants – and particularly transcritical CO₂. Carrefour first decided to go down the natural refrigerants route in 2009. To begin with, hybrid systems were installed to help familiarise staff members with how CO₂ works as a refrigerant. “It has been a process – to improve our knowledge, installers’ knowledge, and the availability of components,” Martini explains.

Since those first steps, the decision to switch to CO₂ transcritical in Europe has proven so successful that the Group is planning to roll out the systems in other parts of the world – starting with Brazil.

“We started in Europe in 2011, 2012 and 2013, making the first pilots in different countries. Now we’re doing the same process outside Europe,” Martini says. With several years of experience in the bag, Carrefour now has a confidence in and understanding of natural refrigerant technologies that had perhaps been lacking at the outset. “Now we are exporting this knowledge, both internal and external, to other countries,” Martini says.

Leading from the front: Paolo Martini



Hypermercado Carrefour, L’Ametlla del Vallès

CO₂ EQUATOR DISAPPEARING

The efficiency of CO₂ refrigeration systems in warm climates has long been a matter of intense debate and source of concern among experts. Yet Martini is convinced that such fears are long past their sell-by date.

In Spain, Carrefour currently boasts CO₂ transcritical systems in 18 Hypermarkets and one Supermarket. It has installed CO₂ subcritical systems in nine Hypermarkets and 14 Supermarkets.

“The first Hypermarkets using transcritical CO₂ were in the north of Spain, where maximum temperatures tend to be moderate. Energy consumption there for the new systems was low, even compared to subcritical installations,” says José Francisco Mollá, technical director of Carrefour Spain.

“This, together with the fact that we didn’t encounter any significant problems, encouraged us to continue doing CO₂ installations in places where ambient temperatures are higher,” Mollá explains.

He sees continuous innovation in CO₂ technology for commercial and industrial applications, specifically focused on improving the performance of transcritical systems in warm climates, as a major driver of increased uptake of natural refrigerant solutions in Spain.

“Pressure from the EU F-Gas Regulation and a Spanish tax penalising the use of fluorinated gases are encouraging the use of alternatives,” Mollá adds.

Yet Carrefour’s Spanish journey has not always been plain sailing. The country’s high average outside temperature guaranteed that the efficiency of CO₂ transcritical refrigeration systems would be closely scrutinised from the outset.

Technology manufacturers worked in tandem with Carrefour to find the answer.



“We solved the performance challenges in high ambient temperatures by integrating several elements into the installations. We installed parallel compression, sub-coolers and ejectors to improve performance when the ambient temperature is high,” says Ivan Díaz, Carrefour Spain’s national Refrigeration & HVAC manager.

What are the results so far? An impressive average of over 45% energy efficiency savings from refrigeration systems alone, in comparison to the standard HFC installations in place previously.

Martini, meanwhile, urges governments or end users harbouring lingering doubts as to the suitability of CO₂ in high ambient temperature conditions to run tests and pilot schemes to see the results for themselves.

“Why not work together with industry and consultants to conduct tests and prove that natural refrigerants can also work well in places like Portugal, for example?”

Martini’s colleagues in Spain share his optimism. “Each [alternative to f-gases] has advantages and disadvantages. An analysis is needed to identify the best option for each case. The configuration of a standard supermarket, for instance, led us to conclude that CO₂ is the preferred option,” Mollá says.

SWITCHING FROM F-GASES TO NATREFS... WORLDWIDE

Worldwide, Carrefour is increasing the pace of the switch from HFC refrigeration to CO₂ systems. Fitting CO₂ transcritical packs in larger format stores such as Markets and Hypermarkets is proving a fruitful place to start. “By the end of 2015, we had 170 stores with hybrid systems and 90 stores with CO₂ transcritical systems – these stores are mainly the biggest format,” Martini says.

“It’s about checking energy consumption and system reliability. We got good results. We started by making a prototype in Italy, a prototype in France, a prototype in Spain, and so on. Each country made its own pilot system. Then they started to feel comfortable with the technology,” he recalls.

Martini’s Spanish colleague Mollá cites the legislative trend towards reducing emissions from fluorinated gases, growing societal concern about global warming, and “the reassuring fact that transcritical CO₂ installations were sufficiently developed and offering good results in Northern Europe” as the main drivers of Carrefour Spain’s decision to adopt CO₂ transcritical technology.

continued on p.36 →





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→ Recent years have seen the performance of CO₂ refrigeration systems improve dramatically as technological innovation picks up pace. This is having the knock-on effect of increasing the number of new CO₂ installations. At the same time, Carrefour is dramatically reducing the number of new hybrid system installations. “By the second half of 2015, we had more projects in CO₂ transcritical than in hybrid,” Martini says.

“For Markets and Hypermarkets, I really believe that CO₂ is the best solution – so, remote central packs with remote cabinets,” he argues.

However, at present the majority of Carrefour stores are in the smaller Express or small Market formats. “We are evaluating natural refrigerant solutions for these smallest formats. We could accelerate even more, having a sustainable and economically competitive solution with CO₂ challenging HFCs for those smaller formats too,” he argues.

Hydrocarbons – another member of the natural refrigerants family – can also be an effective solution for convenience stores. Martini believes hydrocarbons are a good solution for smaller plug-in systems, as well as commercial plug-in equipment, like chest freezers, and water loop systems.



CO₂ transcritical in action



Hypermercado Carrefour, L'Ametlla del Vallès

TAKING NATREFS BEYOND THE SHOP FLOOR

Natural refrigerants are also having an impact beyond the shop floor. For retail giants like Carrefour, any strategy for reducing overall carbon footprint must also take into account the distribution network.

With this in mind, the Group is currently weighing up which type of natural refrigerant to use in its logistics centres. “That could be cascade systems – ammonia and pumped/direct expansion CO₂, and also transcritical CO₂ without using ammonia (just using CO₂ as the refrigerant),” Martini says.

As CO₂ technology develops, he sees it increasingly challenging ammonia for cold store logistics – particularly seeing as CO₂ does not come with the same administrative requirements as ammonia.

What obstacles have the Carrefour Group encountered along the path to becoming HFC-free? Martini says a lack of adequately trained technicians and limited availability of components posed problems at first. But now installers feel more comfortable with the technology and suppliers are more supportive.

Does Carrefour want to be seen as a leader in adopting natural refrigerants? “Yes! We’d like to show that it’s possible to use natural refrigerants in our sector, commercial refrigeration, and also for industrial applications,” Martini says.

From this perspective, the Carrefour Group is particularly proud to demonstrate that CO₂ can be used for commercial refrigeration in supermarkets in climates as warm as Brazil and Spain.



Carrefour Spain's technical director shows off Gavà store

TAKING EUROPEAN KNOW-HOW TO BRAZIL

In fact, as recently as April 2016, Carrefour installed two transcritical CO₂ packs in Brazil – its first beyond Europe's shores. "For the moment we've started with Brazil. But we're also thinking about following the same approach in other countries," Martini says.

The Group has two store brands in Brazil – Carrefour and Atacadão. As far as Carrefour is concerned, its Brazilian operations comprise the same store formats as in Europe. "We've got Carrefour Market, Carrefour Hypermarket and Carrefour Express. And Atacadão is more one format – it's a cash and carry," Martini says.

The first CO₂ transcritical installation is in a Carrefour Hypermarket in Cambuci, a district of São Paulo, and the second is in an Atacadão store in Atibaia, a municipality in São Paulo state. Both systems use parallel compression and adiabatic gas coolers.

Some retailers, however, are still reluctant to consider CO₂ for commercial refrigeration in warm climates, citing efficiency concerns. Will the higher average ambient temperatures in the South American country affect the performance of CO₂ as a refrigerant? "Since 2013, we've been moving the so-called CO₂ equator southwards. We've arrived in Valencia and Malaga, so those are pretty warm average ambient temperatures!"

In fact, in mid-2014 Carrefour teamed up with Frigo-Consulting to install an integral CO₂ system for HVAC&R – using CO₂ for air conditioning as well as refrigeration purposes – at its Piazza Siena store in Milan. The new system reduces the store's carbon footprint by a massive 250 tonnes of CO₂ emissions per year compared to the previous R404A-based installation.

Detailed performance data for the two Brazilian stores are not yet available, but Martini is confident they will prove to be success stories. "I've already seen that the central packages are working pretty fine," he says.

"The goal is to compare these transcritical CO₂ systems with the standard packs used in Carrefour and Atacadão stores in Brazil until now. The goal is to prove that this technology delivers good service results even in Brazil. Just like we did in Spain," Martini explains.

DRIVING POSITIVE CHANGE

As a pioneer, Martini believes Carrefour has an important role to play in triggering change across the food and beverage retail sector. "Why not signal to other retailers that it's possible from an efficiency point of view...that it's possible to train companies...that it's possible to get knowledge about how to deal with natural refrigerants?" the expert argues.

Martini is calling on other retail giants to join Carrefour in using natural refrigerants. "The more of us there are, the better it is for everybody," he insists. "Why not work together, even if we're competitors in other aspects? Regarding technologies, it's good to exchange information between us. To work together to widen the use of natural refrigerants," he argues.

Communicating the benefits of using natural refrigerants to their own customers, though, is proving to be more challenging. "Communicating about putting doors on cabinets is easier than communicating about something that's in the back of a store, enclosed inside a machine room that nobody even knows about," he admits.

"With cabinet doors, customers can see the difference, because they suddenly have to open the door. Or they read the label to compare car emissions, for example. So with other technologies it's easier [than with refrigeration technology]."

CREATING NEW MARKETS

Yet while there is clearly progress to make in informing customers that they are helping to protect the environment by shopping in natural refrigerant-based stores, there is

continued on p.38 →

→ another extremely powerful force at play in driving uptake of environmentally friendly technologies – regulation.

“For sure, the EU F-Gas Regulation is a very important driver – because it doesn’t give you a lot of options,” argues Martini, warning that, “every day, the chemical industry is pushing and finding temporary solutions for refrigeration systems, like refrigerant blends”.

Adopting natural refrigerants now avoids new investment costs further down the line. “At Carrefour, we would like to go straight to a final solution. By using CO₂ or other natural refrigerants, we are also avoiding [the risk] that in two or three years’ time, there may be another update of the F-Gas Regulation, limiting other gases and decreasing even more the GWP of the gases that we’re allowed to use in our systems,” the refrigeration expert states.

One crucial effect of legislation is that it has the power to drive the development of or even to create new markets. Has the situation in Europe become more positive for adopting natural refrigerant technologies, for example?

“Yes – for sure it’s easier! More industries are working with them. More components are available. And more skilled people are available,” Martini observes.

Moreover, he notes that the price of CO₂ components is already falling, because more companies are now producing them. “I think this is a trend, and that we’ll get even better prices in future,” he says.

CLOSING THE TRAINING GAP

One oft-cited obstacle to greater market penetration of natural refrigerant-based systems is an alleged lack of technicians trained in using the technologies. Martini, however, paints a brighter picture. He believes the situation is improving as quickly as the technology itself is developing.

“I think it’s getting easier. In Europe it definitely is. But we need to work on training in South America and Asia, for sure. Here in Europe, installers are also providing more options to do training,” Martini says.

Technology manufacturers themselves are also stepping up to fill the training gap. In Germany, for example, Bitzer inaugurated a new international training centre – the SCHAUFLEER Academy – in February 2016. Also in Germany, Carrier opened its CO₂OLacademy in 2015.

“With the increased training offer in refrigeration, both from industry, but also from public organisations, we now have a good number of options for training our technicians,” says Martini.



“You can also get training at universities. In Belgium, Limburg University is making a training centre. In France, we have some training schools. But we mainly work with industry. With industry, you have the opportunity to train installers and Carrefour staff,” he explains.

Spain is a success story in this regard. “At the beginning, a lack of trained installers and maintenance staff posed problems in adopting CO₂ transcritical systems, says Carrefour Spain’s Díaz.

The supermarket giant responded by involving industry from the outset. “Our first installations were carried out with the support of Carrier and Frigo-Consulting. The installation of the central refrigeration units included support from the manufacturer,” Díaz recalls.

Carrefour Spain now has a well-established process in place for rolling out CO₂ transcritical refrigeration systems in new or retrofitted stores. “During the first five years, the companies involved in installing the systems will be responsible for their maintenance. As part of the installation process, the system supplier also provides training to Carrefour staff involved in maintenance,” Díaz explains.

What’s more, all Carrefour’s CO₂ transcritical installations in Spain are connected to a network. “This gives us the option of getting technical support remotely, or seeking a second opinion from the company in charge of maintenance if necessary,” he says.



FOOD RETAILERS DRIVING NATREF UPTAKE

From his conversations with his counterparts at other major European retailers, Martini is confident that the move towards natural refrigerants in food retail applications is here to stay.

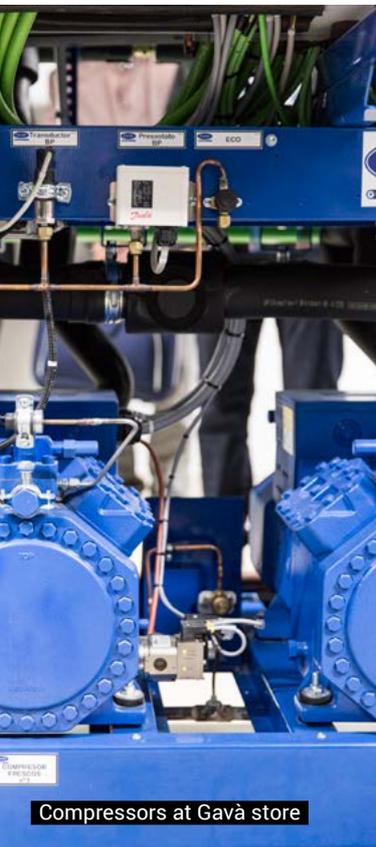
Proactive retailers have a huge role to play in driving greater uptake of natural refrigerants across the food and beverage industry, according to Martini. Together, large supermarket chains have the power to move entire markets. “They should work from the cost point of view, making tenders and challenging [the natural refrigerant technology] industry to be more competitive and to give them better prices,” he says.

For lifelong engineers like Martini, innovation begins at home.

“If I have to decide what system to install in my house, for sure I look for an environmentally sustainable solution,” Martini says with a grin. He also uses LED light bulbs. “And I separate the garbage. But that’s just about good behaviour!” he laughs.

At Carrefour, Martini is in charge of international support for refrigeration and HVAC. He moved to Belgium from his native Italy to take up the role. What strikes him most about the different ways of doing business between north and south?

“Is there really any difference?! Here in Europe I think we’re pretty similar!” he says with a smile.



Compressors at Gavà store

Cosmopolitan by nature, Martini insists it was “pretty natural” to move from Italy to Belgium to work for a French company in a role that requires plenty of travel in Europe. “And also to Spain – but Spain is more like Italy!” he jokes.

A passionate cook and a born traveller, Martini comes across as a man comfortable in his own skin. “I’m really satisfied about what I’m doing now. I really like being part of the change within Carrefour, and I like Carrefour’s long-term vision,” he says.

So will he be around to see it through? “I’d like to continue with this process and to be a part of it until the end – until we’ve switched entirely our installations to natural refrigerants,” he says.

One thing is certain: at this pace, the industry Martini joined as a young engineer will soon look very different, with natural refrigerants well placed to become the refrigerants of choice. [@ AW](#)

SPOTLIGHT ON SPAIN

Hypermercado Carrefour, Gavà

- Surface area: 8,300m²
- System: CO₂ transcritical with parallel compression and subcooler from Carrier installed by Cofrico
- Cofrico trained Carrefour staff to maintain system
- System management and monitoring: Danfoss electronic controls
- Plate heat exchanger from Alfa Laval reclaims heat for producing sanitary hot water
- Carrier’s sub-cooler improves system performance by cooling down discharge of gas cooler when ambient temperature is high

Hypermercado Carrefour, L’Ametlla del Vallès

- Surface area: 3,200m²
- New system: Carrier CO₂OLtec CO₂ transcritical with ejector & parallel compressor
- Installation: Retrofit of 25-year old store. Store remained open throughout the installation
- System management and monitoring: Eckelmann electronic controls
- Future plans: Considering alternatives to f-gas air conditioning system

Both stores:

- Gava & L’Ametlla del Vallès systems: 46% more efficient than previous direct expansion systems using f-gases
- Design pressure: 25 bars (low temps), 45 bars (medium temps), 120 bars (high temps)
- 90% centralised, 10% autonomous cabinets: giving staff freedom to move the units around to adapt to evolving store needs
- Option of adding 30% extra cooling capacity (to add more freezers or display cases in future, or to guarantee power in event of a compressor failure)
- Centralised system uses 3 variable speed Bitzer compressors, for high, medium and low pressure respectively
- Refrigeration cabinets feature doors, LED lighting and electronic ventilators to reduce energy consumption
- Communications: Stickers on display cases inform customers of the use of natural refrigerants



Alessandro Greggio
Group Head of Marketing Retail & Refrigeration
CAREL INDUSTRIES

CAREL BRINGING NATREFS TO WARMER CLIMATES

Italy-based multinational CAREL is showing how new 'EmJ' ejector technology jointly developed with Carrier can bring high-efficiency CO₂ refrigeration systems to higher ambient temperature regions than often considered feasible – potentially opening the door to wider uptake of natural refrigerant solutions in warmer climates.

– By Andrew Williams



We feel that the concept of the 'CO₂ equator' has been superseded. All limits – even trekking on Everest or in the Sahara – can be overcome if you have the right 'gear' or equipment," Alessandro Greggio, Group Head of Marketing – Retail & Refrigeration at CAREL Industries S.p.A, told *Accelerate Europe*.

Overcoming the so-called 'CO₂ equator' – the previously accepted geographical limit for cost-effective and efficient performance of CO₂ systems in all food retail store formats – would dramatically extend the scope to use CO₂ as a natural refrigerant across the spectrum, from smaller convenience stores to large hypermarkets.

"We feel that the gear that's now available to those who wish to overcome the current limits, however challenging these may be, is adequate – as long as you have the desire and the right training," Greggio says.

As Group Head of Marketing Retail & Refrigeration, he is currently responsible for the strategic development of CAREL's offering in the food retail and food service segments, through the corresponding Business Units.



BOOSTING SYSTEM EFFICIENCY

The ATMOsphere Europe conference in Barcelona on 19-20 April provided the perfect stage for HVAC&R firms CAREL and Carrier Commercial Refrigeration Europe to preview the new electronic modulating ejector (EmJ), which is designed to increase the energy efficiency of transcritical CO₂ systems in warmer climates.

"This represents a significant leap forward in the technology available to the industry for more efficient implementation of future CO₂ systems," says CAREL's Greggio.

The Italian firm, headquartered in Brugine, near Padua, is already reporting considerable interest in the new product. The ejector helps bring CO₂ systems to warmer climates without critical loss of energy efficiency, and extends their use to systems of different sizes or to systems with major variations in capacity.

"This is made possible by the truly continuous electronic modulation on the EmJ ejector, meaning that it is capable of increasing system efficiency by up to 25% – with annual averages of 10% in the typical climates of southern Europe," Greggio says.

It also helps system designers to reduce costs by simplifying the refrigeration circuit. "The EmJ electronic modulating ejector brings positive benefits not only in terms of energy consumption, thus removing the CO₂ equator, but also regarding total cost of ownership – modulating operation means that other system components aren't needed," he argues.

Other innovations are helping to improve the performance of CO₂ refrigeration systems too. "Evaporative cooling may be a viable option for sudden peaks in annual temperature. Parallel compression and sub-coolers are already industrially available," Greggio says.

"As a result of the numerous [offerings] now available industrially and commercially, recent technological innovations, and the availability of expertise and know-how, we feel it is realistic to now consider that the 'CO₂ equator' has been overcome both in Europe and by extension in similar climates in the rest of the world," he argues.

SPREAD THE WORD: 'THE ERA OF CO₂ INDUSTRIAL IMPLEMENTATION' IS HERE

Training of technicians is crucial to increasing the uptake of CO₂ transcritical technology worldwide. Similarly, the benefits of transcritical systems must be communicated to customers to ensure that end users understand the technological developments that are helping to make CO₂ more attractive as a refrigerant.

"Desire and the right training are needed," says Greggio. "It is clear that there is still a lack of understanding regarding the safety, service continuity, cost and effective efficiency of CO₂ transcritical systems – above all in warmer climates – among end users."

"This influences negatively management decisions to trial transcritical CO₂ technology," he says – particularly given that energy consumption from commercial refrigeration is an important part of a supermarket's operating expenditure.

To the industry, "we need to very practically and pragmatically convey the message that we're no longer in the era of CO₂ technical pioneering, but rather in the era of its industrial implementation," he says.

CAREL is not afraid to head out into the field to offer installers and component manufacturers on-the-job training in how to use its equipment. "Challenges can be overcome with the right practical training, not just theory and e-learning. The subject of CO₂ is no exception," Greggio says.

continued on p.42 →

→ NATREFS: A SOLUTION TO EU F-GAS RULES

With the EU's F-Gas Regulation driving a phase-down of climate-damaging HFCs, the need to adopt alternatives represents a huge opportunity to boost uptake of natural refrigerants in Europe.

"It's evident that the F-Gas Regulation has increased – and will continue to increase – pressure on industry to use CO₂ and other natural refrigerants, such as hydrocarbons and ammonia," Greggio says.

Indeed, the company already offers products for other natural refrigerants, such as electronic expansion valves (EEVs) and drivers for hydrocarbons and ammonia, as well as controls for third-party components such as compressors. For ammonia in particular, it offers a successful line of programmable control solutions and EEVs for industrial refrigeration applications.

"CAREL has invested in solutions that can be used to overcome the limits both already introduced and soon to be introduced by the F-Gas Regulation," Greggio explains, stressing that the company will definitely follow this strategic investment path by continuing to supply solutions that respond to the challenges of the regulation.

The Italian company has been operating for longer in the HVAC market than in refrigeration, with market strategies for each sector designed to complement one another. There too, the potential is strong. "We have seen growing interest in natural refrigerants in several different HVAC applications," Greggio says.

He cites process chillers, light commercial chillers and residential heat pumps as the most promising growth areas. "In these cases, the EU Eco-Design Regulation plays a similarly important role to F-Gas – indeed, perhaps an even more important one," he says.

AN ITALIAN SUCCESS STORY

CAREL is particularly active in its home market of Italy, supplying and supporting almost every Italian manufacturer of CO₂ solutions. "Our Italian operations are indeed our showpiece regarding integration between refrigeration and air conditioning, made possible thanks to the technical expertise of our local partners and the structure of our local subsidiary," says Greggio.

He believes Europe's expertise and success in using CO₂ refrigeration systems serves as a positive inspiration for the rest of the world. "We're increasingly seeing considerable exports of finished units to overseas countries and recently even Down Under. At CAREL, we're very pleased with the examples to which we have contributed," he says.

Fast-forward a decade from now, and where does Greggio see the market for natural refrigerant technologies?

"CAREL's DNA is founded on and devoted to continual innovation applied to thermodynamics, aimed at achieving energy efficiency and reducing carbon footprint," he says.

Given that the evident trends and market demand are also moving in that direction, he foresees a bright future for the company's solutions, arguing that they "are and will be capable of meeting the most demanding energy and environmental challenges".

Indeed, the future for natural refrigerants shines similarly bright. @AW



CAREL's CO₂ technology portfolio

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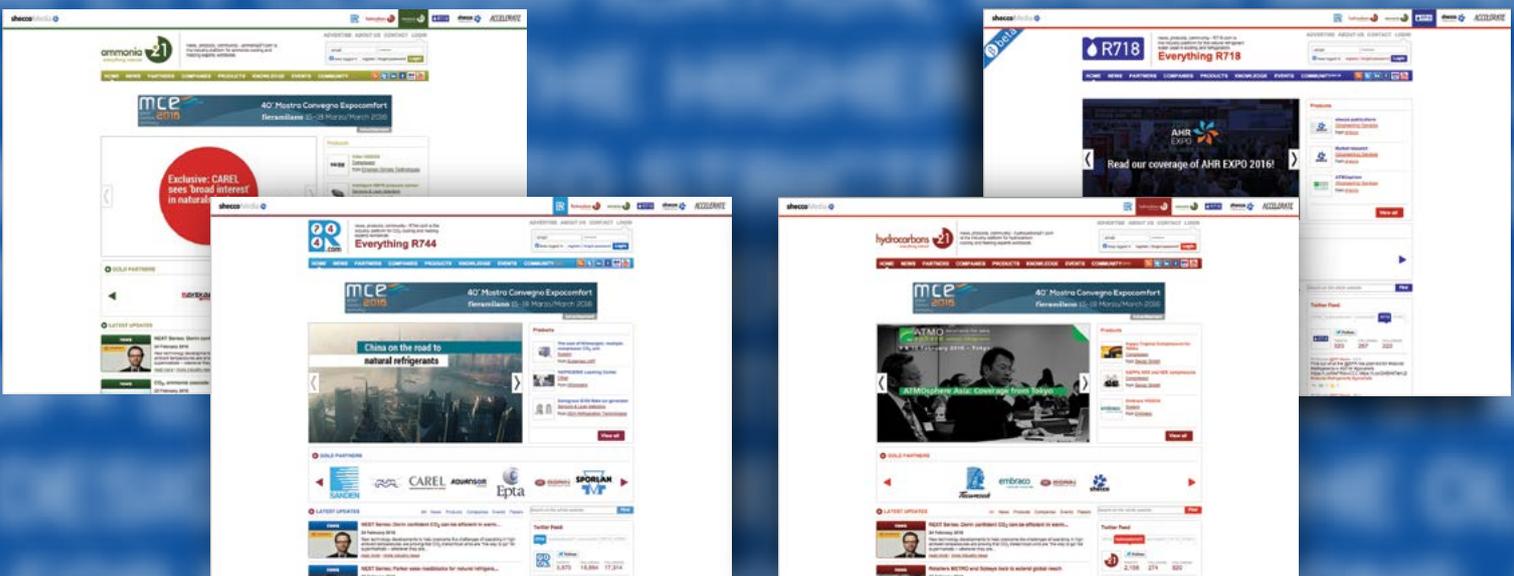
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GETTING TO THE TOP WITH CO₂ ALONE

Danish company Advansor is showing how CO₂ transcritical technology can be rolled out across the world and in all climates. To mark the firm's 10th anniversary, *Accelerate Europe* spoke to founder and managing director Kim G. Christensen about their journey so far and his vision for the next 10 years.

– By Andrew Williams





continued on p.46

→ Advansor, headquartered in Aarhus on the east coast of Denmark's Jutland peninsula, is a leading manufacturer of refrigeration technology for supermarkets, food processing, air conditioning and industrial refrigeration – using CO₂ as the only refrigerant.

"What we've been very good at is only focusing on CO₂," says Christensen, crediting the decision to stand by this strategy as a central pillar of Advansor's success since it was founded in 2006.

Having left the Danish Technical University with a Master's in Mechanical Engineering (Refrigeration Systems) in 1995, Christensen spent the next decade working on R&D in the field of refrigeration at the Danish Technological Institute.

He admits to having occasionally entertained doubts as to whether solely focusing on CO₂ was the right decision to make. "It's not even just focusing on CO₂ – we've only been focusing on transcritical CO₂," he says.

It was, however, this singular drive that the Dane credits for Advansor's continued success over its 10 years of existence, amid growing competition from more firms entering the CO₂ transcritical market in Europe. "The whole organisation is only thinking about one thing – and that's doing the best transcritical rack," he explains.

"We've believed in this since the beginning and we knew for sure that it would be successful," Christensen insists. "Now the followers are realising that CO₂ transcritical is here to stay and that they will need to act too," he says.

Christensen puts the company's success partly down to honesty about what the technology can and can't do. "When you market or want to sell one technology only, you should only sell it in applications where it really makes sense," he argues.

"The truth always comes out. So I always say to our sales people, 'don't try to sell CO₂ when CO₂ isn't the best option'. That's another key to our success. People trust us," he says.

SUPERMARKET SECTOR DRIVING TECHNOLOGICAL INNOVATION

Advansor has been hugely successful in installing large-scale refrigeration systems in big supermarkets for companies like Tesco, Sainsbury's and Carrefour. But Christensen knew which way the wind was blowing.

Around four years ago, "we saw that retailers were not investing in hypermarkets or big stores anymore. They started to invest in convenience stores – smaller formats," he says.

Asked whether going into convenience store formats like Carrefour Express or Sainsbury's Local is a path that Advansor will take, Christensen is unequivocal: "Definitely. It has to be our future, because that's where the supermarkets are spending their money." "To be an ambitious OEM (Original Equipment Manufacturer) on supermarket racks, we must have products for that store format," he says.

With this in mind, Advansor is currently developing a new product for its portfolio. At present it offers the ValuePack line for stores of 1,000-2,000m², and a small 3KW condensing unit. "But we now see the need to have something in between – a kind of even smaller ValuePack based on the principles of a condensing unit. It'll be a booster system, able to service both low temperature and medium temperature capacities, with only two or three compressors,"

Supermarkets are not the only area that the company is focusing on. "Another area is industrial [refrigeration]," says Christensen. "That's the reason why last year we set up a small organisation inside Advansor – it's only two people at this time – to focus only on industrial," he explains.

They are looking into opportunities in industrial applications like distribution centres, warehouses and food factories. "Today industrial is about 12% of our turnover. We want to triple that. It should be 35% of our turnover by 2020," Christensen says.

continued on p.48 →



Advansor's Kim G. Christensen

Report on Natural Refrigerants Training in **Europe**



2016
**GUIDE TO NATURAL REFRIGERANTS
TRAINING IN EUROPE**
— STATE OF THE INDUSTRY

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To feature your case studies, showcase your products or create visibility for your company in the GUIDE, please contact

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Celebrating Advansor's 10th anniversary

→ CROSSING THE CO₂ EQUATOR

New technological innovations are bringing high-efficiency CO₂ refrigeration systems to higher ambient temperature regions than had previously been considered technically and economically feasible – potentially putting an end to the so-called 'CO₂ equator': the previously accepted geographical limit for cost-effective construction of CO₂ systems in all food retail store formats.

Christensen identifies three distinct stages to overcoming the CO₂ equator: the R&D phase, the commercialisation phase, and the maintenance phase.

He also preaches caution. Innovations like ejectors, parallel compressions, sub-coolers and de-superheaters are helping to overcome system performance challenges in higher ambient temperature regions, but they also make the system more complicated to operate, he warns. He fears that marketing the technology too early could even be detrimental to its long-term success.

"It's one thing to have an ejector available. It's another thing to have it actually running in a supermarket, with people out there able to service it and understand it," Christensen warns.

"When we sell these ejectors, for example, we have to make sure that the Spanish refrigeration guy, who doesn't speak English and doesn't necessarily know much about these ejectors, is able to service that system on a Saturday night," he says.

Despite such challenges, Christensen is convinced that performance issues in warmer climates can be definitively overcome.

"I'd say the CO₂ equator has already moved south. We can do systems in Spain and Portugal now – even without ejectors

– which are competitive with HFC systems. We shouldn't be afraid of selling transcritical CO₂ systems in these countries, because we're already there with that technology," he insists.

Christensen sees a bright future for CO₂ transcritical technology, and predicts that given time, the successful integration of new innovations "will completely destroy the CO₂ equator. We won't even be talking about the CO₂ equator anymore".

Lack of training is often cited as another barrier to wider uptake of CO₂ transcritical systems. But Christensen refutes this. "The story that there isn't enough CO₂ training capacity is a lie," he insists.

He urges retailers and contractors in areas without access to local training to visit existing facilities elsewhere. He cites courses at universities in France and Belgium, refrigeration schools in Denmark and Sweden, and training centres run by companies like Bitzer, Carrier and Advansor itself among the many options currently available.

As for Advansor itself, what's the biggest achievement of the last decade? "That we survived," he quips. With money tight and cash flow briefly an issue in the early years, he even recalls successfully keeping the Danish authorities at bay with an offer of five compressors!

"I'm most proud of having actually succeeded in bringing Advansor from a two-person company to one of the leaders in this industry," Christensen says.

And where does he hope to see the company by the time its 20th anniversary comes around? As the market leader in CO₂ transcritical technology having stuck to its strategy since the beginning: "You do it because you believe in it. It's the right thing to do." @ AW



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ATMOSPHERE AUSTRALIA BUILDS INDUSTRY MOMENTUM

Participants in the first ever ATMOSphere event in Australia expressed hope and confidence in the true potential and opportunities for natural refrigerants Down Under.

– By James Ranson

Vith close to 200 delegates walking through the doors at Rydges Melbourne on 16 May – many of whom arrived well before the jangling of the first bell – it was clear that industry is prepared, and more importantly willing, to mobilise as one.

The ATMOSphere team was absolutely delighted to welcome such a high number of industry figures and key stakeholders, with the final figure far exceeding initial expectations. Attendees listened in to over 30 international presentations from Australia, New Zealand, Belgium, Denmark, Italy, Japan, South Africa, the UK and the US.

Amid essential discussions covering key policy measures, market trends, technology, safety standards and training, it was clear that the country's first taste of ATMOSphere will have a lasting impact on the HVAC&R industry.



POLICY, MARKET DIMENSION

The key presentation in the policy session came from Patrick McInerney of the Australian Department of Environment. Industry is eagerly awaiting the outcome of the Federal Government's Ozone Protection and Synthetic Greenhouse Gas Management programme (OPSGGM), which will finalise which HFC phase-down or mitigation options will be adopted. A decision is expected soon, but the 2 July federal election could well push back the process.

In August 2015 the Australian Government announced an emissions reduction target of 26-28% (compared to 2005 levels) by 2030 and an 85% phase-down of HFCs by 2036. The OPSGGM received 57 submissions with strong support for the national phase-down on HFC imports, while a live poll at the event indicated strong support for the option to ban specified equipment containing specified high-GWP refrigerants, a measure recently adopted in California.

shecco's Deputy Manager for Market Development Klára Skačanová cited the California Air Resources Board's aggressive stance to phase-out HFCs with GWPs higher than 150 in specified equipment and applications as a word-leading example for Australia to follow.

"Basically times are getting tougher for high-GWP HFCs and that's going to create huge opportunities for natural refrigerants," says shecco Managing Director Marc Chasserot.

The market trends session revealed quite clearly the plethora of opportunities available for tried-and-tested systems from Asian, European and US manufacturers looking to enter the market.

Warm climate variants of transcritical systems with ejectors, CO₂ heat pumps and cascade NH₃/CO₂ solutions were among some of the proposed solutions that had domestic delegates listening intently.

Bitzer, Advansor, Heatcraft, Mayekawa and Mitsubishi Heavy Industries are just some of the global manufacturers already making moves Down Under.

Team Leader/Project Engineer at Denmark-based Advansor, Peter Bao, is very familiar with Bitzer's CO₂ compressors having used hundreds of them in Advansor's 750 transcritical installations worldwide.

Advansor recently delivered four transcritical booster systems with parallel compression to Brazil and is eager to deliver a similar solution to the Australian market. Bao displayed a projected energy consumption chart for Melbourne, with its CO₂ booster including parallel compression revealing a 10% drop compared to a synthetic-based R404A system.

Robert DelVentura, Vice-President Global Innovations at Heatcraft Worldwide Refrigeration, echoed moves from Advansor. "In Australia we're looking for installations with ejectors and parallel compression and we're hoping to have some projects confirmed in the third quarter of 2016," DelVentura says. Heatcraft's Australian division has a strong customer base in the region and launched its first transcritical rack for warm ambients the following day at ARBS 2016 in Melbourne.

continued on p.52 →





→ ASSOCIATION COHESION CRITICAL

A range of key Australian and New Zealand HVAC&R associations discussed the barriers and opportunities for natural refrigerants including the Australia Refrigeration Association (ARA), the Australian Refrigeration Mechanics Association (ARMA), the Climate Control Companies Association of New Zealand (CCCA), Refrigerants Australia, the Air Conditioning and Refrigeration Equipment Manufacturers Association of Australia (AREMA) and the Refrigeration and Air Conditioning Contractors Association Australia (RACCA).

The need to raise training standards and implement a nationwide refrigerant licensing scheme in Australia – like that in place in New Zealand – was evident, as well as to more effectively disseminate information to raise greater awareness of the safe use of all refrigerants to produce a new generation of future-proofed technicians.

CCCA chair Matthew Darby believes it is up to the industry to raise the low skill levels and training standards that are holding natural refrigerant technology back. “It’s up to us as professionals to help up-skill and train our industry,” he says. “In an industry where regulation is not going to occur, it is up to us to have meaningful discussions with end users, the operators and the companies involved to ensure that whatever solutions we put forward, they are environmental and sustainable.”

The Australian Institute of Refrigeration, Airconditioning and Heating’s (AIRAH) executive manager, Phil Wilkinson, spoke of the association’s PRIME initiative, a vehicle developed by a coalition of stakeholders to engage the whole industry to move to a ‘low-emissions’ future. In the days proceeding ATMOsphere, AIRAH received crucial funding to help commission the initiative.

NATREF SOLUTIONS APLENTY

End users were delighted to finally have the platform to openly discuss natural refrigerant solutions and barriers across all aspects of the industry. Key commercial players like Coles and Woolworths, and Countdown and Foodstuffs in New Zealand, will continue to set the agenda and be an example to follow.

They cannot and will not wait for government to implement regulation or provide subsidies.

“We’re not in a position to be able to wait,” says Coles’ National Engineering Refrigeration Manager Stuart Saville. “We’ve got new stores that need building and old stores that need retrofitting. What we’re excited to see is the number of international players entering the market, not just Heatcraft but also Advansor, Bitzer and SCM Frigo.”

As in Europe, CO₂ will undoubtedly make a significant impact on the food retail sector. In fact it already has, with hundreds of CO₂ cascade systems in operation in Australia and New Zealand. All major retailers are installing or investigating transcritical CO₂ as the future-proof solution for food retail, while hydrocarbon showcases and water-loop systems are also making a significant imprint.

Woolworths’ Head of Engineering Michael Englebright confirmed the company would deliver its first CO₂ transcritical booster system with parallel compression in 2016, throwing down the gauntlet for suppliers. “Once we see how the system reacts then the sky’s the limit,” Englebright says.

The swathe of natural refrigerant solutions presented to industrial end users in the case studies session is clearly not yet fully understood by the whole potential customer base. From hydrocarbon chillers, low-charge ammonia, DX ammonia, CO₂ transcritical and CO₂/NH₃ systems to water-based solutions – all are being tested and offer carbon-neutral, highly efficient investments for customers.

Hydrocarbon chillers in particular can fill a gap in Australia in small to medium-sized industrial applications, where natural refrigerant offerings are lacking.

“We’re sort of being pushed in Australia to accept that [hydrocarbons] are only acceptable in systems with under 150g charge,” said C.A Group Services Managing Director Ian Tuena. “But systems like chillers used in open air environments can have much larger charges. And I think small to medium air conditioning, heat pumps and medium temperature refrigeration present real areas of growth for hydrocarbons.” @ JR

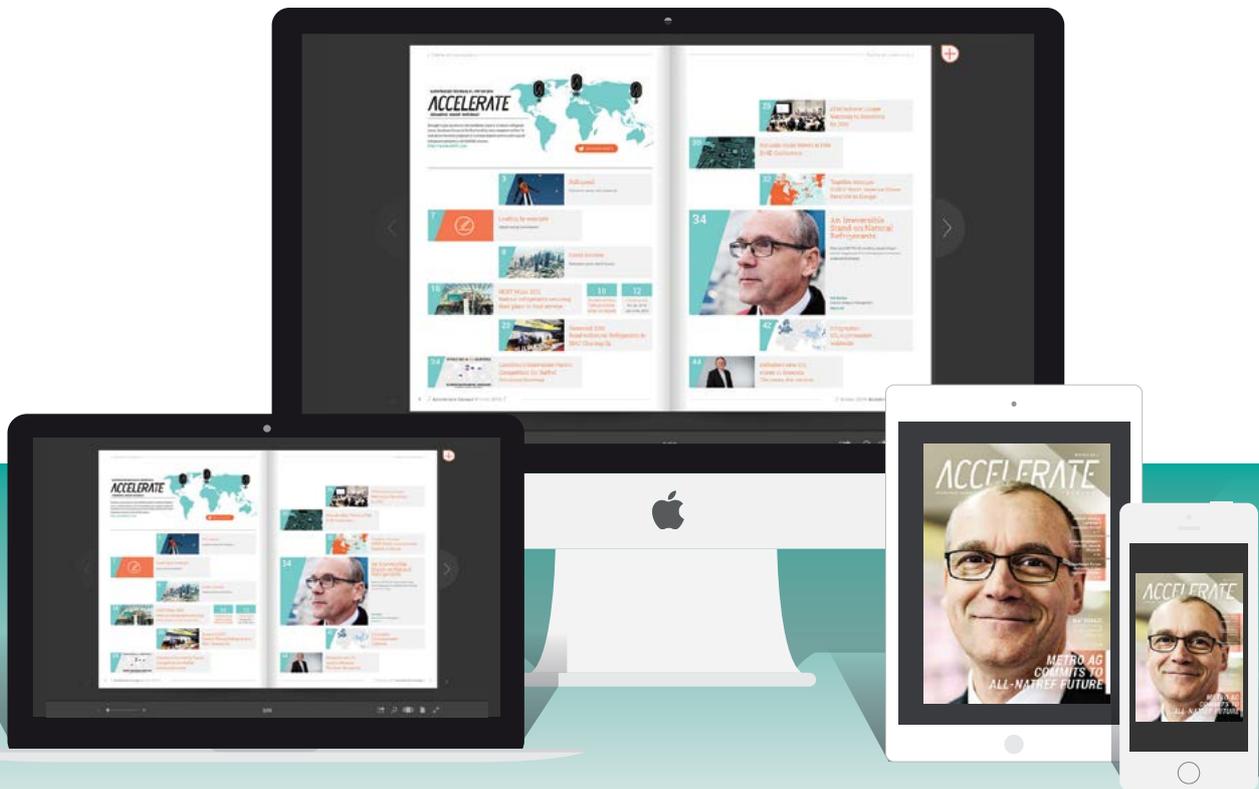


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Stuart Saville, Coles

COLES PUTTING CO₂ ON THE MAP DOWN UNDER

The Australian retailer's first transcritical installation, which encompasses refrigeration, air conditioning and heating, is recording promising efficiency numbers, setting the stage for more installations of the technology.

- by James Ranson and Jan Dusek

Stuart Saville is a man of purpose. Charged with driving the sustainability agenda for Coles – one of the two dominant food retailers in Australia with Woolworths – Saville, national engineering refrigeration manager, is measured in his thoughts but knows he is onto a good thing.

Decked out with “all the bells and whistles,” Coles' first CO₂ transcritical booster installation at its recently opened flagship store in North Coburg, Melbourne, has so far performed above expectations.

Management was hoping for energy reductions of 10%. But since the store opened in August 2015, the refrigeration system has so far seen an impressive 15% efficiency improvement (with a maximum of 22%) during the cooler months, compared to its baseline CO₂/R134a systems.

It's little wonder industry figures and rival retailers have been keeping their ears close to the ground for news on one of Australia's five commercial transcritical installations, which include three at competitor Metcash IGA stores.

The transcritical installation is the result of Coles' longtime use of subcritical CO₂ systems at 120 of its 780 supermarkets. The chain is also testing other natural refrigerants, including propane in display cases at a Liquorland outlet adjacent to the North Coburg store, and one ammonia/CO₂ cascade system.

Accelerate Australia, a sister publication of *Accelerate Europe*, was invited to see the bustling North Coburg store with Saville and Brian Toulson, senior project engineer for UK-based City Refrigeration Holdings, whose Australian arm, City Facilities Management, partners with Coles on all of its installations.

Described as a "concept store," the 39,826-square-foot supermarket is Coles' first attempt at an all-natural solution (only one back-up compressor is running on HFC R134a). Coles is eager to implement CO₂ transcritical systems in two more stores as early as this year and is all but convinced that ejector technology will accompany one or both.

Meanwhile, the North Coburg installation encompasses not only refrigeration but also air conditioning and heating, making it one of the most versatile transcritical installations in the world. The booster system includes two Bitzer CO₂ centralised racks supplying a load of 610kW; parallel compression; adiabatic cooling; hot gas defrost, 250kW of chilled water capacity to supply store air conditioning; heat reclaim supplying store hot water and heating; and four solar inverters generating up to 100kW.

OPTIMISING ENERGY

The transcritical system has performed well so far, even in warmer temperatures. Toulson, who has been in the engine room and seen the system under stable operation on a 43°C day, said no stone had been left unturned in ensuring the store was as advanced as possible. "We looked at everything that would help the energy profile and we really wanted to get rid of synthetic refrigerants and also to hit the optimum energy savings that we could."

Recalling the efficiency monitoring that started last autumn, Toulson noted the collective interest from his technical staff, who would scurry to the plant room to monitor the operation of the system on the first 30°C and 32°C days. "That's no longer the case and in fact on the 43°C day the operation of the [CO₂ transcritical] system was very stable. We've got to the stage now where our mechanics and technicians don't even bother coming here on the hot days; they go to the stores which have heat issues."

Coles has measured the transcritical system against one of its benchmark stores fitted with a CO₂/R134a cascade system, using all the key metrics considered to be pertinent to get a true measure: overall refrigeration capacity, sales floor area, climatic region, and case length. "We were expecting to see in

the vicinity of a 10% reduction in power consumption but after a full six-month period (August-January), we found that the consumption has actually come in at about 15% under one of our benchmark stores," Saville said.

The next step is to measure the system's efficiency during the upcoming summer months "so that we can clearly demonstrate what the savings have been," Toulson said. "Hopefully then we can seek endorsement for two further stores."

PREMIUM TEMPLATE

Avoiding the intricacies involved with installing any HVAC&R system is imperative for end users like Coles. The company ideally wants to use the technology as a template. "We'll trial another couple of stores with transcritical, we'll take the learnings that we've had, take some of the complexity out of what we've done here, and try to simplify it and drive down the capital cost," Toulson said.

Bitzer and Danfoss were chosen as key suppliers due to their "experience and excellent track record in Europe," Saville said. Bitzer and Danfoss helped both Coles and City Facilities Management with the design and installation. "We had buy-in from both of them [Bitzer and Danfoss] to ask for their assistance to ensure our technicians were fluent in installation, servicing and maintenance of the system."

Indeed, European retailers considering investing in CO₂ transcritical refrigeration systems for warmer regions would do well to hear from Coles' experiences.

continued on p.56 →



From left: Brian Toulson, City Facilities Management; and Stuart Saville, Coles

→ Even though Saville and Toulson are restrained in their appraisal of the transcritical system's performance, there is an undeniable sense of achievement so far. The addition of ejector technology will no doubt help transfer the technology to stores in remote, high ambient regions.

"Probably if [the installation] had been six months later we would've run ejectors in unison with parallel compression in this store, but we'll definitely be looking at ejectors in our next iteration of a transcritical system," Saville said.

Although the southern city of Melbourne can reach temperatures of 45°C in the summer, the other seasons are typically much cooler than in the northern states, which pose a more consistent challenge for CO₂ transcritical in terms of high ambient temperatures.

The team estimates that initial capital costs of the first CO₂ transcritical store were around 27%-28% higher than their "business as usual" cascade CO₂/R134a system, adding that it took Coles around two years when it installed its first cascade system in 2005 to reach cost parity with its now obsolete all-HFC model.

"We would expect to see the same kind of timeline for the transition to transcritical once it's up and running," Saville said. "[In 2005] we were able to simplify the systems and saw the added interest in CO₂ in retail in Australia, with more end users actually using the technology. The market penetration of CO₂ in Australia is really quite deep. @ JR & JD

SYSTEM SPECS

Coles' transcritical CO₂ booster system in North Coburg, Melbourne, Australia, has the following specifications:

- 39,826-square-foot sales floor
- Total fixture load of 610kW
- Two centralised CO₂ Bitzer racks supplying three temperature ranges: LT, MT and HT
- Booster system with parallel compression into the flash gas bypass
- 320kW MT display cases and rooms
- 40kW LT fixtures (-17.5°F and -31°F)
- Bitzer compressors: 4 MT, 3 HT and 2 LT compressors per rack
- Hot gas defrost for all LT fixtures
- Two 90kW Alfa Laval heat exchangers for heat reclaim used for potable water and store heating
- 250kW chilled water from racks recirculated to power 100% of store AC through plate heat exchanger
- ARNEG hydrocarbon (R290) display cases
- 108 evaporators connected to MT, LT
- Four solar inverters generating 100kW power capacity
- Two Alfa Laval (Bitzer/Buffalo Trident supplier) roof-mounted adiabatic gas coolers
- Gas coolers fitted with K65 copper/steel heat exchanger
- Number of stores converted to natural refrigerants/year: 25-30



Ejector technology for the biggest Italian Hypermarket

*In a historic place of technology
as the former Alfa Romeo factory in Arese (MI),
Arneg has launched the Ejector technology
for CO₂ transcritical systems
where the biggest Shopping Center in Italy
and Europe was inaugurated last April 14th.*



Arneg, in collaboration with Danfoss, Dorin and Luve, has developed two innovative CO₂ transcritical systems that supply more than 150 cabinets and cold rooms for an amount of 290 kW of MT refrigerating power and 30 cabinets in LT range for 38 kW of refrigerating power. Both racks are designed to work with a MultiEjector system.

It is well known that, above 30°C of ambient temperature, the efficiency of a simple transcritical system drops. MultiEjector technology target is able to recover the energy of the high-pressure gas discharge line, instead of wasting it in the common expansion valve. The recovered energy is given to the MT suction fluid, in order to raise its pressure. The work spent to bring the fluid from the lowest pressure of the system to higher pressure is lower than a simple transcritical system. In this way the Ejector technology allows CO₂ system to be competitive with a conventional R404A system even in warm climates. It is estimated that it is possible to reach up to 10% energy saving than a R404A system using a CO₂ Ejector rack, even in warm places as Arese, where in summer temperature can reach more than 38°C. Arneg implemented the MultyEjector block in a parallel compressor transcritical system, in order to maximize the

work of the parallel compressors. The main advantage of this system is to compress the flash gas before it reaches the lowest pressure of the cycle. With the MultiEjector system there are more advantages as more gas is compressed from the intermediate pressure stage and not from the lowest one. Moreover, to optimize the energy recovery, the intermediate pressure can be modulated depending on the gas cooler pressure.

In order to contribute to the building energy demand, both systems are able to produce up to 120 kW of hot water.

With this new further development within CO₂ technology, this natural gas can be considered, without any doubt, the best refrigerant, also in South of Europe, being able to guarantee both a reduction of the environment impact of the retail industry both energy savings. We have not to look to the Store Iper – La Grande in Arese as a single pioneering project, but as the starting point of a technology that can be widespread in warmer locations as Italy as well.

With this project Arneg shows that it is up to date with the newest and advanced technology that can be offered to the Retail Market and is looking at the future with really innovative eyes.

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READY FOR TAKEOFF: PUTTING NATURAL REFRIGERANTS INTO SPACE

The Dutch National Aerospace Centre (NLR) is crossing new frontiers by developing a hydrocarbon heat pump to cool down spacecraft. If successful the project may lead to new applications for natural refrigerants back on Earth.

– By Andrew Williams



Spacecraft are designed to take payloads into space, for use on missions or for delivery to the International Space Station (ISS). With electronic equipment becoming ever smaller, spacecraft should theoretically be able to carry larger payloads. But this poses a challenge: disposing of the waste heat given off by all this equipment.

“You have to radiate that waste heat into space. To radiate into space, you need a large surface area,” says Dr. Henk Jan Van Gerner, an aerospace engineer at the NLR.

Bigger radiators are not an option, because they already determine the size of the entire spacecraft. “If you make the radiators larger, you make the spacecraft larger,” Van Gerner says.

Increasing the temperature of the radiators, then, holds the key to success. The higher their temperature, the more waste heat they can radiate into space – even with their current surface area. “That’s where the heat pump comes in,” he explains. Heat pumps deliver higher radiator temperatures, radiating more waste heat into space and maintaining the payload at a safe low temperature.

INTO ORBIT: HYDROCARBON HEAT PUMPS

“The whole idea of the heat pump is to help you to either make the spacecraft smaller or fit more electronic equipment in the same sized spacecraft,” Van Gerner says.

Operating a heat pump in spaces poses particular challenges. “We couldn’t use commercially available compressors for space applications, because they’re heavy. Commercial compressors are also huge. They’re too large for our application. What we need is a compressor of 2-4kg, which is 10 times lighter than what is currently commercially available,” Van Gerner explains.

Another issue with commercial compressors is that they are noisy. They also vibrate. “Vibration is a big problem in a spacecraft, because you have to point a signal to Earth – really accurately! If your spacecraft is vibrating, it’s impossible to do that,” he says.

The NLR has previous experience of putting natural refrigerant technology into orbit. It built the thermal control system for the AMS02 tracker – a large detector of cosmic particles mounted on the ISS in 2011 – using CO₂ as the refrigerant.

The NLR team’s heat pump uses the natural refrigerant isopentane (R601a), a hydrocarbon. “What we needed was a very lightweight, vibration-free compressor,” Van Gerner says. He commissioned Swiss firm Celeroton to design a very high-speed compressor (180,000 rpm) with 10 times lower mass than commercial compressors, yet capable of operating at comparable efficiency.

After ruling out refrigerants that are banned or being phased out under the Montreal Protocol, analysis showed that isopentane delivered the best compressor performance.

Van Gerner’s team still need to overcome various challenges before sending the system into space – not least the question of its lifetime. The heat pump currently relies on ball bearings – but these only last for 20 hours. But Van Gerner is in no doubt that his team will succeed – their new prototype uses gas bearings.

Potential future applications of the space heat pump back on Earth include cooling aircraft sensors or providing air conditioning in electric cars – or anywhere else that needs lightweight, quiet, vibration-free compressors. [@ AW](#)

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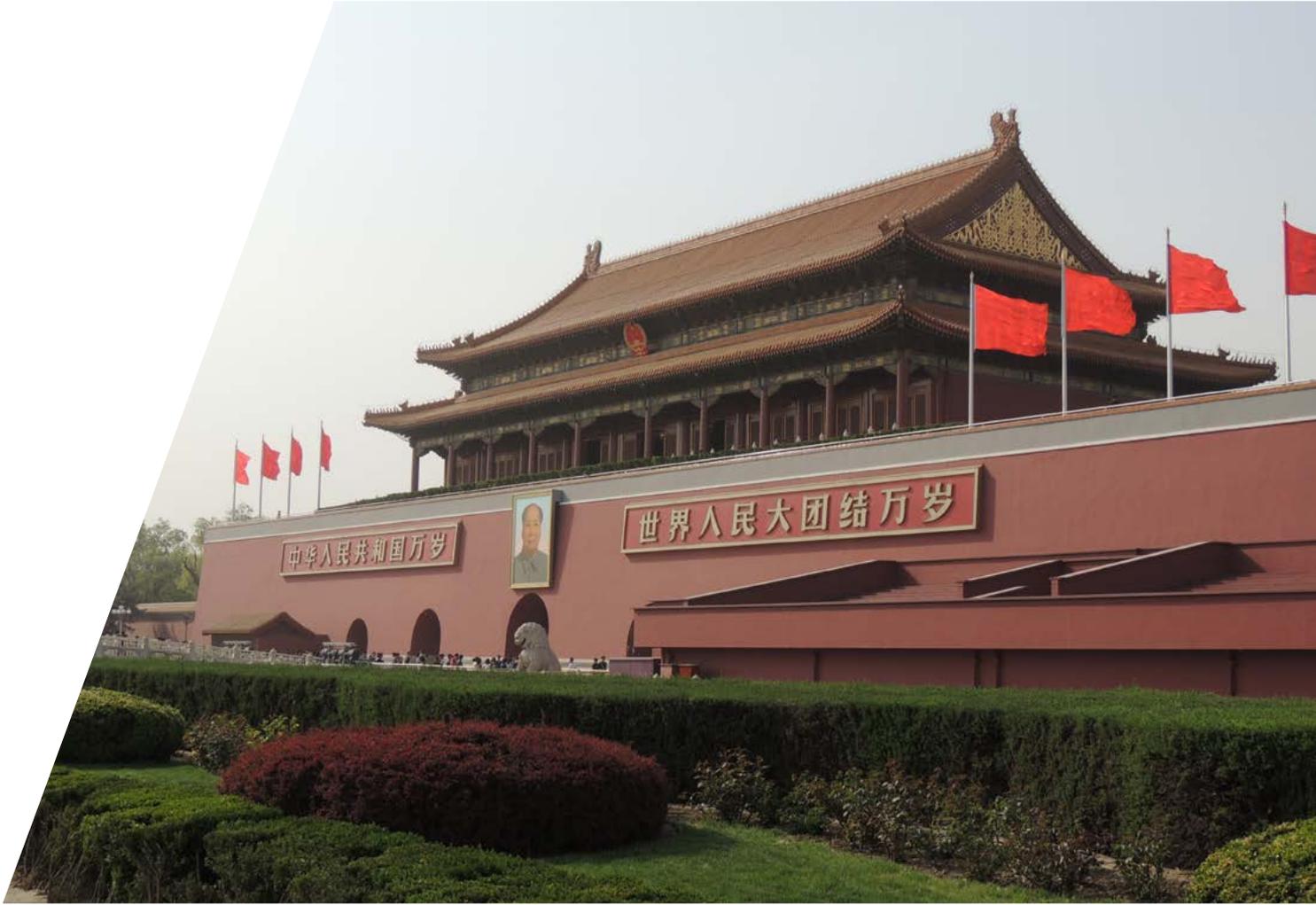
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NATURAL REFRIGERANTS KEY TO CHINA'S SUSTAINABLE GROWTH

The phase-out of HCFCs and a 2015 revision of the Environmental Protection Law are creating new opportunities for natural refrigerants in room air-conditioning, heat pump, commercial and industrial refrigeration applications in China.

– By Andrew Williams

China produces the vast majority (92%) of HCFCs in developing countries. No doubt, then, that the industrial powerhouse's move to completely eliminate their production and consumption by 2030, under the auspices of the Montreal Protocol, will have a major global impact.

At China Refrigeration, held in Beijing on 7-9 April, the importance of embracing natural refrigerant technology in the cold chain, welcoming proven overseas manufacturers onto the market, and subsidising new technology to accelerate the transition were all highlighted as critical components to set the wheels in motion.

The Chinese government recognises the role that natural refrigerants can play in putting the country on a sustainable footing. "In China, natural refrigerants can contribute to reducing greenhouse gas emissions and lead to bluer skies," Xiao Xuezhi, Deputy Director-General of China's Foreign Economic Cooperation Office (FECO), told the Ozone2Climate Industry Roundtable.

In 2015, FECO issued a list of recommended substitutes for HCFCs. It is currently finalising proposals for Stage II of the HCFC Phase-out Management Plan and the revision of national standards for natural refrigerants – altogether representing a significant shift in China's approach.



SOLUTIONS FOR CHINA

For Rüdiger Rudischhauser, Vice-President Sales International at Snowkey (part of Chinese manufacturer Fujian Snowman Co. Ltd.), “food processing is the megatrend” not just in China but also globally.

Rudischhauser believes natural refrigerants are essential to deliver more sustainable food processes in applications like food preservation, cold storage and blast freezing for a global population that is expected to hit nine billion people by 2050.

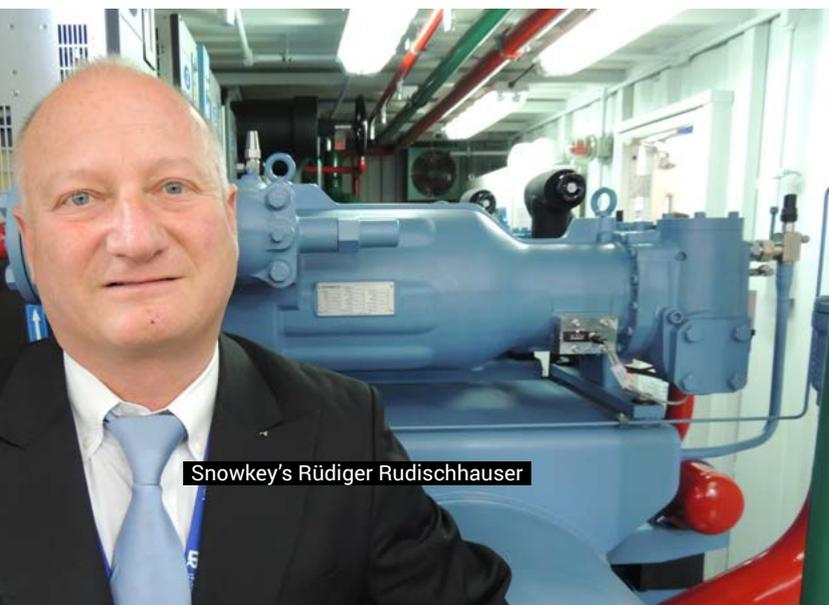
Snowkey plans to install a CO₂ transcritical system in a major supermarket in China very soon. “I’m very positive about bringing CO₂ transcritical to China, because the ambient temperatures in the northern part of China are very favourable,” Rudischhauser said. “Our R&D centre is here. This is our home market and our home turf.”

This is leading manufacturers like Snowkey to bring complete technology packages to China. “We see the future not just in compressors, but in complete packages and solutions – on the industrial and commercial side - which clearly shows that in China we have already made that step of forward integration from being a compressor manufacturer to a system provider,” he explained.

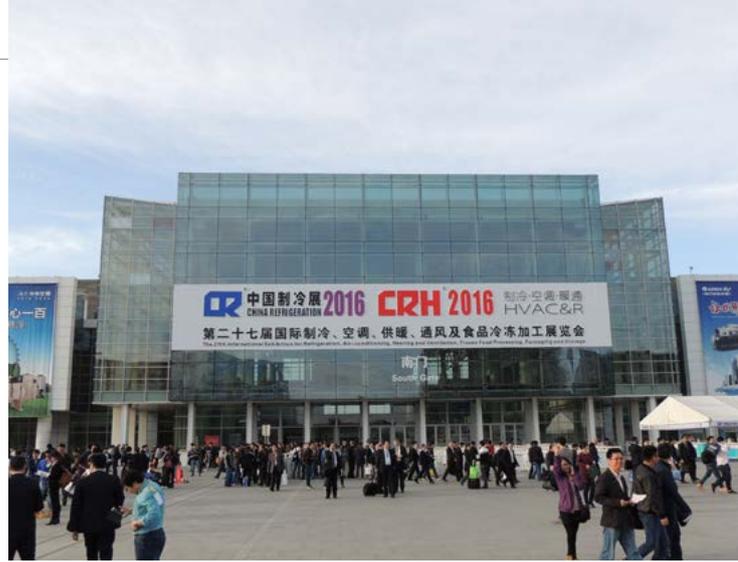
EUROPEAN KNOW-HOW

Major European manufacturers like German compressor manufacturer Bitzer also see opportunities in bringing their natural refrigerant technologies to the Chinese market. Bitzer has supplied a subcritical CO₂ cascade system to a METRO China supermarket in the city of Weifang, and some heat pumps.

“Globally, Bitzer is very strong in promoting CO₂ applications,” said Bill Feng, General Manager – Sales and Marketing, Great China Region at Bitzer. “We have [the] METRO store with CO₂ for refrigeration [and are] also starting on some heat pump applications in industrial segments, for instance in railway stations in the north.”



Snowkey's Rüdiger Rudischhauser



USHERING IN HYDROCARBONS

Transitioning end-of-cycle HCFC equipment to hydrocarbons is also necessary in a country still heavily reliant on R22 for domestic air conditioning and other light commercial applications, such as household freezers and beverage vending machines.

As part of its ‘HCFC Phase-out Management Action Plan’, the Chinese Ministry of Environmental Protection published a list of nine air conditioner makers eligible to receive the so-called Incremental Operating Cost (IOC) subsidy in 2015.

The subsidy is designed to help companies cover the cost of transforming air conditioner production lines to R290 (propane) and the increased cost of producing R290 units in the first few years of production.

Gree’s demonstration project to provide 243 R290 air conditioning units to Shenzhen University is central to the transition.

Meanwhile German compressor manufacturer SECOP, which primarily supplies systems for household, light commercial and DC-powered refrigeration, plans to focus solely on hydrocarbons. “That’s what we’re good at,” said Pieter Boink of SECOP. “We have different dynamics in different markets. One thing we’re really good at in China is looking at total cost. It’s very easy to choose natural refrigerants, because propane gives you very high efficiency – bringing costs down – and it’s green.”

Asked how he sees the market for hydrocarbon air conditioning developing in China, Bonny Dai, Senior Regional Marketing Manager (China) at Danfoss Commercial Compressors, said the company considers R290 as an exceptional refrigerant from a thermodynamic standpoint. “Danfoss has furthermore made investments also in compressor labs in order to deal with A3 and A2/A2L flammability and to investigate compressor solutions for both the residential and light commercial air conditioning and refrigeration applications,” he said.

Jan Dusek, Business Development Manager, shecco Japan, says that there are already over 750,000 retail display cases, vending machines and bottle coolers using CO₂ or hydrocarbons in China. “The use of natural refrigerants in light commercial refrigeration is a strong trend in most major economies,” says Dusek, adding: “China is the fastest growing world market for commercial refrigeration.” @ AW



SPOTLIGHT ON NEW INDUSTRIAL REFRIGERATION SYSTEMS FROM JAPAN

While ammonia has long been an accepted industry standard refrigerant, especially in larger industrial refrigeration systems, a new generation of natural refrigerant technology is shaking up the sector. A special edition *Accelerate Corporate*, recently published in partnership with Japan-based Mayekawa, investigates further.

– By James Ranson & Andrew Williams

 For us, there are no other options but natural refrigerants,” says NittoBest Corporation’s Managing Director and General Manager of Production, Soichiro Tsukada.

After an extensive review of its production processes and a critical need to reduce energy consumption and boost efficiency, NittoBest had only one future solution in mind when it installed its first NH₃/CO₂ refrigeration system in 2014.

METI, MOE SUBSIDIES ACCELERATING NATREF UPTAKE

NittoBest Corporation specialises in the production of frozen, canned, packed, chilled, and retort-pouched food products with a total of 13 factories and affiliated companies throughout Japan.

The company started investigating natural refrigerants in 2010, but decided to take a cautious approach and continue researching the available solutions. In February 2014 the company made its move, installing an NH₃/CO₂ system from another local supplier through its Kyushu Best Foods chain at a facility in Fukuoka Prefecture.

Fast forward another nine months and NittoBest had installed a total of nine Mayekawa NewTon units at its Yamagata factory. A decisive factor in the decision, says Tsukada, was funding received from Japan's Ministry of Economy Trade and Industry (METI) and Ministry of the Environment (MOE). The latter helped subsidise one third of the total cost of installation, while the former aided in financing one third of the difference in total cost between a system based on fluorinated refrigerants and a natural refrigerant-based one.

Only around 15% of food-processing facilities in Japan use non f-gas alternatives for refrigeration. However, of the companies that have gone down the natural refrigerant route, typically around 60% of their systems are natural refrigerant-based – indicating that the subsidies do encourage long-term commitments from end users.

"Funding programmes are essential in further expanding the use of natural refrigerants," said Tsukada. They enable manufacturers of natural refrigerant components, systems and equipment to establish dedicated manufacturing capacity, which NittoBest believes will eventually drive down costs.

With the Yamagata factory proving a great success, NittoBest plans to relocate production lines there from other facilities. Tsukada said the company intends to switch to natural refrigerant technology when that transition occurs, including replacing old freezers with new ones. "Natural refrigerants are the only alternative that we are considering shifting to, and this is irreversible," he said.

'THE AGE OF NATURAL REFRIGERANTS IS HERE'

Japanese company Nissui Logistics, meanwhile, installed the first ever Mayekawa NewTon. In 2008 Nissui provided the first test case at its Kawasaki facility. The logistics company has since installed a further two, in Osaka-Kou (port) and Osaka-Maishima, Japan. It now has offices in 40 locations around the globe.

Headquartered in Minato Ward, Tokyo, Nissui Logistics provides refrigerated warehousing, storage and freight transportation services – predominantly processed salmon. Its 17 distribution centres include one in Osaka-Kou Port, which is jointly operated by Nissui and two other companies.

Nissui's General Manager of the Equipment Management Department Michinori Kogawa said Kawasaki's installation of three NewTons with 14,000 tons of refrigeration capacity at the facility saw the company immediately reduce its energy usage by 80,000 kW a year.

Back in 2008, with the Montreal Protocol firmly in view, Kogawa said the company had an obligation to "fulfill [its] corporate responsibility" and felt that "the age of natural refrigerants [was] here".

The installation drew a swathe of interested parties from the industrial refrigeration industry, including government officials from Japan and abroad and other warehouse operators. That interest, and the MOE's subsidies, has helped Mayekawa grow the market for the NewTon around the globe.

MOE SUBSIDIES ACCELERATING NATURAL REFRIGERANTS GROWTH

Japanese Ministry of Environment (MOE) subsidies originally encouraged end users to purchase natural refrigerant technology by covering up to one third of the difference in total cost between a system based on fluorinated refrigerants and a natural refrigerant-based one. The subsidy now covers up to 50% of the total cost of the system, a key shift according to Kogawa.

The third generation NewTon comes in a little under at 1.2-1.3 times more expensive than HFC systems, discounting the subsidy. But with half of the introduction cost of natural refrigerant systems having been covered since 2014, they are cheaper than HFC units. That saw the number of applications sharply increase, explains Kogawa.

"The [global phase-down of hydrofluorocarbons] will cause great difficulty for [end users] but will serve as a driving force for businesses to make the shift to natural refrigerants," Kogawa says. "Natural refrigerants will become mainstream in the future because they are safe and energy efficient."

Accelerate Corporate combines expert research, end-user interviews and trend analysis on climate-friendly HVAC&R technologies. @ JR & AW



NATURAL REFRIGERANTS TAKE CENTRE STAGE AT EUROPEAN HEAT PUMP FORUM

Natural refrigerants were very much in the limelight in Paris at the 9th European Heat Pump Association annual forum, which showcased a plethora of heat pump technologies using natural refrigerants, ranging from NH₃-based systems for district heating and cooling to residential systems with hydrocarbons or CO₂.

– By Alvaro de Oña

Bringing together some 150 participants ranging from national associations and policy and market experts to academia and manufacturers, the Heat Pump Forum – which took place on 18-20 May – is the platform for sharing the best available knowledge regarding heat pump applications in Europe.

REALISING THE POTENTIAL OF HEAT PUMPS...

In the wake of the Paris Agreement struck during UNFCCC climate talks at COP21 in December 2015, the pressure to reduce dependency on fossil fuels is on. Currently representing 15% of the market, heat pumps for heating and cooling could help lead the transition towards a more sustainable building sector.

Following the adoption by the European Commission of the EU's first ever Heating and Cooling Strategy in February 2016, several pieces of EU legislation will need to be revised. This will likely affect, among others, the Energy Performance of Buildings Directive, the Energy Efficiency Directive, technical standards under the Eco-design Directive, or the Energy Label initiative. In short, almost every piece of legislation relevant to the heating sector is being revised in 2016. All this presents a raft of opportunities for heat pump applications.

"With the current technology we could decarbonise the whole building sector today. We need to make sure that the message is further shared to make it possible," EHPA Secretary General Thomas Nowak concluded at the end of the three-day forum.

...WITH A PLETHORA OF OPTIONS

Ammonia-based systems were widely identified as the most suitable solution for industrial applications. Kenneth Hoffmann, from GEA, opened the session with the company's air-to-ground heat pumps suitable for potato chip driers. Capable of delivering hot water outlet temperature up to 80°, a yearly Coefficient of Performance (COP) of 7.0 and payback in less than three years, the system reduces greenhouse gas emissions by 70% compared to currently used technology. GEA also announced plans to develop an ammonia-based heat pump system for the London Underground. Reclaiming hot air from the underground ventilation shaft, at a constant temperature of 24° to 30°, the system will supply hot water to nearby buildings, as well as cooling capacity for the trains when needed.

Star Renewables presented other promising examples of ammonia-based systems using water as a source. Careful urban planning, taking into account sources of heat from different sources of water, from river to waste water, was key to the success of the projects. To convince local authorities on each occasion, cost savings throughout the lifecycle emerged as a decisive factor. "Current installations today with ammonia are ready to operate until 2050," said Star Renewable Energy's David Pearson.

Pierre-Alain Giroud, from Swiss company Zero °, for his part, showed how it is possible to combine natural refrigerant-based heat pump technology and solar panels as source of energy. This innovative project provides heating and cooling to the Saas Fee ski resort in the Swiss Alps at an altitude of over 1,800 metres. Using Mayekawa compressors, and with a COP ranging from four to 11, the installation demonstrates how heat pumps can be integrated into an energy grid to provide solutions for a network of buildings.

Hydrocarbon-based heat pumps for residential applications were a major trend. Joachim Maul, from German manufacturer AIT, showed how their propane-based heat pumps can be a solution to upgrade obsolete boilers in existing constructions. R290 systems, according to Maul, can be taken to mass production in a straightforward manner, and are capable of reaching high temperatures efficiently even at low ambient temperatures. However, the technology faces legislative barriers under current technical standards, which restrict the charge limit for propane to very low levels.

Hydrocarbon-based heat pumps were also on the radar of two EU-funded projects presented at the forum: the Next Generation Heat Pump project (NxtHPG) and the Green Heat Pump project. Presentations included Danfoss' new generation of scroll compressors using R290, comparative studies of different refrigerants from the Fraunhofer Institute, innovative heat pump design by the Austrian Institute of Technology, or system modelling and performance simulations by Sweden's Royal Institute of Technology (KTH). The common thread throughout the session was a focus on propane as a suitable solution for residential installations.

The case studies were complemented by an overview from shecco on global trends for natural refrigerants, with a special focus on the success of Japanese EcoCute CO2 heat pumps for residential use. The subsequent discussion focused on barriers currently presenting obstacles to more widespread use of natural refrigerants.

As the Paris forum showed, heat pumps based on natural refrigerants are already emerging as clear candidates to replace existing systems today. 2016 is shaping up to be a crucial year for the buildings sector, which accounts for a massive 40% of total energy consumption in Europe. [@AO](#)



INDUSTRY EXPERTS SEE BRIGHT FUTURE FOR AMMONIA REFRIGERATION

University of Illinois Professor Pega Hrnjak sees a robust future for low-charge packaged ammonia systems in industrial refrigeration – and potential for ammonia secondary chillers in a range of applications. Meanwhile at the IIAR Conference and Exhibition in Orlando, the manifold industrial refrigeration components on display addressed low-charge, safety, efficiency, space saving and more.

– By Michael Garry & Andrew Williams

Accelerate America sat down with Professor Predrag (Pega) Hrnjak to discuss the direction of ammonia refrigeration at the 2016 International Institute of Ammonia Refrigeration (IIAR) Industrial Refrigeration Conference & Exhibition in Orlando, Florida on 20-23 March. Born in Belgrade, Yugoslavia, Pega is one of the leading researchers, teachers and experts in the refrigeration industry. He started his activities in the US during the 1980s, and in 1993 joined the faculty of the University of Illinois, Urbana, where he is a professor in the Department of Mechanical Science and Engineering.

He is also director of the University of Illinois's Air Conditioning and Refrigeration Center, an NSF-funded, industry-university cooperative research centre. He is president of Creative Thermal Solutions (CTS), his private research-and-development company, also based in Urbana.



TOWARDS A FUTURE OF PACKAGED SYSTEMS

Pega believes the growth in low-charge ammonia systems at this point is coming from owners of larger ammonia systems interested in charge reduction. "I wish it would come from smaller plants using HFCs," he says.

Pega likes packaged units whenever possible because of the shorter length of the lines and the reduction of the charge. He also points out that they can be placed locally near the cooling loads. "The only disadvantage is that when you have multiple units, maintenance technicians need to go from unit to unit on the roof, instead of doing all activities in a machine room," he says.

"I think you will see more and more premade, packaged systems. That is the direction to go. There is almost always better craftsmanship in the factory as well as better control and lower costs with faster delivery time, in principle. This is how every industry has developed: by increasing the quality and lowering the cost," the professor observes.

"What we are seeing now is a reduction of custom-made industrial refrigeration systems and an increase in premade, factory-built packaged systems that one can almost buy off the shelf," he believes.

Are packaged units as efficient as central systems? "It's very tough to perfectly compare them, but I'd say the efficiencies are similar. If manufactured well, packaged systems should have even higher efficiency," Pega argues.

OPPORTUNITIES IN CHILLER MARKET

He sees opportunities to use ammonia in chillers, where it is used to cool a secondary liquid such as CO₂ or glycol. Possible applications for ammonia/glycol chillers include industrial cooling or comfort cooling for large hotel lobbies or airports, he says.

"Most chillers don't currently use ammonia as the primary refrigerant; they use R22, R410A, or R123 and R11 in old centrifugal chillers. But ammonia, being indisputably efficient, can easily replace especially the first two refrigerants. They all use secondary liquids, so there is a market that is prepared for using chillers," Pega says.

The chiller market for air conditioning tends to feature smaller units that use reciprocating, scroll or screw compressors. "That is a potential market for ammonia chillers. Hermetic or semi-hermetic ammonia compressors would be a great boost in that direction," he says.

Pega is convinced that ammonia has a promising future in comfort cooling applications. However, "we need to promote regulations that would lift restrictions on a charge as low as say 3kg in a unit that can provide a minimum capacity of 100 kW. Then ammonia would be really competitive in the HVAC market with R22 systems," he says.

What about the health risk of using ammonia in locations like supermarkets? "Keep the ammonia outside, not in the areas with high concentration of people, and just use a secondary fluid inside. Ammonia can be dangerous as a liquid in contact with skin or eyes, but not as a vapour," Pega says. "In any case, most of the chillers are outside, on the roof, because it is easy to remove heat by air," he adds.

Everything from low-charge packages and DX evaporators to liquid separators and screw compressors could be found on the IIR exhibition floor, home to dozens of component makers, OEMs, contractors and training companies.

continued on p.68 →



→ NEXT STEP FOR EVAPCO

Evapco, based in Taneytown, Maryland, is “shifting into second gear” in its marketing of Evapcold, a line of self-contained low-charge ammonia refrigeration units, says Kurt Liebendorfer, Evapco’s vice-president. Evapcold is being installed at Western Gateway Storage in Ogden, Utah.

Liebendorfer says new buildings (greenfield projects), which account for about half of the market for Evapcold units, “have long funding, design and development phases,” up to a year, “and we’re progressing there.” He also expects Evapcold to be adopted in expansions of existing buildings.

Colmac Coil, Colville, Washington state, has been seeing considerable interest in its Advanced DX low-charge ammonia evaporator, used for low temperatures in concert with a central machine room. The DX evaporator cuts the charge by a factor of 4-5 times compared with a conventional pumped ammonia system. Colmac has recently installed its Advanced DX system at several US cold storage warehouses, including facilities operated by Preferred Freezer Services in Richland, Washington state; Shepherd’s Processed Eggs, Spanish Fork, Utah; Joliet Cold Storage, Joliet, Illinois; and US Cold Storage, Laredo, Texas.

At the Alfa Laval booth, the company featured its U-Turn liquid separator, designed to work with plate heat exchangers in ammonia applications. It has been used, for example, by the city of Montreal over the past year in municipal ice rinks. It is also used in the food industry.

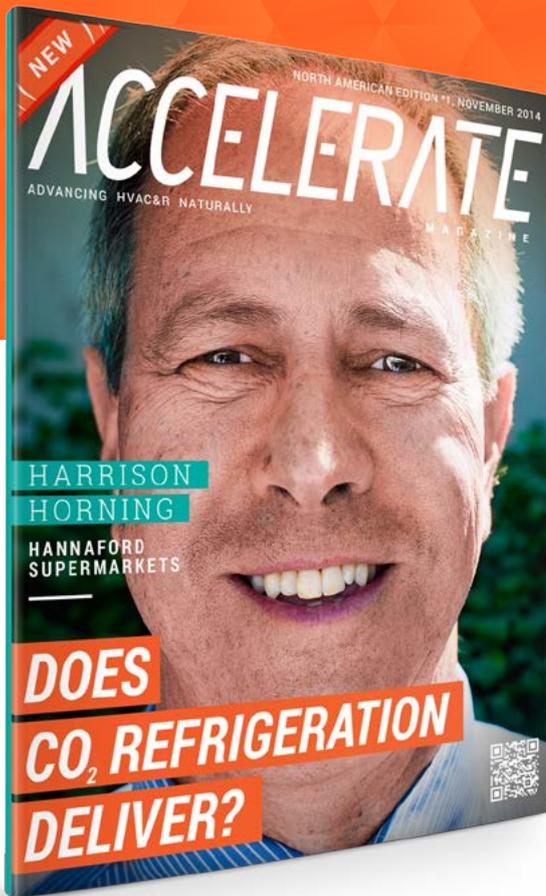
The u-shaped separator is placed on top of the Alfa Laval M10 semi-welded gasketed heat exchanger in an evaporator, and the Alfa Laval AlfaNova 400 in a condenser. The combination saves space, reduces ammonia charge and maximises efficiency.

IMPROVING SAFETY

Danfoss, Baltimore, Maryland, displayed a larger version of its ICF Flexline valve station for evaporators in cold storage or food processing plants. The modular unit is designed to improve the safety of an ammonia system. “It is a direct-weld solution, with no gaskets, making it easier to service,” says Jim Hower, industrial refrigeration US sales manager for Danfoss.

Parker Hannifin, Broadview, Illinois, showcased a new stainless steel electronic valve for ammonia liquid feed and CO₂ (for which it is rated 52 bar). It also displayed a capacitive-based back-up module that, in the event of power loss, “fails closed or to a known position,” says Andy Kuester, division marketing manager for Parker. “It’s better than a battery back-up because batteries degrade.”

Bitzer US, Flowery Branch, Georgia, highlighted its multiple screw compressor configuration for industrial applications in the range of 100-300 TR. Used in low-charge chillers, the compressors offer higher efficiency and redundancy compared with a single compressor with triple the horsepower. When load requirements drop, one or two of the compressors can be shut down, as compared to using a slide valve in a single compressor, which is less efficient. **© MG & AW**



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REGULATORS: TRAINING HOLDS KEY TO GREATER UPTAKE OF NATREFS

Improving access to training is crucial for triggering faster uptake of natural refrigerant technology in Europe, according to policymakers presenting at this year's ATMOsphere Europe conference in Barcelona.

– By Justina Tamasiunaite



Participants in the event, held at the Crowne Plaza Fira Center hotel on 19-20 April, heard EU and national experts express their concerns over a lack of trained technicians capable of working with natural refrigerants across Europe.

Katja Becken from the German Federal Environment Agency says Germany is considering making practical training on natural refrigerants mandatory, as part of initial vocational training, in the future. “But to make training on natural refrigerants mandatory, we need to enable training facilities.”

Under Germany's Climate Action Programme 2020, several ideas are currently on the table, including financial support for training facilities and hands-on practical training on natural refrigerants, to help familiarise beginners and professionals with the technology.

In southern Europe, where natural refrigerant technology is not yet as widespread as in northern Europe, the lack of trained technicians is even more acute – raising a significant barrier to wider uptake of these climate-friendly solutions there.

Ricardo Almeida of the Portuguese Environmental Agency says “adequate training and knowledge among contractors operating in different countries, particularly in the south of Europe, should be guaranteed”.

Portugal is committed to reducing HFC emissions, but at the same time must ensure that alternative applications are safe, cost-efficient, reliable and effective, Almeida explains. “If the future perspective is based on natural fluids, retrofits cannot be the solution,” he warns.

Guillermo Martínez López from the Spanish Office for Climate Change – part of the Ministry of Agriculture, Food and Environment – stresses that his office is waiting for the government's approval to move forward with new requirements for training on alternative refrigerants and a certification system for technicians.

NORWAY AND GERMANY – EXCELLENT EXAMPLES TO FOLLOW

In terms of policy and industry actions taken to reduce the use of HFCs, some European countries, such as Norway and Germany, are more advanced in the move away from high-GWP substances and natural refrigerant technology has become more the standard rather than the exception.

For example, in Norway a tax-and-refund scheme on fluorinated refrigerants has been in place since 2003. At its current level of 383 NOK (€40)/tCO₂eq, the tax has provided a supportive regulatory framework for natural refrigerant technologies, especially in larger systems, says Torgrim Asphjell from the Norwegian Environment Agency.

Spain followed the example of northern European countries by introducing a tax on fluorinated refrigerants in 2014. Although the tax level is much lower than in Norway (€13/tCO₂eq), Martínez López expects to see significant emission reductions as a result of adopting HFC alternative technologies in new refrigeration installations and retrofitting towards lower GWP substances in existing facilities.



While policy representatives from Spain and Portugal were hesitant as to whether natural refrigerant solutions would work for all applications in their countries, Norway has adopted a clear stance in favour of natural refrigerants. “In the long term we want to phase down fluorinated gases and get back to natural refrigerants because we think that this is a sustainable and long-term solution,” says Asphjell.

Since 2008, Germany has invested millions of euros in incentivising innovative companies working in the commercial refrigeration sector to accelerate the uptake of climate-friendly technologies. “Last year we provided 18 million euros to finance 252 refrigeration systems running on natural refrigerants. In total we spent 114 million euros on 1,300 projects from 2008 to 2014,” says Becken.

Additionally, Germany is considering introducing financial support for demonstration projects in different fields of application as part of its Climate Action Programme 2020.

AMBITIOUS POLICY MEASURES DRIVE INNOVATION WORLDWIDE

shecco’s Klara Skačanová shed light on the latest policy developments shaping the natural refrigerant industry in other regions worldwide. She outlined recent regulatory changes in the US, where California is proposing ambitious action to reduce HFC emissions which if adopted would outstrip the EU’s F-Gas Regulation.

The Japanese and Chinese governments are also creating favourable regulatory conditions for the introduction of natural refrigerants. In China, the government is showing increased support for natural refrigerants across different sectors. This can be seen in the draft list of recommended substitutes for HCFCs published in mid-2015, the final version of which is expected later this year. Most of the substitutes on the list are natural refrigerants across a wide range of applications.

The Japanese Ministry of Environment has allocated JPY 7.3 billion (€57.3 million) in subsidies for the adoption of natural refrigerant technology in the current Japanese fiscal year. The sectors covered by the subsidy scheme have been extended to include chemical manufacturing processes and ice-skating rinks, in addition to cold storage, food manufacturing, and food retail.

As for policies to fast-track natural refrigerant uptake outside Europe, Skačanová says “regulatory actions at national level to reduce emissions of HFCs are intensifying across the world, creating opportunities for natural refrigerants. However, the level of ambition depends on the level of awareness of the market situation by policymakers and other relevant stakeholders”. @JT

CALIFORNIA POLICY PAVING WAY FOR NATURAL REFRIGERANTS

The California Air Resources Board has unveiled its Proposed Strategy to crack down on HFCs, paving the way for increased uptake of natural refrigerants.

– By Klára Skačánová

In April, the California Air Resources Board (CARB) took another step towards curbing emissions of high-GWP HFCs with the publication of its Proposed Strategy to reduce short-lived climate pollutants, which also include methane and black carbon (soot).

While HFCs account currently for 4% of California's GHG emissions, their amount is expected to double in the next few decades if no additional measures are taken. "Fluorinated gases, and in particular HFCs, are the fastest-growing source of GHG emissions in California and globally," reads the proposal.

The Air Resources Board is putting forward actions to cut HFC emissions by 40% by 2030, compared to 2013 levels. Meeting these targets will help to achieve the Governor's goal to cut all greenhouse gas emissions in California by 40% below 1990 levels by 2030 and help to meet federal air quality standards for 2031 and beyond.

"The impact of these super pollutants is real and the fight against climate change must include a strategy to aggressively reduce them," said California Governor Edmund G. Brown Jr.

The suggested measures to reduce HFC emissions were first outlined in a Concept Paper that CARB published in May 2015. Following consultations with industry experts, the agency released a Draft Strategy later in 2015. Now, with the Proposed Strategy, the measures that will influence the refrigeration and air conditioning business in California are taking a more concrete shape.

The Proposed Strategy notes: "Early action, ahead of some of the phase down schedules being proposed internationally, can

avoid locking-in the use of high-GWP refrigerants in new or retrofitted systems in the coming years."

"Without early action to reduce unnecessary emissions now and into the future, the State [of California] would need to take additional – likely more costly – steps to meet its 2030 climate targets," the document reads.

The proposal further notes that although low-GWP technologies are assumed to have at least 10% higher initial cost, "in many cases, the added initial cost is offset or reversed through energy savings of low-GWP refrigeration and AC. Additionally, low-GWP refrigerants such as carbon dioxide refrigerant, ammonia, and hydrocarbons are less expensive than HFCs".

HFC BANS

Similar to HFC policies adopted elsewhere, such as the EU F-Gas Regulation or Japan's F-Gas law, CARB is proposing a combination of measures to reduce HFC emissions. In the EU and some countries that had restricted the use of fluorinated refrigerants even before the revised F-Gas Regulation, bans on HFCs in new equipment have proven to be the most effective tool to shift away from fluorinated refrigerants and invest in HFC-free technologies.

In the US, the Environmental Protection Agency has started imposing restrictions on the use of certain high-GWP HFCs for specific end-uses, an action that is already having an impact in the market.

The recommended bans for new equipment in CARB's Proposed Strategy would go beyond the EPA restrictions and even the

continued on p.74 →



Each Nation and each Industry Sector bears an individual responsibility in the fight against climate change.

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→ EU F-Gas Regulation, potentially making California one of the most advanced regions in terms of HFC legislation. A ban on HFCs with GWPs above 150 in new commercial and industrial refrigeration is proposed to start as of 2020. Such a ban would be in line with the deadline for phasing out R22, thereby enabling technology end-users to go directly to the most climate-friendly solution, avoiding intermediary HFC refrigerants.

For residential refrigeration, CARB suggests a ban on HFCs with GWPs above 150 in new equipment to start in 2021, aligning it with the recent EPA SNAP proposal to delist R134a and other high-GWP refrigerants in this sector.

New stationary air-conditioning equipment (residential, commercial and industrial) is also targeted for prohibitions starting in 2021 for HFCs with GWPs greater than 750. Nevertheless, the paper notes that GWP limits might be subject to change when evidence about the availability of HFC alternatives is proven. "For example, low and medium-pressure chillers used for air-conditioning may be able to use refrigerants with a GWP less than 150."

Another key proposed measure to reduce the use of high-GWP refrigerants is the prohibition of the sale of new refrigerants with GWPs greater than 2,500, beginning in 2020. Reclaimed or recycled refrigerants would be exempt from the sales ban.

"A sales ban on very high-GWP refrigerants is enforceable and provides immediate reductions," explains the Proposed Strategy. "Such a ban facilitates a much faster transition from very high-GWP refrigerants to lower-GWP alternatives in existing equipment (thus avoiding the ongoing high-GWP emissions from equipment that typically lasts for 15 years or longer)."

FINANCIAL INCENTIVES

Developing an incentive programme is particularly important to help the industry transition towards low-GWP refrigeration technology, such as CO₂, ammonia and hydrocarbons. The Governor's proposed 2016-2017 budget includes \$20 million for incentives to reduce HFC emissions from refrigerants.

The report notes that substantial progress has already been made regarding the safe use of natural refrigerants in North America and other parts of the world. For example, at least 300,000 HFC-free light commercial refrigeration units have been deployed in North America, with more than 250 stores using CO₂ systems and over 250 'next-generation' small-charge ammonia industrial refrigeration systems.

The report also states that California reserves the right to put forward a proposal to phase down the use of HFCs in the absence of an agreement this year for a global HFC phase-down within the Montreal Protocol, where ongoing discussions are taking place.

"If a national or international HFC phasedown agreement cannot be reached in 2016, ARB may pursue a California HFC phasedown schedule that will help meet the State GHG emission reduction goals. California would seek a partnership with the EU, Canada, Japan, and Australia, all of which are currently pursuing their own separate HFC phasedown programs," outlines the Proposed Strategy.

The Final Strategy will be presented to the Board for a vote in autumn 2016. **OKS**



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SHORT TAKES

By Andrew Williams, Alvaro de Oña and Nina Masson

ITALY'S LARGEST HYPERMARKET OPTS FOR CO₂ REFRIGERATION

- By Andrew Williams

In April 2016, the largest hypermarket in Italy opened its doors in Milan. Italian supermarket giant Iper's brand new 10,000 m² hypermarket is pioneering a CO₂ transcritical refrigeration system using ejector technology to enhance efficiency in temperatures of up to 38°C, further demonstrating that CO₂ refrigeration is advancing across southern Europe as an efficient and viable solution.

The Iper hypermarket is part of the new Arese shopping centre, which is the largest shopping centre in Italy and one of the largest in Europe. Sustainability is a key pillar of the building's design, which qualifies for U.S. Green Building Council (USGBC) LEED Gold certification, meaning that the hypermarket has been designed and constructed to use less water and energy and to reduce greenhouse gas emissions.

"Using CO₂ to power the refrigeration system is a perfect match to the intentions of LEED. CO₂ is a natural refrigerant and an excellent choice when it comes to reducing greenhouse gas emissions. At the same time, CO₂ provides high performance and exceptional properties for heat reclaim," says Gabriele De Bona, a Key Account Manager at Danfoss Italy.

The Iper hypermarket is one of the first stores to implement new ejector technology from Italian firm Arneg into a transcritical refrigeration system. Convinced by the results of

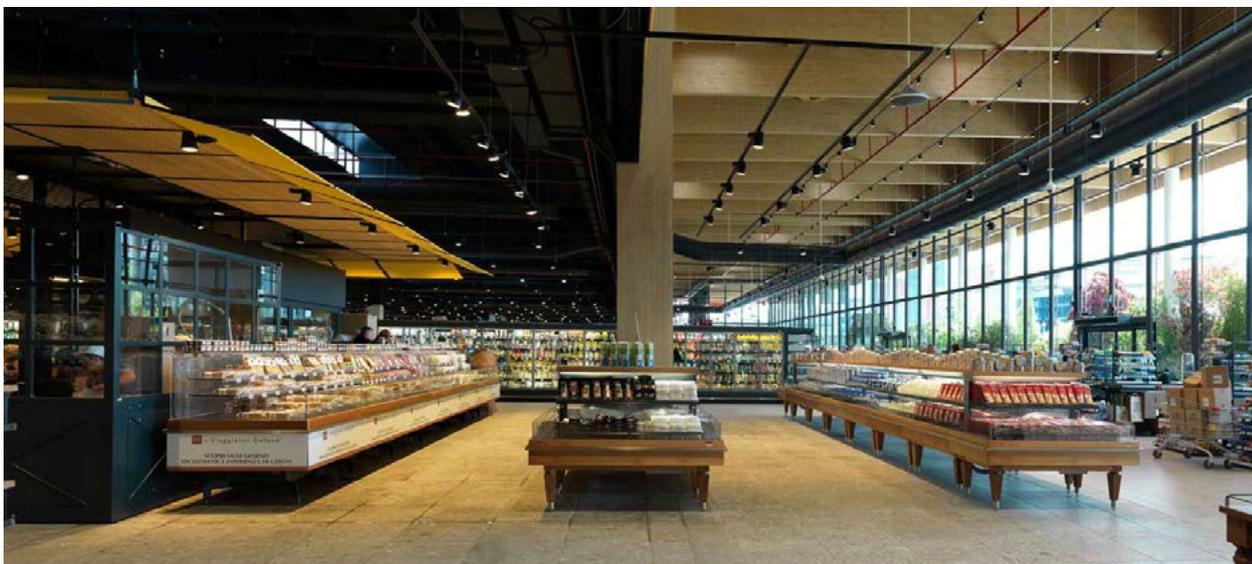
numerous tests in recent years, Arneg chose the new ejector technology to enhance the hypermarket's energy efficiency.

"Electricity for refrigeration makes up 50% of the total energy consumption of the hypermarket, and our customer Iper has an ambition to cut down this consumption year by year as part of their sustainability programme. Another ambition of the visionary retailer is to switch to natural refrigerants to cut the carbon footprint," says Arneg's Technical Support Manager Enrico Zambotto.

"In order to fulfill these goals, we proposed a transcritical CO₂ solution. It is a large installation with several hundred cabinets and cold rooms operating under ambient temperatures up to 38°C," Zambotto adds.

Since it was only commissioned in April 2016, it is still too early to provide figures for actual energy savings at the Milan hypermarket. However, the experience of Danfoss (which took part in system design, testing of packs and commissioning) from similar installations with heat recovery, intelligent control and ejector technology points to energy savings of up to 50% compared to more conventional installations.

Arneg's turnkey refrigeration solution features components from Danfoss, LU-VE and Dorin. [@ AW](#)



CO₂ IN MOBILE AIR CONDITIONING – WIEDER ZURÜCK?

– By Alvaro de Oña

The use of CO₂ as a refrigerant in cars seems to be making a gradual comeback in Germany. A recent one-day symposium on the topic served to share the latest technology updates regarding the use of CO₂ in mobile air conditioning (MAC) systems.

The symposium, organised by independent research institute TWK (Test- und Weiterbildungszentrum Wärmepumpen und Kältetechnik), took place in Karlsruhe on 2 June with a strong focus on technology innovations. Targeting a German-speaking audience, the presentations touched upon practically every aspect of the systems, including latest trends in compressors, joints and valves, lubricants and even two-stage ejectors. The development of CO₂ heat pumps for mobile applications, or the safe handling of CO₂ in comparison with other refrigerants, were also in the spotlight.

The German Environment Agency (UBA) complemented the technical session with a general overview of the use of

CO₂ in cars. Technical development of CO₂ systems seems to be accelerating in Germany, following last year's major announcement by Daimler that it will use CO₂ in its S- and E-Class models as from 2017, prior to it becoming standard in other models, including its A, B, and C-Class.

Also in 2015, Mercedes, along with other German automobile manufacturers, helped draft the first ever standards for CO₂ MAC with the German Association of the Automotive Industry (VDA). The publicly accessible DIN specifications covering CO₂ components for MAC systems are designed to reduce costs compared to HFC and HFO-based systems.

Under the EU's MAC Directive, f-gases with a GWP of more than 150 times greater than CO₂ (GWP 1) – namely the widely used hydrofluorocarbon R134a (GWP 1300) – will be prohibited in new cars and vans from 1 January 2017. **AO**

JOIN SUPERSMART AND MAKE EUROPE'S FOOD RETAIL SECTOR MORE EFFICIENT!

– By Nina Masson

Efficient solutions for supermarket heating, cooling and refrigeration – such as integrated systems or the use of natural refrigerant-based equipment – are already technically available in Europe. However, non-technical barriers, like a lack of general awareness or specific expert knowledge, have prevented the market from growing more quickly.

The EU-funded 'SuperSmart' project aims to change this through information campaigns, workshops and dedicated training for stakeholders in the supermarket sector. To make these measures as effective as possible, a new survey has been launched to rank non-technological barriers and identify focus areas for the training sessions. The survey is available in six European languages.

After a successful kick-off workshop in Barcelona on 18 April, the SuperSmart team, which brings together nine European partners, has also developed a second survey on a European Ecolabel for food retail stores, to determine the scope of such a label and the criteria to be included. Both surveys are available from the project website (www.supersmart-supermarket.org).

More importantly, SuperSmart is seeking the active contribution of all parties involved in HVAC&R solutions for European food retail stores. Any party interested in receiving free-of-charge training sessions on how to build or refurbish energy-efficient supermarkets can write to training@supersmart-supermarket.org. Suppliers, end users and members of the research community keen to drive energy-efficient HVAC&R solutions forward are welcome to express their interest in joining one of three Innovation Panels using the contact form on the project website. **NM**



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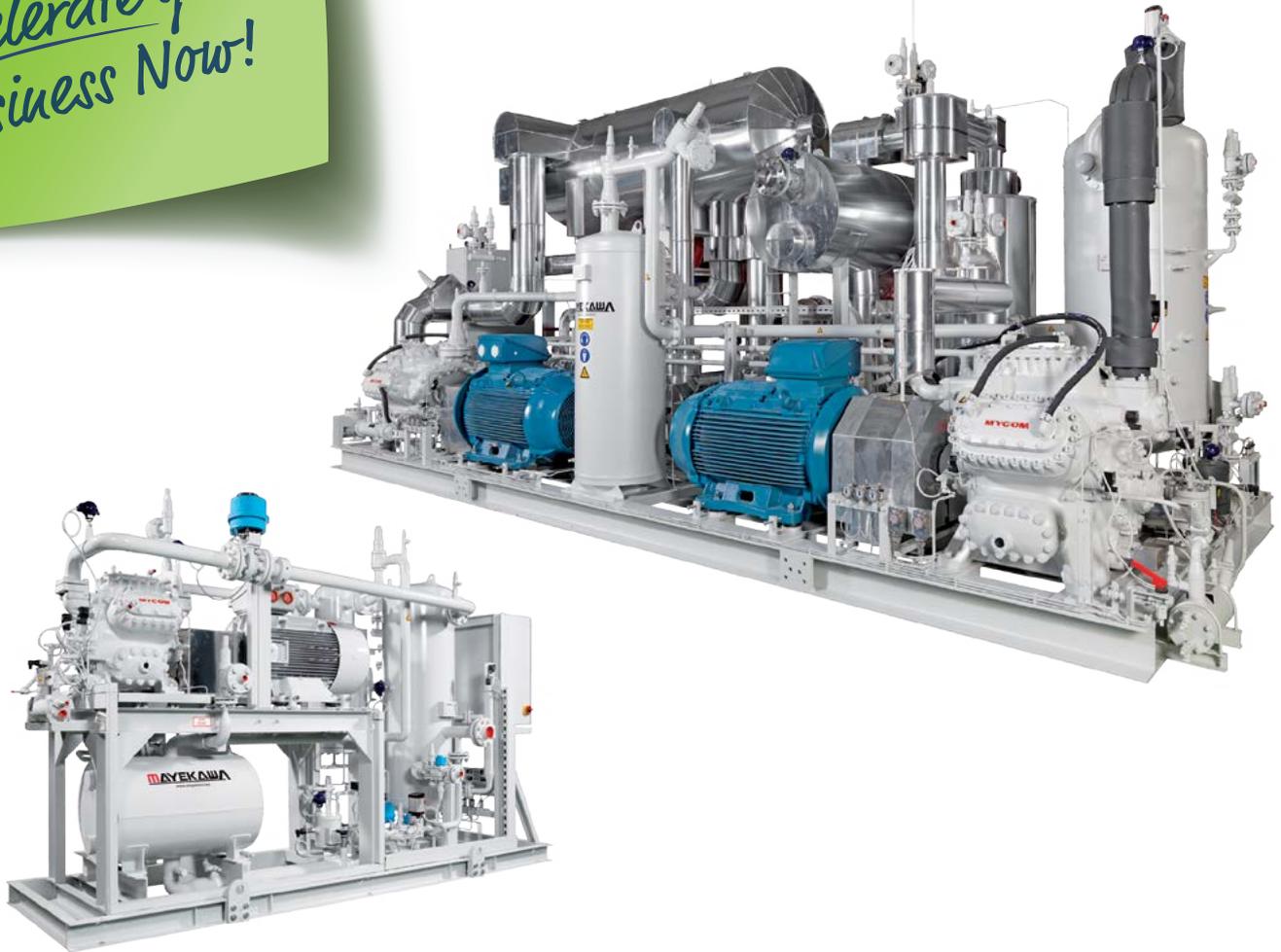
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