

A close-up portrait of a man with short brown hair, a goatee, and black-rimmed glasses. He is wearing a light purple checkered shirt under a dark blue suit jacket. The background is a soft, out-of-focus blue sky.

SUMMER 2017

ACCELERATE

ADVANCING HVAC&R NATURALLY

E U R O P E

Nestlé's visionary pioneers

Coop Group
flying high
with ammonia

p. 14

VINCENT GRASS
Refrigeration Team Leader
Corporate Operations –
Engineering Services
Nestlé

p. 22

NatRefs take
over EuroShop

p. 34

Technology
focus:
Propane
heat pumps

p. 68

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Tapping into the pioneering spirit

— Editor's note by Andrew Williams



As the HVAC&R sector around the world grapples with regulatory pressure to reduce HFC consumption, the summer edition of *Accelerate Europe* looks at how early adopters of natural refrigerant-based solutions – among manufacturers and end users alike – have inspired others to make the transition.

Swiss multinational Nestlé began replacing its CFC and HCFC systems with ammonia in 1986. Today, its commitment to adopting natural refrigerants for HVAC&R applications wherever possible remains consistent and firm. *Accelerate Europe* toured a host of Nestlé sites around company headquarters in the lakeside town of Vevey, to hear from refrigeration team leader Vincent Grass how a succession of inspirational individuals have helped to bring natural-refrigerant technologies and know-how to new parts of the world (p. 22).

Another Swiss giant, the Coop Group, is putting natural refrigerants at the heart of its strategy for becoming CO₂-neutral by 2023. At its new ammonia-cooled production site in the suburbs of Basel, the leading retailer produces chocolate, wine and foodstuffs for sale in its own stores and for export worldwide (p. 14).

Indeed, natural refrigerant-based HVAC&R solutions are already helping many other European retailers to reduce their environmental footprint. At EuroShop in Düsseldorf – the world's biggest retail trade fair – it was clear that CO₂ and hydrocarbon solutions were the main focus for commercial refrigeration manufacturers (p. 34).

Slowly but surely, the European vending sector is also looking to natural refrigerants as a means of complying with the EU F-Gas Regulation. At Vending Paris, some manufacturers had already begun adopting or testing hydrocarbon and CO₂-based vending machines and bottle coolers (p. 42).

From ammonia heat pumps for fish farms to propane chillers for seafood vendors, natural refrigerant-based solutions abounded in Brussels at Seafood Expo Global – the world's biggest seafood trade fair (p. 46).

For heat pumps to be more successful they must be efficient, have a low environmental impact and be economical to buy. Propane heat pumps meet all these requirements. *Accelerate Europe* was at ISH in Frankfurt to see what can be done to boost their uptake (p. 68).

In deciding between a combined heat and power plant or a heat pump to save energy at its new meat processing facility near Brussels, Belgian retailer the Colruyt Group opted for an ammonia heat pump (p. 60).

A perceived lack of training among technicians and installers is often cited as a barrier to wider uptake of natural-refrigerant-based technologies. But a new report shows that training is in fact readily available for those who need it (p. 58). Features on the Spanish HVAC&R market (p. 56) and Austrian company AHT Cooling Systems (p. 64) are just two of the other stories waiting for you in this summer edition.

Let me take this opportunity to wish you a pleasant and relaxing summer break. Whether you're spending your summer holidays on the beaches of Europe or elsewhere, you may well find that your local supermarket is already using natural refrigerants! See you in September.

■ AW



ACCELERATE

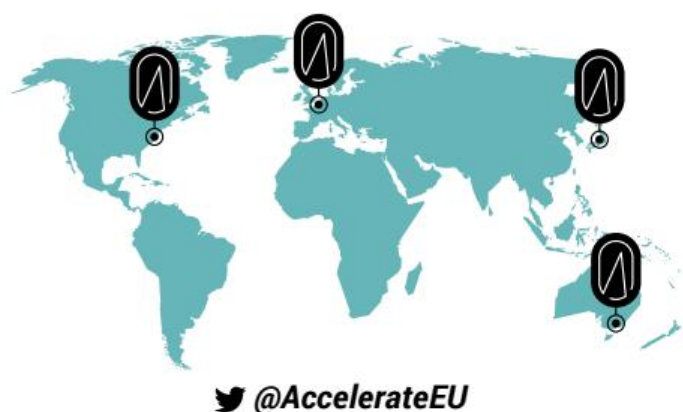
ADVANCING HVAC&R NATURALLY

EUROPE

ABOUT ACCELERATE EUROPE

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>



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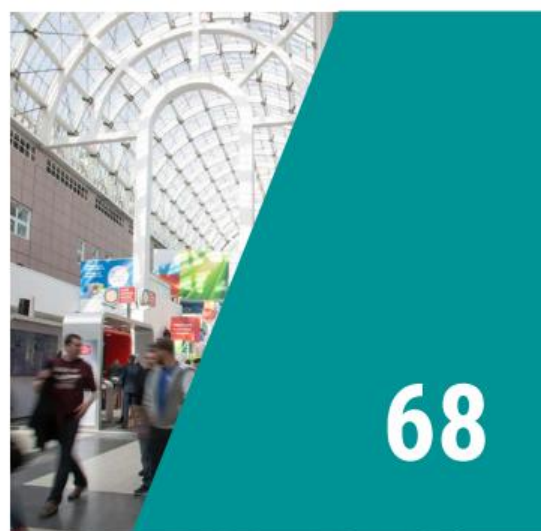
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Timely application of Kigali Amendment demands a fresh approach to standards

Last year's Kigali Amendment to the Montreal Protocol saw the global community take another important step towards reducing CO₂ emissions from human activity in order to preserve our planet for future generations. The global phase-down of HFCs in the refrigeration sector is making an important contribution to international mitigation efforts.

Recent regulations in different parts of the world (EU F-Gas Regulation, US SNAP rules and CARB actions, etc.) impose bans on high-GWP refrigerants in the next few years in several refrigeration and air conditioning segments, including different categories of light commercial refrigeration.

Today, light commercial refrigeration appliances follow IEC (International Electrotechnical Commission) safety standards. IEC product standards are the reference for regional and national legislation (e.g. EN and UL standards, EPA rules, etc.).

The present IEC standard used for hermetically sealed applications (IEC60335-2-89) limits to 150 grams the charge of any flammable refrigerant, which makes the full application of the Kigali Amendment for transitioning to low-GWP refrigerants more difficult – notwithstanding the fact that by using multiple independent circuits, the problem of charge limits in bigger cabinets can be solved using the existing standard.

In the IEC SC61C/WG4 working group, the industry is trying to define specific additional measures needed to allow higher charge levels without increasing risks above the existing standard.

Activity led by Werner Schwaiger, from the Austrian National Committee, started in 2015. Recently, during a meeting held in Turin at the end of April this year, the working group addressed comments received on the last draft of the amendment to IEC standard 60335-2-89.

The main factor used to minimise the creation of a flammable mixture around the appliance is the airflow. Its effectiveness must be certified using a special leak test. The leak test was developed with the help of specialised laboratories in Great Britain and in Germany. Additionally, outcomes of an AHRI project to assess the severity of negative events due to flammable refrigerants (both A3 and A2Ls), currently in progress in the US, will be taken into consideration.

As a result, a new Draft for Comments (DC) document, which considers the 500g limit for propane charges and which will also allow the use of slightly flammable A2L safety class refrigerant alternatives, will be circulated in May. If positively commented upon and if a consensus is reached, the document will be submitted to the SC61C committee to go to the first official vote as a Committee Draft (CDV) during the Plenary Meeting of the SC61C in October in Vladivostok.

During 2018, in the event of positive CDV and FDIS votes (a majority of 66.7% of P-members is required), the final standard amendment should be published.

It is important to note that the majority of experts participating in WG4 working group activity are from leading US companies. Therefore there is a good chance that UL and the EPA will also adopt the approved IEC standard into American legislation quite soon. The European version of the IEC standard will be voted in parallel and other regions, like China, Japan, etc., should follow as well.

Marek Zgliczynski
Chair of IEC SC61C
Embraco, Commercial Refrigeration R&D



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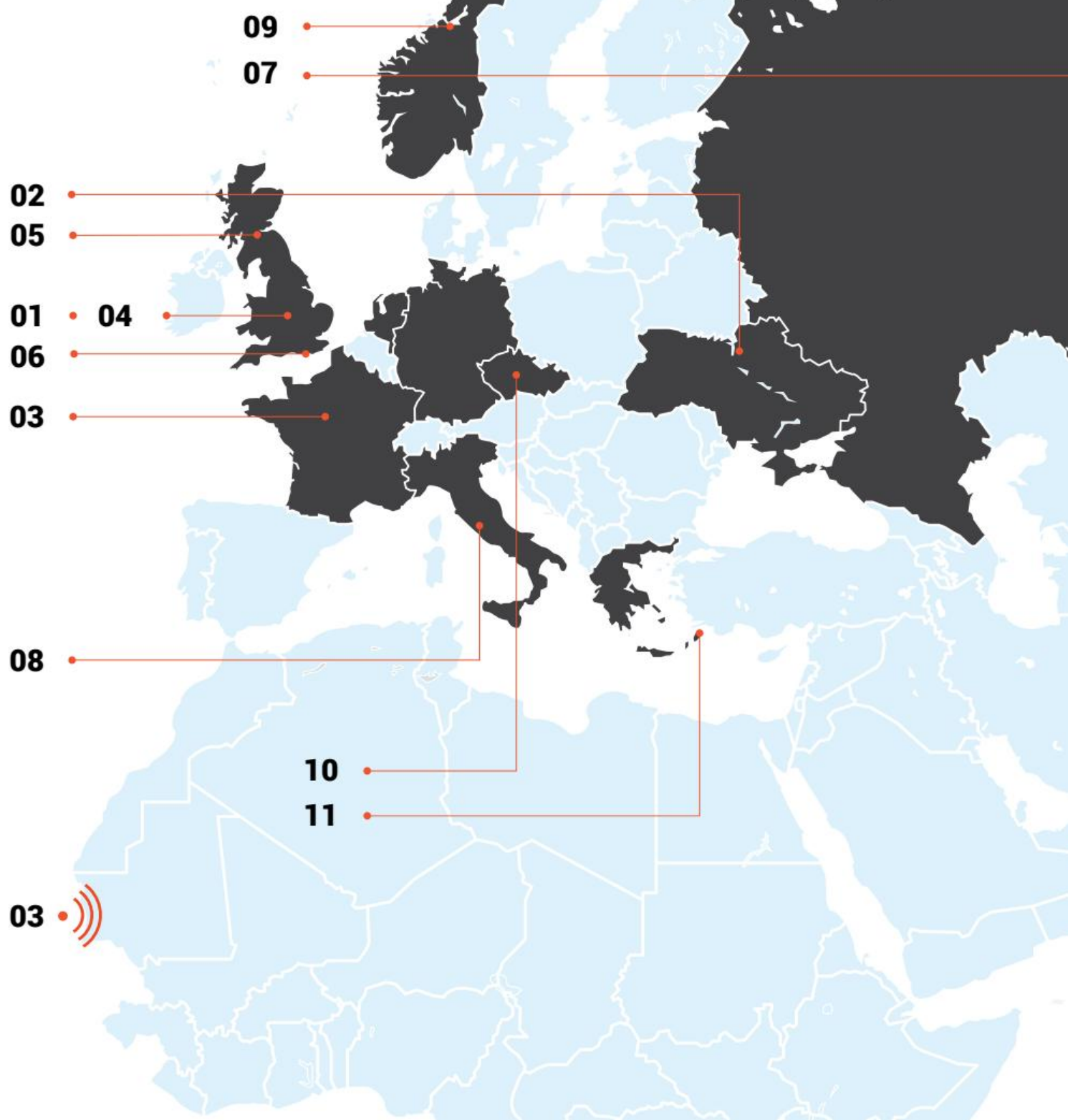
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EVENTS GUIDE

May / June 2017

July / August 2017



• **01** 23-24 May, Birmingham, UK
Edie Live 2017

www: <http://exhibition.edie.net/>

twitter: @edielive #edielive

• **02** 30 May-2 June, Kiev, Ukraine
Aqua Therm Kiev

www: <http://www.aqua-therm.kiev.ua/en-GB/>

• **03** 31 May, Webinar Wednesday - Danfoss
**What is sustainable cooling in the EU?
A cross-sector perspective**

www: www.webinarwednesday.net

twitter: #webinarwednesday

• **04** 6-7 June, Birmingham, UK
Commercial Kitchen

www: <http://www.commercialkitchenshow.co.uk/>

twitter: @comkitchenshow

• **05** 3-5 July, Edinburgh, UK
PLEA 2017 Conference

www: <https://plea2017.net/>

twitter: #plea2017

• **06** 7-9 July, Brighton, UK
**European Conference on Sustainability, Energy
& the Environment 2017**

www: <http://iafor.org/conferences/ecsee2017/>

twitter: #ECSEE

• **07** 10-13 July, Ekaterinburg, Russia
INNOPROM 2017

www: <http://www.innoprom.com/en/for-participants-conditions/>

twitter: #innoprom

• **08** 3-4 August, Rome, Italy
**63rd International Conference on Environment
and Natural Science (ICENS)**

www: <http://iserd.co/Conference/2016/Italy/ICENS/>

• **09** 21-24 August, Trondheim, Norway
Nor-Fishing

www: <http://www.nor-fishing.no/?lang=en>

twitter: @NorFishing #NorFishing

• **10** 24-29 August, Ceske Budejovice, Czech Republic
Eco-Style 2017

www: <https://www.tradefairdates.com/Eco-Style-M8856/esk-Budjovice.html>

• **11** 31 Aug.-2 Sept., Rhodes, Greece
**15th International Conference on
Environmental Science and Technology**

www: <https://cest.gnest.org/>

twitter: #CEST2017

EUROPE IN BRIEF

MARKET

Daimler R134a fleet recall may open door to CO₂

Germany's Federal Motor Transport Authority has asked Daimler to recall 134,000 cars fitted with R134a-based air-conditioning systems in violation of the EU's Mobile Air Conditioning (MAC) Directive. The Federal Environment Agency is urging the manufacturer to turn to CO₂ as an alternative.

"The introduction of CO₂ air-conditioning systems for passenger cars, which was launched by Daimler, is an environmentally sound and safe solution that must be continued," the UBA told the *Frankfurter Rundschau* at the end of April.

The recall concerns vehicles that were fitted with R134a in the first half of 2013 and affects Mercedes A-Class, B-Class, CLA-Class, S-Class and SL-Class models.

The MAC Directive prohibits the use of f-gases with a global warming potential (GWP) of more than 150 times greater than CO₂ in new types of car and van introduced from 2011, and in all new cars and vans produced from 2017.

Daimler had refused to use R1234yf on safety grounds, instead preferring to invest in the development of CO₂-based systems. In the meantime, it continued to produce cars fitted with R134a – leading to a lengthy court battle.

Daimler is working to roll out air-conditioning systems using CO₂ as the refrigerant across its entire fleet. It currently only offers CO₂-based air-conditioning in its S- and E-Class models, and must therefore replace R134a with R1234yf in the other recalled models.

■ Andrew Williams

MARKET

Send us your nominations for the 1st Accelerate Europe Awards

The first annual *Accelerate Europe* Awards will recognise exemplary companies and individuals that are doing the most with natural refrigerant solutions in Europe. A special awards ceremony will honour the winners during ATMosphere Europe 2017, to be held in Berlin on 25-27 September. The winning companies and individual will be profiled in the December 2017 issue of *Accelerate Europe* magazine.

A total of five awards are to be presented in three categories: Best in Sector, Person of the Year and Innovation of the Year. The Best in Sector awards will go to end user companies in three sectors – food retail, foodservice and industrial.

The nominations may be submitted by anyone involved with HVAC&R; companies and individuals may nominate themselves. The nomination process was launched in March this year and will run until July 2017, with the winners decided by a panel of experts assembled by shecco.

For more information and the nomination criteria, please send an email to info@atmo.org. ■ Eda Isaksson

TECHNOLOGY

Ammonia, CO₂ working in tandem to cool Dutch fleet

Ammonia and CO₂ are increasingly competing with one another for industrial refrigeration, but when they work together in fisheries and fish processing like for the Dutch fishing fleet, they can deliver an 8% reduction in energy used compared to traditional ammonia plate freezers.

Speaking in April at the Sustainable Management Of Refrigeration Technologies in the Marine And Off-Shore Fisheries Sectors conference in Bangkok, Thailand, Alexander Cohr Pachai – technology manager at global refrigeration company Johnson Controls – said: "The temperature is achieved much faster due to the good properties that CO₂ has in a plate freezer."

The key is that CO₂ allows the fish to be frozen equally when in the plate freezer.

The CO₂ circuit complements the ammonia circuit in that the compressors and overall system size are smaller, thus maximising the space in a trawler.

To ensure the system does not fail, there is also a "[refrigerated sea water] RSW system cooled by NH₃," Pachai said.

The efficiency of the cascade system helps to reduce fuel consumption and increase daily freezing capacity.

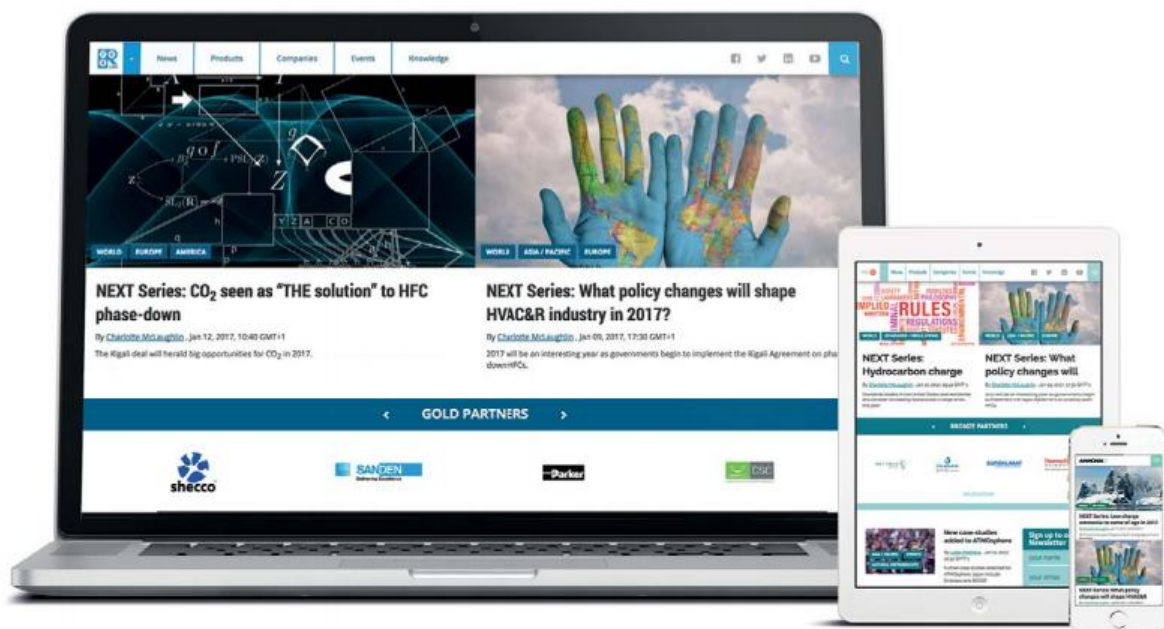
In the Netherlands, seven systems have been converted from HCFCs to NH₃-CO₂ so far, according to Pachai. And there has been "one vessel new built with an ammonia/CO₂ cascade," he says.

■ Charlotte McLaughlin

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EUROPE IN BRIEF

MARKET

'Click & Collect' food retail systems cooled with hydrocarbons

As consumers become increasingly 'digitised', 'Click & Collect' services look set to become more commonplace across Europe – with supermarkets leading the way. Manufacturers are beginning to tune into this trend, with German firm Viessmann and Austrian company Hauser presenting innovative cooling systems for this application at EuroShop.

'Click & Collect' allows supermarket customers to order their shopping online and easily collect it from an external pick-up station – such as a train station, supermarket car park, petrol station, bus stop or airport.

Viessmann presented its 'Click4Food' solution using propane and isobutane for cooling. It plans to develop the 'Click & Collect' concept together with its retail customers, expanding sales of refrigerated goods beyond the traditional grocery business, according to Mikko Blomqvist, product manager at Viessmann.

Austria-based Hauser is opting for a different concept with isobutane as the only refrigerant. The system is organised in rows of three going down, with each compartment using a different compressor and refrigeration system. Each row is also at a different temperature: one for frozen produce, one for fridges, and one for ambient goods.

Paul Broadhurst of Hauser says the refrigerated lockers will be installed "mainly in supermarket parking lots".

■ Charlotte McLaughlin

MARKET

Huayi Compressor Barcelona covering all capacities with R290

As hydrocarbons become increasingly prevalent in most household and commercial applications, Huayi Compressor Barcelona is looking to cover all cooling capacities in these sectors by extending its established R290 range by creating the S and B propane ranges.

"We offer the most complete range of compressors for any applications," says Pedro Olalla, sales director at Huayi Compressor Barcelona.

This means they now have a complete range of compressor models designed for working with R290 in the U, B and S ranges and standard ranges L, P and X.

The addition of the new propane compressors means the range now covers the complete commercial refrigeration market, from small freezers and bottle coolers in the B range to large freezers in the S range.

The compressor manufacturer still has many offerings of R600a (isobutane) for smaller applications but realises that many OEMs only want to work with one refrigerant.

"For many who don't want to handle many refrigerants, you can use R290 [for all]," Olalla said.

■ Charlotte McLaughlin

TECHNOLOGY

Japan's Nidec to acquire SECOP

Japanese engineering company Nidec has agreed a deal to purchase German manufacturer SECOP from AURELIUS Equity Opportunities SE & Co. KGaA for €185 million.

The Nidec Group, headquartered in Kyoto, entered into a stock purchase agreement on 25 April to acquire a 100% equity share of Secop Holding GmbH, Secop s.r.o., Secop Compressors (Tianjin) Co. Ltd. and Secop Inc. ('SECOP'), and shareholder loans from Secop Beteiligungs GmbH.

The two companies agreed a purchase price of €185 million in an all-cash transaction. Nidec plans to finance the acquisition with debt financing, and aims to close the transaction by the end of June 2017.

By adding compressors to its product portfolio, Nidec will gain direct access to the refrigeration market and its attractive growth opportunities. Nidec hopes to tap into synergies with its own motor business to reduce procurement costs for compressor components, thanks to their similarities with motors.

SECOP is a global provider of specialised compressors for refrigeration and freezer appliances operating in the household and light commercial segments. Nidec is the world's No.1 manufacturer of small precision motors.

■ Anti Gkizelis

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Photography by Anna Salhofer



Georg Weinhofer, Coop Group, responsible for sustainability in the logistics department

Coop Group flying high with ammonia

Swiss retail giant the Coop Group is putting natural refrigerants at the heart of its strategy for becoming CO₂-neutral by 2023. *Accelerate Europe* visits the group's new production site in Pratteln to find out how ammonia is helping to deliver this target.

– By Andrew Williams

Exiting the motorway at Pratteln, near the Swiss border city of Basel, drivers cannot miss the proud 'coop' sign adorning the roof of the buildings below.

At its factory in the suburbs of Basel, Swiss retailer the Coop Group produces chocolate, wine and foodstuffs such as dried fruit and nuts for sale in its own stores and for export around the world.

The Coop Group consists of a retail arm comprising Coop supermarkets and other specialist formats such as pharmacies, petrol stations and DIY stores in Switzerland, and a European wholesale and production business.

Group sales in 2016 amounted to CHF 28,322 million (EUR 26,152 million). The group employs some 85,000 people and boasts 2,250 retail stores and 226 wholesale outlets in its portfolio.

The Pratteln site is home to three of the Coop Group's own brands: Chocolats Halba (premium Swiss chocolate), Sunray (foodstuffs) and Cave (wine). The factory produces over 13,000 tonnes of premium Swiss chocolate for retail, industry and export every year – US retail giant Walmart is a big customer.

Under the Sunray banner, 32,500 tonnes of foodstuffs sourced from around the world are processed into 600 different products including dried fruit, nuts, sugar, herbs and spices. 74 million packets per year leave the factory doors.

Cave, the Coop Group's winery, is the largest in Switzerland. Whites, reds, rosés and dessert wines are among the 36 million bottles produced in Pratteln every year. Cave vinifies must from seven Swiss cantons, and refines and bottles wine from all over the world.

Ammonia: the factory's beating heart

All this requires a lot of cooling. *Accelerate Europe* toured the site with Georg Weinhofer – assistant to the head of the logistics department at the Coop Group – and Thomas Fischer, senior project manager at Swiss refrigeration consulting and engineering company Frigo-Consulting Ltd., which has been supporting the retailer with its transition to natural refrigerants.

"The main motivation to adopt natural refrigerants was (and still is) the reduction of CO₂ emissions, and hence to contribute to our ambition to become CO₂-neutral by 2023," says Weinhofer, who is responsible for sustainability in logistics.

The Coop Group has been working with natural refrigerants since the mid-2000s. In tune with its commitment to become CO₂-neutral by 2023, all its new and refurbished supermarkets have used natural refrigerant CO₂ since 2009.

400 of Coop's 850 supermarkets use CO₂ as the sole refrigerant. 90% of the 400 systems are CO₂ transcritical.

Coop uses ammonia in all new or refurbished production sites and distribution centres in Switzerland. What led Coop to choose ammonia in particular?

"Ammonia has outstanding thermodynamic properties, and is therefore the perfect fit for high-refrigeration capacities. It has been used for over 130 years. Ammonia is also climate-neutral and reasonably priced," Weinhofer says.

Another important factor is the availability of technology. "So far, CO₂ systems haven't been available in the capacities we need for our distribution centres and production sites," Weinhofer says.

"We're aware that our daughter company Transgourmet is using CO₂ in some distribution centres and cash & carry markets. We're in exchanges with colleagues there on that topic," he said.

Six refrigeration chillers and two heat pumps, all of which use ammonia, were installed on the site in spring 2016. The cooling capacity of each chiller is 1,000 kW. Likewise, the heat pumps each contribute 1,000 kW of heating.

The six chillers are flexible enough to provide cooling for the site's different needs. They provide cooling in temperature ranges of +2/+8°C and +6/+12°C, and heat recovery (+19/+25°C and +30/+40°C).

"In addition, we have two large cold rooms served by CO₂ refrigeration installations," Fischer says.

Producing chocolate, cooling wine storerooms, and air-conditioning and dehumidifying the premises are among the onsite processes that require cooling.

"The six refrigeration units can be run individually and their cooling energy can be passed on to two cooling grids," Fischer explains.

Each of the six refrigeration systems runs independently from the others, helping to minimise the ammonia refrigerant charge and providing guaranteed backup.

The refrigeration units are able to recover heat at temperatures of up to 40°C. The heat pumps can achieve temperatures of up to 60°C. "This waste energy is used to heat the chocolate pipes, to heat the facility, and for dehumidification operations," Fischer says.

The facility's production divisions require individual cooling and customised temperature levels, for example during the conching process. A conche is a surface-scraping mixer and agitator that evenly distributes cocoa butter within chocolate. Conching is the key to giving chocolate its final flavour and texture.



Coop Group's new production site in Pratteln, near Basel



Thomas Fischer, Senior Consultant
at Frigo-Consulting



'Ammonia outruns all synthetic refrigerants'

Synthetic refrigerants were never in the picture. "Compared to ammonia, HFOs have disadvantages in terms of sustainability. Ammonia outruns all synthetic refrigerants with regard to energy efficiency, and is therefore a forward-looking and sustainable solution," Fischer says.

The Coop Group already operates ammonia systems in other locations. This experience, together with the low charge of ammonia and round-the-clock monitoring, means that "there were never any safety concerns" in opting for an ammonia solution, Fischer says.

"At the moment, the installation is being monitored around the clock by a surveillance system from the refrigeration company. The technical service staff will be trained to do specific checks and maintenance work. Thanks to the full-service contract, the installation is serviced monthly," he explains.

The refrigeration system is just one part of the sustainability picture in Pratteln. To produce heat and steam for industrial processes, woodchips are burned instead of natural gas. A rooftop 550 kW solar photovoltaic system provides some of the site's electricity. ■ [AW](#)



13,000 tonnes of premium Swiss chocolate ('Schoggi') are produced on-site, some of which is sold in this factory store.



300 tanks for almost 7 million litres of wine are installed on-site.



Cooling with natural refrigerants

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Air-cooled ammonia condenser

Coop Group: Pratteln production site – main features:

- **Installation type:** 6 chillers and 2 heat pumps
- **Refrigerant:** Ammonia
- **Refrigeration capacity:** 1,000 kW per chiller (6,000 kW total)
- **Heating capacity:** 1,000 kW per chiller (2,000 kW total)
- **Refrigeration temperature ranges:** +2/+8°C and +6/+12°C
- **Heat recovery temperature ranges:** +30/+40°C and +40/+60°C
- **Heat pump and refrigeration unit manufacturer:** RV Cooling Tech
- **Screw compressors (refrigeration units):** Howden
- **Piston compressors (heat pumps):** Mayekawa
- **Commissioning, assembly, installation:** SK Systemkälte

NH₃ chiller

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Natural Refrigerants Training in Europe

The Training Offer

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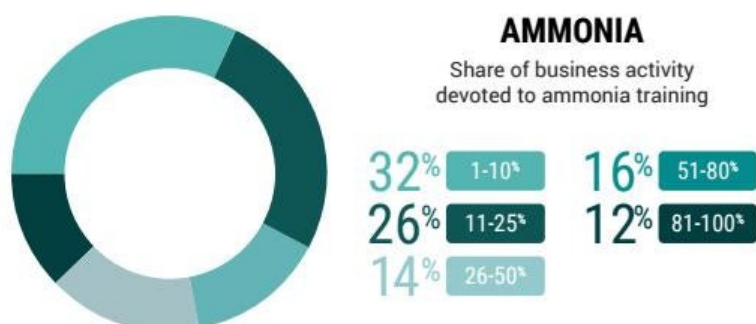
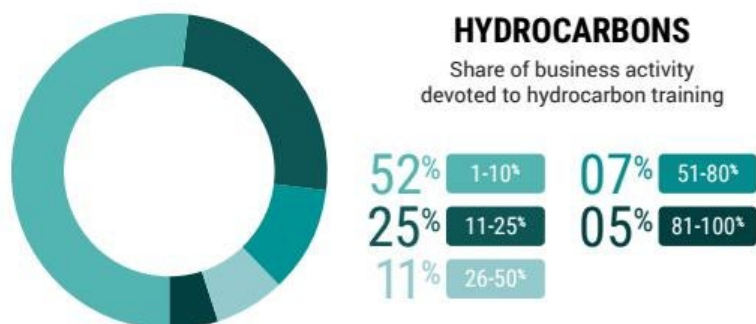
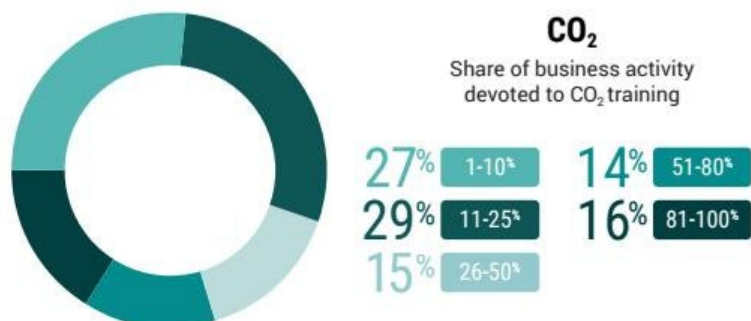
Natural refrigerant training providers:



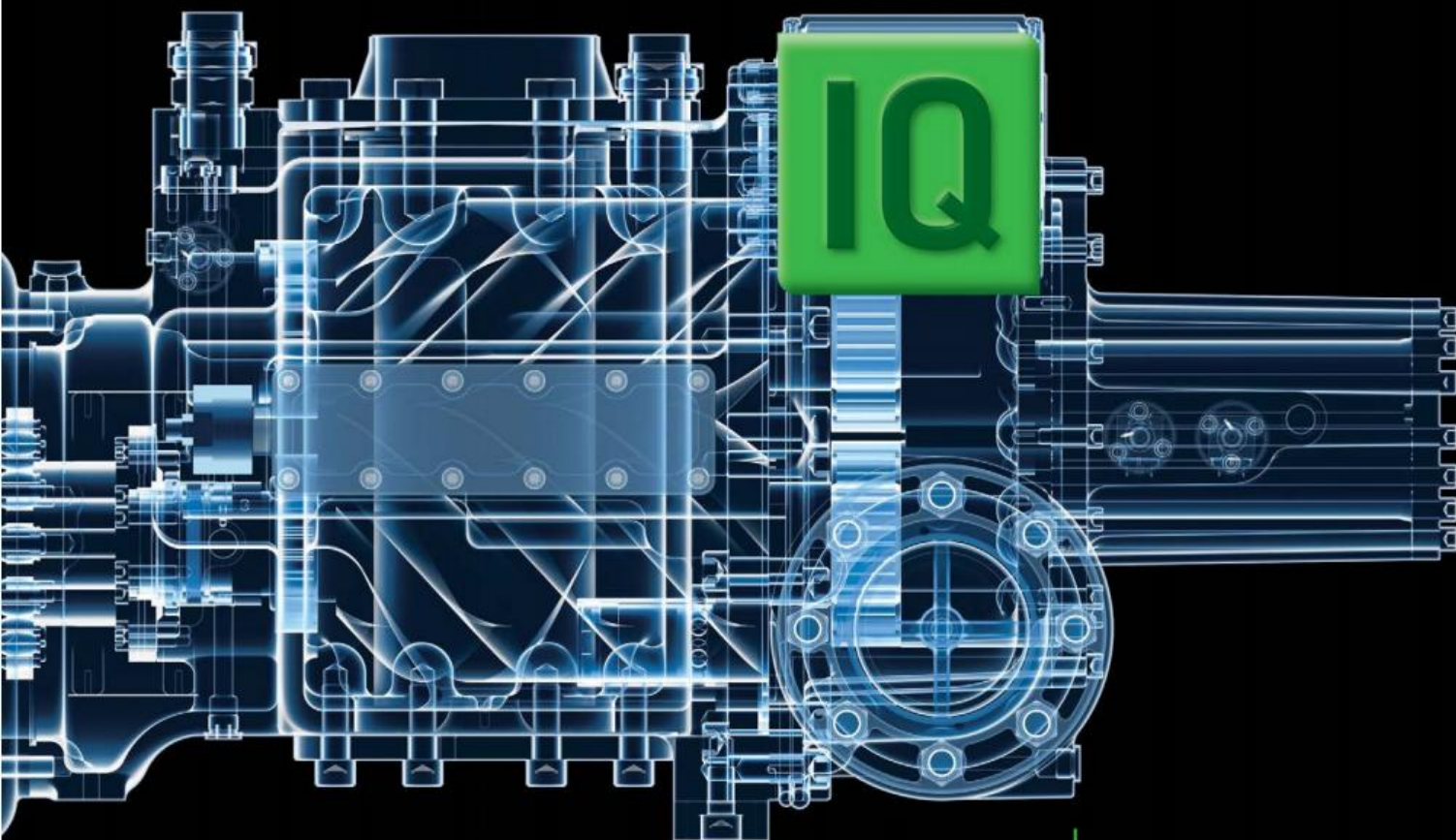
Natural refrigerant training receivers:



Business Activity by Natural Refrigerant:



Source: GUIDE to Natural Refrigerants Training in Europe 2017.



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THE HEART OF FRESHNESS



Nestlé's pioneering vision

Swiss multinational Nestlé began replacing its CFC and HCFC systems with natural refrigerants in 1986. Today, its commitment to adopting natural refrigerants for HVAC&R applications wherever possible is helping to bring the technology to new parts of the world – thanks to the vision of Vincent Grass and his predecessors. *Accelerate Europe* reports from Nestlé's home town of Vevey.

— By Andrew Williams

Timeline

1986

One year before Montreal Protocol is signed and three years before it enters into force. Nestlé begins replacing existing CFC and HCFC plants with ammonia systems in production sites.

2000

Nestlé's first system to use CO₂ (in its first large NH₃/CO₂ cascade system) in Beauvais, France.

2001

Nestlé's first official position paper on industrial refrigeration pledges to replace its few remaining CFC and HCFC systems with natural refrigerants.

Nestlé opens world's first large NH₃/CO₂ cascade system to use compressed CO₂ in Hayes, UK.

From industrial refrigeration systems with NH₃/CO₂ at key production sites in Switzerland to ammonia-cooled data centres and the worldwide deployment of hydrocarbon-based display cabinets, the commitment of Nestlé to natural refrigerants is consistent and firm.

With snow-capped mountains casting their reflections in the water, visitors to Nestlé's lakeside headquarters in the Swiss town of Vevey cannot fail to be inspired by the magnificent surroundings.

Vincent Grass is a man with a vision as far-reaching as the lofty Alpine summits that tower above him on his daily commute, alongside Lake Geneva from his home in Evian, in nearby France. As refrigeration team leader in the 'corporate operations – engineering services' department at Nestlé, the 40-year-old Frenchman is responsible for turning the Swiss multinational's ambition to expand its use of natural refrigerants into a reality.

"We are expanding the use of natural refrigerants across the company," Grass says.

Nestlé's ambition is to strive for zero environmental impact in its operations by 2030. All the electricity consumed by the company in Switzerland, Austria, Brazil, Czech Republic, Germany, Hungary, Ireland, Italy, the Netherlands, Slovakia, and the United Kingdom, for example, comes from renewable sources.

By 2020, Nestlé is aiming to reduce greenhouse gas (GHG) emissions per tonne of product in every product category to achieve an overall reduction of 35% in its manufacturing operations (versus 2010). Also by 2020, the company is aiming to reduce GHG emissions in its distribution operations by 10% (versus 2014).

Natural refrigerants have long played a central role in delivering all this. Since 1992, Nestlé has invested CHF 299 million (EUR 276 million) in replacing HFC systems with natural refrigerant-based alternatives for industrial refrigeration. It installed 47 new industrial refrigeration systems based on natural refrigerants in 2016 alone.

Vincent Grass – Biography

► **Current position:** Refrigeration Team Leader, Corporate Operations – Engineering Services, Nestlé

► **Previous employment:** 2 years at Johnson Controls (JCI) and 10 years at Cofely Axima (formerly QUIRI).

► During this time he was primarily involved in projects with natural refrigerants ammonia and CO₂.

► Experience of projects in Europe (France, Switzerland, Poland) and Africa (breweries).



Vincent Grass

Photography by Anna Salhofer

▶ Reducing industrial refrigeration footprint

The majority of Nestlé's refrigerant charge is attributable to industrial applications.

About 90% of Nestlé's refrigerant charge – and potential risk in terms of direct refrigerant emissions – is in manufacturing. The remaining 10% is in commercial applications.

"We're focusing on industrial because that's where we can make the biggest impact. It's where we have the biggest risk of leakage and the highest electricity consumption," says Grass.

"For most big plants, ammonia is the most efficient option. In combination with CO₂, you can address safety issues and still deliver low temperatures. By adding CO₂, you need more components but the compressors are smaller, so you're reducing your footprint too," he argues.

Nestlé is already using natural refrigerants for over 90% of its industrial refrigeration needs worldwide. In the Europe, Middle East and North Africa (EMENA) region, 91% of its industrial refrigeration is provided by natural refrigerants. In the Americas – Nestlé's biggest market is the USA – the figure is 95%. "In Asia, Oceania and the rest of Africa, we're at 84%," Grass says.

He says it is hard to predict when the firm will achieve 100% natural refrigerants for industrial use. The official target is simply to expand their use in industrial refrigeration by 2020.

"The thing is, we have many different applications in our factories, on different scales and at different temperatures. We also have different geographies, with different climates. The cooling demand is different," Grass explains.

"We strive to hit 100%, but we can't say when we'll be there. Achieving the last 10% is very difficult," he admits.

Factors slowing down progress include lack of available technology in some countries, restrictive charge limits in some jurisdictions, and transitioning away from existing HFC systems on recently acquired sites.

"We need to look at it product-by-product and application-by-application. You have the environment, the climate, the surroundings to consider," Grass explains.

Peter Jaggy is head of engineering at Nestlé. He stresses the need to ensure that staff in headquarters and throughout the 86 countries in which Nestlé operates are on the same page. "On the fringes, there is a lot of activity which we don't necessarily see from here in headquarters. This is why it's not so easy to get from 90% to 100%," he says.

Jaggy has worked for Nestlé for 39 years – his whole professional life. "Refrigeration has always been an interesting subject for me. I'm concerned about the environmental situation on this planet," he says.

Jaggy's four decades in the company have taken him to every continent. He has witnessed an enormous evolution not just in available technology but also in attitudes to environmental sustainability in different parts of the world. "It doesn't always go in the right direction either," he says, expressing pride at the pioneering role that Nestlé has played in bringing natural refrigerants to so many different countries. ▶

“ We started this journey
a long time ago.

We've always been
convinced that natural
refrigerants are the right
way to go. ”

– Vincent Grass, Nestlé

2003

Nestlé builds its first NH₃/CO₂ system using compressed CO₂ in the US, in a Prepared Foods factory in Jonesboro. The factory includes the first automatic horizontal plate freezers using CO₂ as the refrigerant.

2005

Nestlé commissions its first chillers using hydrocarbons as the refrigerant (R290), in a York, UK factory.

2006

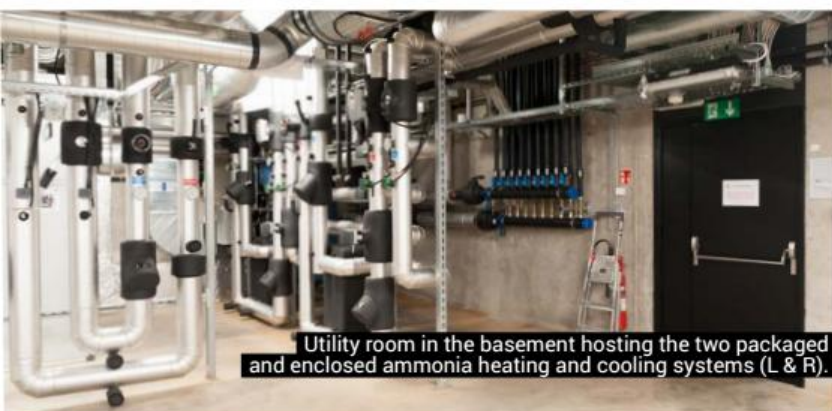
Nestlé installs world's first CO₂ ice cream freezer in its factory in Bangchan, Thailand.



'The Nest', Nestlé's Discovery Centre in Vevey.

The Nest, Vevey, Lake Geneva north shore, Switzerland

- ▶ Nestlé's new discovery centre, the Nest, opened to the public on 15 June 2016 to mark the firm's 150th anniversary.
- ▶ It was built on the spot where company founder Henri Nestlé first developed his infant cereal in 1866.
- ▶ Ammonia-based heat pump provides heating, cooling and sanitary hot water.
- ▶ Water circulates in 9km of underground and internal piping.
- ▶ 36 vertical-loop pipes source heat from the ground.
- ▶ Water was chosen over glycol as the secondary refrigerant thanks to its efficiency. There is no risk of the water freezing, as it does not go outside.
- ▶ Two semi-hermetic Mycom ammonia compressors are housed inside boxes to mask the noise.
- ▶ No ammonia circulates in public areas.
- ▶ Safety features include leak detectors, an emergency ventilation system combined with an air scrubber, an emergency stop system and emergency showers.



Utility room in the basement hosting the two packaged and enclosed ammonia heating and cooling systems (L & R).



2008

Nestlé reiterates commitment to natural refrigerants and states that HFCs such as R134a were wrongly presented by their backers as long-term alternatives to CFCs and HCFCs.

Prototype CO₂ ice cream chest freezer fails to meet efficiency requirements.

2010

Consumer Goods Forum (CGF) adopts its first resolution to replace HFCs with natural refrigerants.

2011

Nestlé's first hydrocarbon-based ice-cream chest freezer.

2014

All Nestlé's new ice-cream chest freezers in Europe are HFC-free.

2015

All Nestlé's new ice-cream chest freezers worldwide are HFC-free.

2016

All Nestlé's new island and upright freezers worldwide are HFC-free.



From left: Dirk Lilie (Bussigny Data Centre - Technical Manager), Vincent Grass, Nathalie Gingras-Fleuti (Bussigny Data Centre Site Manager) and Javiera Charad Wilckens (Project Manager - Environmental Sustainability).

► The renaissance of CO₂

Nestlé's natural refrigerants journey begins in 1986 – three years ahead of the entry into force of the Montreal Protocol on Substances that Deplete the Ozone Layer in 1989 – when the company began to replace CFCs and HCFCs with ammonia. "At that time, we focused our efforts on our biggest plants, deciding to move from CFCs directly to ammonia. Later, we extended our use of natural refrigerants to the replacement of HFCs in smaller systems," Grass says.

In 2000, Nestlé turned to natural refrigerant CO₂ for the first time. At a factory in Beauvais, France, it replaced 15 tons of CFC R13 installed in the 1970s with an ammonia/CO₂ cascade system in which the CO₂ circulates without compression. "This was a renaissance of CO₂. It had been used at the turn of the century, but for over 50 years it had not been used at all," Grass says.

What is driving Nestlé's phase-out of HFCs? "In many of the countries in which we operate, there is no regulatory deadline to change. But the day the units don't match capacity any more, we need to switch to another refrigeration solution," Grass says.

Nestlé's long experience with natural refrigerants makes them the obvious choice. Listening to Grass roll back the years, it soon becomes clear that strength of personality among key individuals has been at the heart of what Nestlé is trying to achieve since the very beginning. "My predecessor's predecessor, Holm Gebhardt, was Nestlé's chief refrigeration engineer and did a lot of work on natural refrigerants," he says.

Gebhardt helped to convince not just Nestlé but the wider world that natural refrigerants are viable alternatives to f-gases. Gebhardt was one of the founders of natural refrigerants advocacy group Eurammon in 1996.

In 2000, Gebhardt co-founded the now-defunct Carbon Dioxide Interest Group – bringing together manufacturers and end users – which blazed a trail by raising awareness of CO₂ technology's potential.

"This is why Nestlé is already above 90% natural refrigerants in industrial. We started this journey a long time ago. We've always been convinced that natural refrigerants are the right way to go," Grass says.

Vincent's own background is in refrigeration. He counts spells at Axima and Johnson Controls on his CV. "I did some projects for Nestlé while I was on the supply side. Paul Homsy is my immediate predecessor. Of the seven years I've been at Nestlé, I spent six years working with Paul. He was in charge of refrigeration globally. When Paul retired, I took over from him," Grass says.



Main entrance to one of the ammonia engine rooms, with chilled water piping connected to a water-side economiser.

Data centre, Bussigny municipality, Vaud canton, Switzerland

- ▶ Nestlé's biggest and most important data centre worldwide.
- ▶ Cooling is required for the servers and server room.
- ▶ Six ammonia chillers (three running; three redundant). Total capacity: 6.5 MW.
- ▶ Maintenance staff available 24/7. Should one of the machines fail, an alarm will sound and maintenance staff will be on site within 30 minutes.
- ▶ Oversized adiabatic coolers can operate dry to reduce water consumption.
- ▶ Free cooling effect: when the ambient temperature falls below 11°C, the water that circulates in the data centres begins to be cooled in a water-side economiser.



Low-charge ammonia chiller (Chillpac product from Sabroe).

Nestlé's industrial processes require negative temperatures, sometimes as low as -50°C, for certain applications. Nescafé coffee, for example, is freeze-dried, with the water removed by sublimation. The company also requires freezers for its ice cream and frozen food brands. Indeed, there are opportunities to adopt natural refrigerants throughout the business.

A succession of world firsts

In 2001, Nestlé opened the world's first large NH₃/CO₂ cascade system to use compressed CO₂, built in cooperation with Star Refrigeration. It replaced an R22 system at Nestlé's coffee factory in Hayes, UK.

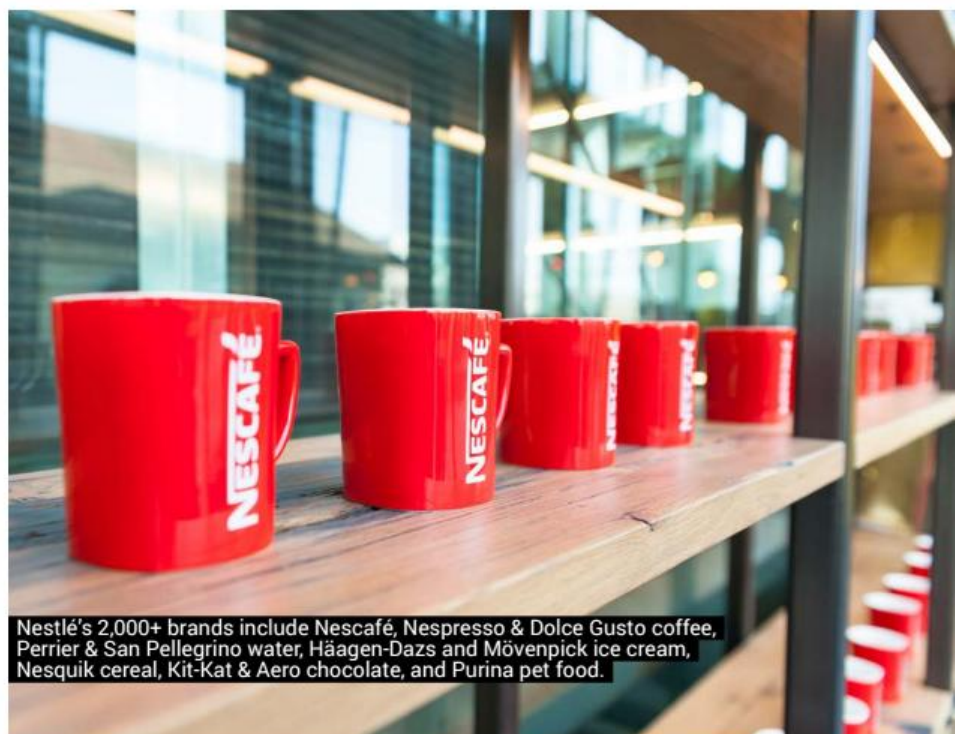
"The valves for CO₂ did not exist at that time. HERL was a valve manufacturer in Germany back then, and they developed the valves for us," says Grass.

New milestones have steadily been reached. In 2005, Nestlé commissioned its first chillers using hydrocarbons as the refrigerant (R290), in a confectionery factory converted to natural refrigerants in York, UK. "We couldn't hook everything up to the same system, so this is where we started to use hydrocarbon chillers – using water or glycol for the end uses," Grass says.

In 2006, Nestlé installs the world's first CO₂ ice cream freezer, in its factory in Bangchan, Thailand. "When you manufacture ice cream in a factory, you use a freezer in which you start to freeze the mixture. In 2006, this equipment did not exist for CO₂. We worked with suppliers to develop the first one," Grass says.

All Nestlé's new ice-cream freezers now use hydrocarbons, either propane or isobutane. "We see good efficiency with hydrocarbons compared to HFCs. It's a significant difference," says Grass.

Nestlé first used a hydrocarbon-based ice-cream chest freezer in 2011. Since 2014, all the company's new ice-cream chest freezers in Europe have been HFC-free. This policy was extended worldwide in 2015. Since 2016, all its new ice-cream chest, upright and island freezers have used natural refrigerants worldwide.



Nestlé's 2,000+ brands include Nescafé, Nespresso & Dolce Gusto coffee, Perrier & San Pellegrino water, Häagen-Dazs and Mövenpick ice cream, Nesquik cereal, Kit-Kat & Aero chocolate, and Purina pet food.

Moreover, Nestlé is a member of the Consumer Goods Forum (CGF), which brings together over 400 consumer goods manufacturers seeking to pursue more sustainable business practices. In October 2016, the CGF Board passed a resolution committing its members to deploying natural refrigerants wherever possible, effective immediately. "In markets where barriers to deployment currently exist, CGF members committed to moving to natural refrigerants in new equipment as soon as possible and by no later than 2025," Grass says.

By 2020, all new proprietary cold beverage dispensers of Nestlé Professional will use natural refrigerants.



Accelerate Europe at the Nescafé Factory (Orbe).

Nescafé factory, Orbe municipality, Vaud canton, Switzerland

- ▶ Uses natural refrigerants throughout production process.
- ▶ NH₃/CO₂ plant for positive and negative temperature cooling. Operating at -54°C for the lowest temperature use (2°C above CO₂ triple point)
- ▶ Hydrocarbon chillers for indirect air conditioning of production areas.
- ▶ Working for Axima at the time, Grass was in charge of the CO₂ side of the installation when it was commissioned in 2003. "The ammonia is confined to this machine room and on the roof in evaporative condensers that reject the heat. The CO₂ is distributed to all the end uses we have on site across the different floors of production. The cold room can reach -50°C, at the limit of what CO₂ can achieve," he says.
- ▶ "We've confined the ammonia to the one room you visited, and to the condensers on the roof. For many years, we also had another ammonia plant for the oldest part of the factory. As we don't have any cooling needs except air conditioning in this part of the factory, we replaced the ammonia system with air-cooled hydrocarbon chillers located on the roof," says Lukas Binggeli, energy engineer at the Orbe factory.

Brewing up a Nescafé

Proud to show refrigeration technology at work on the occasion of *Accelerate Europe's* visit, Grass clearly enjoys the more hands-on parts of his role at Nestlé. "My engineering background is what got me this job in the first place. But at the end of the day, there's a balance to be struck – you can also do a lot in an office!" he says.

"It's great to have had both experiences. I know how it works on the supplier side and I have been exposed to the servicing side, so I can bring these insights to the customer side of things too. I am making the best of my experience," Grass argues.

"When I talk to suppliers, they like it because they're talking to somebody who understands. Together we can achieve more," he says.

Upon arriving at the factory, the coffee that will become Nescafé – arguably the world's most recognisable coffee brand – is cleaned of stones. It is roasted and then ground. "Once ground, it goes into a big coffee machine to capture the aroma. We evaporate some of the water, concentrate all the solids, and then we start to cool it. Then it becomes more viscous, and goes into a continuous air blast freezer where the product is frozen," Grass tells *Accelerate Europe* at the production site in Orbe municipality in the Swiss canton of Vaud, a 40-minute drive from Nestlé's headquarters.

"Once it has been frozen, we grind it again. Then it goes into a vacuum chamber in which the ice turns directly to vapour without first passing through the water stage – thanks to the process of sublimation. You need a cooling system to capture the moisture and remove it from the coffee. It is then filled in and packed into jars. This is the Nescafé freeze-dried soluble coffee production process," he says.

Competing with HFCs

Asked whether Nestlé has the internal expertise to make the switch to natural refrigerants, Grass says, "we have to use suppliers. We work with the key industry players around the world". Jaggy goes further: "We depend 100% on them for the execution."



Ammonia engine room with fixed and variable-speed driven screw compressors. Two compressors are driven by permanent magnet synchronous motors. Nescafé Factory (Orbe).

Assessing the performance of Nestlé's enormous asset base helps the company's suppliers improve their systems. "Worldwide, we have over a thousand ammonia compressors running at any one time. Thanks to this asset base, we see the issues," says Grass.

"In developed countries, the availability of service technicians is quite good, though it depends where you go. Elsewhere in the world, training can be a big issue. In a number of developing countries, if you want to install an ammonia chiller, then finding technicians and operators who already have experience of ammonia is a challenge. You'll have to train them," he says.

"Alone, we can't do much to change this. We pushed manufacturers to open service centres in remote areas, because we told them that we're not ready to pay for overseas assistance every time," Grass admits.

"For component manufacturers, offering training is potentially a big opportunity for their business model. There is a huge shortage of training facilities," he argues.

Another obstacle to wider use of natural refrigerant-based technologies is the cost gap with HFCs. "Non-natural systems often tend to be cheaper to acquire. This is one of the biggest challenges today. We have to continuously fight the battle of convincing our people that it still makes sense to do this, even if it would be cheaper to do something else," says Jaggy.

"We've seen some reduction. When we installed the ammonia heat pump in the Nest [Nestlé's discovery centre in Vevey], I was surprised because it was the first time that I had seen an ammonia system at the same price as an HFC system. It's more efficient and it is cost-competitive, so there was nothing else to say!"

"The efforts we're making save us a lot of money too. Yes, the initial investment may be more, for example after budgeting for safety considerations. But an industrial ammonia plant usually lasts for 30-40 years. When we opt for ammonia, we know there won't be any deadlines to phase out or replace it later," Jaggy says.

Telling the natural refrigerants story

Most of Nestlé's natural refrigerant-based technologies are put to use behind the scenes in its factories. Opportunities to communicate about this to consumers are limited. But ice-cream freezers in shops are one area where the company can reach out to customers more easily.

"We're working with our ice-cream business to put a logo on our freezers featuring a QR code that customers can scan to access information about natural refrigerants and their benefits," says Javiera Charad, project manager



CO₂ engine room with HPC 108S reciprocating compressors from Sabroe (JCI) operating at -54°C. Nescafé Factory (Orbe).

— environmental sustainability at Nestlé. A Chilean with an engineering background, she has held her current role for five years. Previously she worked on supply chain issues and in marketing for Nestlé in her homeland.

Grass is optimistic about what the future holds. “When I was on the supplier side, I had to sell units. It was heart-breaking trying to sell solutions that you’re convinced are the future, and then seeing your client take the short-term solution. Unfortunately this kind of decision-making often shifts towards the short-term approach.”

“This job gives me an opportunity, as a human being, to take action. And so, I decided to join. Now I’m on the customer side, and I can make change happen. In the seven years I’ve been here, we’ve done a lot. I’ve had a lot of fun. And we still have a lot to do.”

The future of Nestlé would appear to be in good hands. ■ [AW](#)



Born in Switzerland Nestlé at home with NatRefs

Accelerate Europe reports from Vevey.

Group sales in 2016:
CHF 89.5 billion
(€82.5 billion)*

Nestlé sells its products in
191 countries.

In Switzerland, over
115 different nationalities
work directly for the Nestlé Group.

Nestlé headquarters, En Bergère, Vevey, Lake Geneva north shore, Switzerland

- ▶ In summer, the building is refreshed by the water from nearby Lake Geneva through radiant cooling panels attached to the ceiling.
- ▶ As part of an on-going refurbishment project to be completed by 2020, two ammonia heat pumps for heating and cooling will be added and will save an estimated 1,500 tonnes of CO₂-equivalent emissions per year.
- ▶ Small subcritical CO₂ plant on site for the top management's restaurant, designed by Frigo-Consulting.

Nestlé Shop, Orbe municipality, Vaud canton, Switzerland

- ▶ Uses 100% natural refrigerants: CO₂ and hydrocarbons.
- ▶ The CO₂ system, a Green & Cool condensing unit, is located outside.
- ▶ All wall-mounted display cabinets in Orbe store are connected to the CO₂ system, and the island cabinets use propane. The chest freezers use propane too.
- ▶ No heating required. Heat rejected by cabinets is sufficient to heat shop in winter. A CO₂ heat pump lies dormant, just in case.

Over **one billion products** across
over **2,000 Nestlé product** lines
are sold every day.

Nestlé employs over
328,000 people in
189 countries.

Operating profit in 2016:
CHF 13.7 billion
(€12.44 billion)*

Wellness Centre, Nestlé headquarters, Vevey, Switzerland

- ▶ The building houses a fitness centre, medical centre and restaurant.
- ▶ NH₃/glycol/CO₂ plant located in the basement.
- ▶ The secondary loop is glycol. The glycol is cooled by ammonia, and the glycol is used to condense the CO₂. The glycol is also distributed to all positive temperature uses.
- ▶ CO₂ subcritical system used for low temperature (freezing) in the cold rooms, and glycol goes up into the display cabinets in the public areas.
- ▶ The ammonia is confined to the machine room in the basement. Safety discharge valves discharge it on the roof.

CPW innovation centre, Orbe municipality, Vaud canton, Switzerland:

- ▶ Cereal Partners Worldwide (CPW) is a joint breakfast cereal venture between Nestlé and General Mills.
- ▶ The Orbe building, built in 2010 and inaugurated on 1 February 2011, is CPW's R&D headquarters.
- ▶ First industrial building in Switzerland to be LEED Platinum-certified.
- ▶ Home of R&D and piloting new processes.
- ▶ Built of wood, with a vegetal roof.
- ▶ Air refreshed with river water.
- ▶ Heating provided by GEA ammonia heat pump.
- ▶ CO₂ system provides cooling.
- ▶ Positive and negative temperature cold rooms for trialling new products and processes.

Alimentarium, Vevey, Lake Geneva north shore, Switzerland

- ▶ Nestlé's nutrition museum, the Alimentarium, was extensively refurbished to mark the company's 150th anniversary. It reopened on 2 June 2016.
- ▶ The building is air-conditioned by an indirect hydrocarbon chiller.



CO₂ and hydrocarbons take over EuroShop

At the world's biggest retail trade fair, with 113,000 visitors and 2,368 exhibitors, it was clear that CO₂ and hydrocarbon solutions were the main focus for commercial refrigeration manufacturers.

—By Charlotte McLaughlin, Andrew Williams & Eda Isaksson

Many exhibitors and visitors to EuroShop – held at the Messe in Düsseldorf, Germany from 5-9 March 2017 – commented on the widespread use of CO₂ and propane for food retail, with many believing these natural refrigerants will become the global standard for commercial refrigeration.

“There is only really CO₂ and propane here [at EuroShop] – not much else,” Michael Nagler, business development manager for CO₂ applications at German-based compressor manufacturer GEA, told *Accelerate Europe*.

Ümit Radanli of Turkish cabinet and systems manufacturer Kaplanlar Cooling – a 30-year-old company based in Turkey – agrees. “Both our company philosophy and market trends are leading us to work with natural refrigerants. With each oncoming year, we will be producing more and more products with CO₂ and other natural refrigerants,” Radanli says.

In a further indication of the move towards natural refrigerants, a recent report on global trends in refrigeration and air conditioning by Danish giant Danfoss predicts that by 2025, CO₂ and propane will have become the only real options for light commercial and commercial applications worldwide.



CAREL Group Managing Director
Francesco Nalini speaking at EuroShop

‘Natural refrigerants at high efficiencies in all latitudes’

Italian multinational CAREL is confident that natural refrigerant-based systems can now operate efficiently in all climates.

Until now, users of natural refrigerant-based technologies in food retail have sometimes been forced to “compromise” or accept “trade-offs” on issues such as efficiency or range of applications, admits CAREL Group Managing Director Francesco Nalini.

“We believe that these trade-offs are very quickly being overcome. I see a very bright future for natural refrigerants in Europe, because it’s now possible to have natural refrigerants at high efficiencies in all latitudes,” Nalini says.

In this spirit, CAREL – together with Carrier – has extended its range of EmJ modulating ejectors, helping to bring CO₂ transcritical systems to all climates in all store formats.

From small convenience stores to large supermarkets, transcritical CO₂ systems can now be optimised to operate in warmer climates. “The EmJ modulating ejector has been designed in six different sizes, so as to offer an effective response for all store formats,” says Nicola Pieretti, application manager at CAREL.

As technological improvements continue to bring CO₂ transcritical technology to warmer climates than previously considered viable, Alessandro Franchin – area export manager at SCM Frigo for Central Europe, Spain, Portugal and Ireland – reports impressive growth in the Spanish and Portuguese markets.

“There has been a lot of movement and more requests in Spain than a year ago,” Franchin told *Accelerate Europe* at EuroShop 2017.

“ I see a very bright future for natural refrigerants in Europe, because it’s now possible to have natural refrigerants at high efficiencies in all latitudes. ”

– CAREL Group Managing Director
Francesco Nalini

SCM Frigo also sees ejectors as a vital means of adapting CO₂ systems to warmer climates. "We are testing a liquid-vapour ejector at the moment in a Luxembourg supermarket," says Franchin.

After receiving the first results in April, SCM Frigo plans to use the ejector in more installations.

Another system manufacturer, Arneg – whose huge booth at EuroShop dominated Hall 16 – presented its new CO₂ rack using a Danfoss ejector at the show.

"We have the two technologies that make CO₂ possible in warm climates – the ejector and parallel compression," says Arneg's Chiara Tognoli.

Other companies showcased different solutions for 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.

The new 'Evalift' solution, from TEKO, is an example of such technology. It is a control component for increasing the evaporating temperature in CO₂ cooling systems.

Alexander Wirsching, the company's technical manager, argues that Evalift can be more effective than using liquid ejectors. "It can be used not just in medium-temperature but also in low-temperature applications, delivering very high efficiency improvements," Wirsching says.



"It's a good alternative to ejector technology, because it's easier for installers and maintenance personnel to understand and to handle," he argues.

The Epta Group has also come up with its own answer – the Full Transcritical Efficiency (FTE) solution. "Eliminating superheat by flooding the evaporators is the key to increasing efficiency in warm climates," Francesco Mastrapasqua, the group's sales and marketing manager for refrigeration systems, told *Accelerate Europe*.

The evaporators of MT (positive) cabinets are overfed. "We operate positive cabinets without any superheat," Mastrapasqua explains.

By operating all the positive cabinets with flooded evaporation technology, the patented FTE solution – based on adding an intelligent liquid receiver – allows the operating temperature of the cabinets to be increased.

The liquid is delivered from the main liquid receiver to the positive and negative cabinets. "We introduce an additional low-pressure receiver to collect the liquid that's coming out of the empty cabinets. Flooding the evaporators means having a mix of liquid and vapour," Mastrapasqua explains.

The solution works all year round, in all climate types. Testing carried out over a two-year period in Italy demonstrated that it is capable of delivering a stable efficiency gain of around 10%, he argues.

Green & Cool's CO₂Y MC

With the help of global distributor Beijer Ref's export network, SCM Frigo is confident of selling 1,000 units in the first year and 3,000 by the end of the second. "It is a simple plug 'n' play unit. All the customer has to do is fit the pipe and they are ready to work," Franchin says.

Emerson is also entering into this ever more crowded marketplace.

Sylvain Lamy, director of refrigeration marketing at Emerson Commercial & Residential Solutions, believes it is necessary to be flexible.

The company offers both centralised and flexible CO₂ systems as its chosen means of complying with the EU F-Gas Regulation. "So we also promote distributed systems of multiple condensing units," Lamy says.

At Chillventa 2016, Emerson debuted its new range of EazyCool outdoor plug 'n' play condensing units for medium-temperature CO₂ transcritical refrigeration applications. The three models – which are currently undergoing field trials ahead of their official launch later this year – offer cooling capacities ranging from 9-15 kW.

At the heart of the unit is the Stream CO₂ compressor, an inverter that modulates compressor frequency to adapt to the cooling load, and a system controller. The controller features Modbus communication and supports cloud monitoring.

"Inside our condensing units, you'll find our flow controls, our electronics, our compressors – everything to do with a refrigeration system is inside," he explains.

Advansor has launched a very different CO₂ refrigeration system for convenience store formats – the compSUPER XXS mini-booster. "This is a new development for us. It's at a very early stage. We only shipped the first units out of our factory this week," Advansor Managing Director Kim G. Christensen told *Accelerate Europe* in Düsseldorf.

► More options for small store formats

In Europe, the market for smaller applications has been slower to take off than in places like Japan where the trend towards small stores has been particularly strong. But this is now changing, as European shoppers flock to smaller stores in urban centres.

European companies are keen to tap into this trend. Advansor, SCM Frigo, Green & Cool (part of Carrier UTC), SANDEN Environmental Solutions and Arneg have all pursued their own CO₂ units for convenience stores.

In Düsseldorf, Green & Cool was exhibiting its larger CO₂Y MC unit.

Green & Cool describes the CO₂Y MC – its new CO₂ condensing unit for larger convenience stores – as the multi-compressor sibling of the smaller CO₂Y unit. The latter was formally launched at Chillventa last October.

The CO₂Y MC comes in various sizes, using from two to five rotary hermetic compressors. The multi-temperature solution can also cover applications from 10 to 40 kW.

SCM Frigo also showed an updated version of its transcritical condensing unit – the CUBO₂ Smart. "We are using the DC brushless Toshiba compressor," SCM Frigo's Franchin explains.

Kaplanlar Cooling's 'CORE' transcritical CO₂ solution

Advansor began as a supplier of transcritical CO₂ racks for supermarkets. It subsequently launched the ValuePack line for smaller store formats.

The new compSUPER XXS transcritical CO₂ unit has a cooling capacity of 30 kW at -10°C and a freezing capacity of 4-5 kW at -30°C.

The system sees Advansor use rotary compressors for the first time. The company normally uses reciprocating compressors. "The intention is to use smaller compressors. It's a multiple compressor system using a brushless DC compressor from Toshiba, allowing us to deliver the capacity that stores need," Christensen says.

Kaplanlar launched a similar system at the show. The 'CORE' system consists of a standard CO₂ booster pack, a gas cooler with an integrated ambient scavenge evaporator, plate heat exchanger, water pump, valve sets, and a controller.

Ümit Radanlı, refrigeration engineering coordinator at Kaplanlar, told *Accelerate Europe* in an exclusive interview that despite its compactness, the system is easy to maintain and user-friendly.



“ We think propane is the best solution on the market for supermarket units. ”

— Reinhold Resch, AHT Cooling Systems

Cabinets – another natural refrigerant success story

In a sign of the growing global popularity of hydrocarbons, many manufacturers have also seen demand for propane-based cabinets rise.

Austrian company AHT already has over one million propane-based food and beverage retail cabinets in operation worldwide.

"We think propane is the best solution on the market for supermarket units," says Reinhold Resch, AHT's vice-president (research and development).

He is convinced that independent plug-in cabinets are the way to go. AHT's plug-ins boast leakage rates of less than 0.1%. Opting for a plug-in solution dispenses with the need for both external production of the cold and the secondary circuit to transport it.

Turkish manufacturer Ugür, meanwhile, produces around 6,000 propane fridges per day; largely thanks to demand from "big suppliers like Pepsi, Unilever and Coca-Cola," Özgür Erkek, the company's export director, told *Accelerate Europe*.

This success with global beverage companies – who often provide distributors such as supermarkets and convenience stores with the fridges that display their wares – has allowed Ugür, established in 1954, to become operational in 142 countries.

"Most of Europe and the US has gone down the hydrocarbons route but in some parts of South America and Asia, this is taking a while," Erkek says.

In a bid to enter the lucrative supermarket sector, Liebherr showcased its new line of energy-efficient chest freezers using R290 for larger sizes and R600a for smaller offerings.

The firm is confident its new products will prove popular. "We are 20% better than the competition in terms of energy savings," insists Heiko Schulz, international sales manager for food retail at Liebherr.

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Competition between natural refrigerants increasing

Competition between different natural refrigerants is also increasing. Some European manufacturers are opting for CO₂ in their cabinets, with the help of SANDEN Environmental Solutions.

Tapping into the trend towards flexibility in European food retail, the Japanese company is pursuing a 'Sanden inside' strategy of fitting CO₂ refrigeration units into cabinets built by Hauser, Arneg and TEKÖ.

"The strategy is to deploy our CO₂ solutions as widely as possible – in commercial refrigeration and also for heating," Olivier Campy, chief operating officer (EMEA) at SANDEN Environmental Solutions, told *Accelerate Europe*.

The 'Sanden inside' strategy sees Sanden install its equipment in different types of cabinet. "What we're showing at our partners' booths is that we're deploying this strategy with different condensing units, whether it's remote units or plug-in units, or air-cooled or water-cooled – basically, any solution for small or medium-sized stores," Campy says.

By combining Sanden's CO₂ technology expertise with the knowhow of the cabinetmakers, Campy hopes to speed up the rollout of smaller CO₂-based cooling systems in Europe.

German regulation driving heat pump market

Elsewhere, "heat pumps will become standard" domestic HVAC&R solutions due to new German regulations governing the use of fossil fuels in boilers, according to GEA's Nagler.

On 1 January 2016, new rules on constructing new buildings entered into force. New buildings in Germany must now meet a maximum primary energy requirement that is 25% lower than the previous threshold.

It does not explicitly ban fossil fuel heating systems, but in practice it would be nearly impossible to meet the new requirements with an oil or gas boiler. This means that people will have to find alternative ways of heating their homes. Heat pumps are one way of achieving this.

Nagler believes this will create opportunities for CO₂ heat pumps. Speaking at the trade fair, he cited the example of Switzerland, where "CO₂ heat pumps have been used a lot".

As the sun set on EuroShop for another three years, it seemed clear that natural refrigerants are primed for growth in heat pumps as well as refrigeration in the years to come.

■ CM, AW & EI

Schulz cites the company's investment in research and development at its energy department as a key driver of cost savings for customers.

When Liebherr began to target the supermarket sector, it knew there would be a trade-off between energy efficiency of the product on the one hand and visual appeal on the other.

"I think we have really found the maximum possibility between the display [through the glass freezer door] and energy efficiency," Schulz says.

He cited the positioning of the block condenser and the fan key as playing central roles in optimising the thermodynamics.

Schulz believes hydrocarbons are the clear answer for plug-ins. "There is some activity with CO₂ [as a refrigerant for plug-in units] but I think the technology is not really ready for the market yet," he says.

"Hydrocarbon refrigeration will be the leading technology," Schulz believes. The firm is currently growing in Southeast Asia and plans to increase sales there.

True Manufacturing, an American firm with a strong presence worldwide, would appear to agree. It will move its entire production portfolio to 100% hydrocarbons by 2019.

"At the moment we are two-thirds through the transition from R134a and R404A to R290," says Kurt Bahnmaier, True's marketing coordinator for Europe.

The transition to R290 has seen True invest heavily in R&D over the last five years.



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European vending tiptoes towards natural refrigerants

At Vending Paris, taking place from 15-17 March, some manufacturers had begun the process of testing hydrocarbon and CO₂-based vending machines and bottle coolers. But not many had attempted a full conversion yet – opening the door for innovators to capture the market. *Accelerate Europe* reports.

—By Charlotte McLaughlin & Andrew Williams



Vending Paris 2017, Paris Expo, Porte de Versailles, Paris, France

One thing is clear: vending machine manufacturers will eventually have to switch to alternatives to HFCs in Europe. The new EU F-Gas Regulation bans the use of HFCs in new plug-in commercial refrigeration equipment as of 2022.

Many at the Paris Expo centre in the Porte de Versailles area of the French capital were already preparing to move, as the deadline draws nearer.

"We hope the F-Gas Regulation will trigger a change soon," Steven Van Holsbeek, sales manager at the Benelux branch of SandenVendo, a division of SANDEN Europe, told *Accelerate Europe*.

Marco Baron, sales director at Italian vending machine maker FAS International, says: "We are currently testing isobutane and CO₂. We will eventually move to this, but at the moment it is difficult."

Much of this hesitation among vending equipment manufacturers can be put down to a lack of familiarity with natural refrigerant component providers. "We need to make sure we have the right compressors," Baron says.

Franck Noeuvéglise, from Brita France, says the company is similarly testing R290 water coolers at its base in Frankfurt, Germany. "We want to make sure the performance and energy efficiency of our machines remains the same," he says.

A growing market for natural refrigerants

Importantly for Brita, the cost of environmentally friendly solutions is not a factor. The company's water coolers are marketed at a higher price point than the average – so if they decide to switch to natural refrigerants soon, they can do so easily, according to Noeuvéglise.

Vending machine manufacturers that have committed to using natural refrigerants are already experiencing success in Europe and beyond, thanks to the unique selling point of their products.

Having recorded growth of 30-40% every year for the past four years, Italian water vending machine and water cooler manufacturer Blupura expects to grow by an even more impressive 43% in 2017 – largely thanks to its commitment to future-proof natural refrigerants.

"We've moving our entire production to propane (R290). Our strategy is 100% R290," Massimiliano Santicchia, export manager at Blupura Srl, told *Accelerate Europe* at the company's Vending Paris booth.

Mistral, another company at Vending Paris, realises that it will need to move this way too. "We are thinking of using R600a and R290, and moving our portfolio this way by 2020," a Mistral spokesperson told *Accelerate Europe*.

Blupura – headquartered in Recanati, Italy – sees its use of natural refrigerants as a central pillar of its wider sustainability efforts. The company's units are manufactured from stainless steel and aluminium and target the hospitality, office, and domestic markets. They are also popular in schools and hospitals.

In 2017, it intends to cease manufacturing water coolers based on isobutane (R600a) in favour of focusing 100% on propane. "R290 is better for water coolers," Santicchia argues.

In Paris, Blupura exhibited its new stainless steel 'COOL1' water dispenser for canteens, schools, gyms and other self-service areas. The unit uses propane as the refrigerant and gives customers the option of topping up their water bottles with either still or sparkling water.

Luca Constantini, CEO and co-founder of Blupura, told *Accelerate Europe* how design had played a central role – alongside sustainability – in the company's success over the past nine years.

"Since the beginning, we've focused on design, and above all, on environmentally friendly details. Blupura is the first company in the water cooler industry to use natural refrigerants," Constantini says.

"Since day one, our water coolers have used R290. We were and still are pioneers in Europe and the United States for using hydrocarbons in the water cooler industry," he says.

CO₂ competing with hydrocarbons

Many players are also looking at CO₂ as a solution for the vending market. "We hope to move the vending market to CO₂ in Europe," SandenVendo's Van Holsbeek told *Accelerate Europe*.

Helping to move the European refrigerated vending market towards climate-friendly technology options is not without its challenges for this CO₂-committed company.

Indeed, at Vending Paris, SandenVendo is advertising but not exhibiting its line of CO₂-cooled food and drinks vending machines.



Yoshitoyo Takeuchi, director and COO, Sanden International (Europe) Ltd.

Moving beyond Europe's shores

"The European vending market is very conservative. Customers are less familiar with CO₂ technology," Van Holsbeek notes.

He contrasts this with the Sanden Corporation's experience in Japan, where "customers are more familiar with CO₂ technology – largely thanks to the influence of big end users like Coca-Cola," he points out.

In Japan, the Coca-Cola Company is currently committed to using natural refrigerants such as CO₂ in its vending machines and relies on Sanden equipment to achieve the switch to CO₂ there.

Nine years have elapsed since Blupura launched in 2008. Since then, the company has expanded its activities beyond Europe to the United States. "We feel that natural refrigerants are our mission," Santicchia says.

Blupura USA Inc. was only founded in 2014, with a warehouse based in Miami and a business developer in North Carolina. In January 2016, it became the first company to receive authorisation from the U.S. Environmental Protection Agency to sell R290-based water coolers in the United States.

Santicchia is optimistic that propane-based equipment will prove a hit with environmentally conscious Americans and is unconcerned by the change of administration in the White House. "We've been marketing these products for years," he says.

Indeed the company is looking to expand its global reach. "We're targeting new markets in Australia, New Zealand, Taiwan and the Middle East," Santicchia says.

With market expansion on the cards, Blupura opened new production facilities totalling 1,400m² in February 2017.



Cola-Cola helping to drive natural refrigerant uptake

In an exclusive interview with *Accelerate Europe*, Yoshitoyo Takeuchi, director and COO of Sanden International (Europe) Ltd., explained how the Coca-Cola Company is helping to drive uptake of natural refrigerant-based technologies.

"We're working with Coca-Cola, and other vending machine manufacturers who use our CO₂ compressors, to challenge the next generation of refrigerant changes," said Takeuchi, who is in charge of business sales and marketing for vending and retail systems.

One of these companies is Sielaff, which is using Sanden CO₂ compressors for its vending machines at the request of the Coca-Cola Company.

"It has been nearly two years now [that we have worked with CO₂] and it's mainly done for Coca-Cola," Peter Bode, key account manager at Sielaff, told *Accelerate Europe*.

Bode believes that the Coca-Cola Company's announcement that it is also looking into hydrocarbon technologies for smaller applications may move the natural refrigerant market still further.

"At the moment we are looking into hydrocarbon compressor manufacturers," he says. ■ **AW & CM**



David Irvine, European Vending Association

Manufacturers aware of F-Gas Regulation...

The European Vending Association (EVA) has actively informed its members about the new EU F-Gas Regulation and believes most companies are aware of its implications and doing something about it.

David Irvine, communications and public affairs manager at the EVA, says some vending equipment manufacturers have begun to phase down HFCs, but that the price of natural refrigerant-based systems continues to represent a barrier for others.

"This is a very cost-sensitive industry," Irvine explains.

He points out that the new F-Gas Regulation is giving manufacturers an incentive to switch to natural refrigerants. "There was no real incentive to pursue this option [...]. Now a lot more is expected," he told *Accelerate Europe*.

...but change takes time

The EVA realised that to encourage vending equipment manufacturers to use natural refrigerants, it needed to work with industry to develop a cost-effective way of making the systems easier to use.

With funding from the European Commission and help from manufacturers in the vending and commercial refrigeration industry, the EVA developed an expansion valve to reduce the energy consumption of chilled vending machines and commercial refrigeration systems.

Under the EXPAND Project, technical development by Re/Gent, New Wave Innovation, Inray Solutions, Vending Marketing, Fricon and Novum – a mixture of companies and research groups – played a key role.

"This expansion valve reduces energy consumption by 20%, which is quite significant," Irvine says.

The project members believe the valve will provide an efficient and cost-effective method for the industry to make the required shift to natural refrigerants.

"Interestingly, [the valve] can be used for hydrocarbons and CO₂, and not just for vending machines but other industries as well – like commercial cold appliances," Irvine says.

The valve will be presented to EVA manufacturer members this year, and is designed to be manufactured cheaply and replicated by EVA members easily.

Vending will be primarily CO₂

Similar to what has already happened in Japan, vending is primarily looking to use CO₂ to keep food and drink cold, not hydrocarbons.

"The general position is to go with CO₂, not hydrocarbons," he says.

Some people cite the risks of a spark as justification for this, according to Irvine. "But saying this, some manufacturers are keeping the door open for hydrocarbons," he says.



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Setting sail for natref shores

From ammonia heat pumps for fish farms to propane chillers for fish shops, natural refrigerant innovations abounded at this year's Seafood Expo Global in Brussels.

—By Charlotte McLaughlin & Pilar Aleu

Manufacturers flocked to Brussels to showcase their ammonia, CO₂ and hydrocarbon systems for fisheries and fishing vessels at Seafood Expo Global, the world's biggest seafood trade fair, which took place on 25-27 April 2017.

South America, Asia rowing away from HCFCs

Industries in Chile, Peru and China are required to phase out R22 as part of their countries' HCFC management strategies, with the marine sector in these emerging economies increasingly turning to ammonia as a future-proof system.

Accelerate Europe spoke to FrioNordica Managing Director Per R. Samuelsen to learn more about how the Norwegian company's heat pump is being used in aquaculture in Chile and how its chillers are being used in Peru.

Aquaculture or the farming of fish has been substantially growing as an industry since the 1970s and now represents half of the total number of fish caught globally. Developing the fish quickly requires a warm growing environment. FrioNordica's ammonia heat pump helps farm fishermen in Chile to accelerate fish development.

The system uses seawater and a minimal amount of ammonia to heat or cool the fish farming pens, depending on the fish being farmed.

The heat pumps are similar to refrigerated seawater (RSW) systems in design but with a slightly different combination of materials. For seawater applications the heat exchangers are made with titanium, but stainless steel is used for freshwater.

The solution can be used for all aspects of aquaculture including chilling fish eggs, heating young fish, and processing. "We mainly focus on the salmon farming industry. This industry is bigger than anything else," Samuelsen explains.

In Chile and Norway the growth of Atlantic salmon is accelerated by using the heat pumps in a salmon hatchery.

The Norwegian company has developed low-charge ammonia chillers, on top of its ammonia heat pump, for fisheries' ice plants and RSW systems.

"We have a very low ammonia charge. It depends on the size of the system, but it is typically 80 kilos in one unit," Samuelsen says. "So that's very low, because a conventional system will have several hundred kilos. But it is important for the safety on board to have a small ammonia charge."

FrioNordica only works with ammonia. "We look at ammonia as safer than Freon systems [...]. You have to make a good plant and high specifications when you [install ammonia systems] and take care of the safety," he points out.

Samuelsen believes “companies who don’t think about being sustainable will be out of business in a few years”.

Sinro Freeze is another company focusing on sustainability. The company makes ammonia and CO₂ refrigeration systems for China and Europe.

“Currently 40% of our total production uses Freon,” Kim Li of Sinro Freeze told *Accelerate Europe*. In China, the company mainly focuses on ammonia/CO₂ and ammonia/glycol cascade solutions for larger systems, Li says.

Currently in China – in contrast to Europe – ammonia represents a safety issue for many installers and end users, according to Li. To turn around the Chinese market, Sinro Freeze often stresses to its final customer that “ammonia systems are 10 to 20% more efficient than HFC systems,” he says.

Ammonia still making a splash in Europe

Arnaud Girard of French cold storage and transportation company Capgel thinks, “ammonia will [continue to be] a standard system” for cold storage in Europe.

“We have 45 distribution centres in France all using ammonia,” says Girard. These are mainly used by the French seafood sector.

Frost is an Icelandic manufacturer of ammonia and CO₂ systems. “We install 50% of our systems in Iceland, in trawlers and on land,” Managing Director Gunmar Larsen told *Accelerate Europe*.

“We’re trying to reduce the amount of ammonia in our systems, so trawlers don’t need large machine rooms for the refrigeration system,” Larsen says.

He reports that Frost is no longer being asked to install HCFC systems.

Also latching on to the CO₂ trend is Danish company DSI, which retrofitted 16 DSI horizontal Freon plate freezers to CO₂ on Seattle-moored fishing vessel Alaska Ocean – owned by Glacier Fish.

This only required DSI to replace parts of the system. “We kept the plate freezers and replaced the hoses and refrigeration plates with ones suited for use with CO₂,” Peter Nygaard Christensen, the company’s sales director, told *Accelerate Europe*.

The installation has allowed the trawler to take advantage of CO₂. “They now have faster freezing times and they can now go down to -50°C if needed,” Christensen says.

He argues that with ammonia or Freon-based systems, the temperatures you can work with are fairly limited compared to the capabilities of CO₂.

DSI is hopeful that this marks a trend towards the adoption of CO₂, especially as R22 is increasingly phased out in the United States. “We do hope that all the new vessels built in the US will go towards CO₂,” Christensen says.

British manufacturer SRS Frigadon says it is making inroads into the marine sector. It is confident that demand for propane (R290) and propylene (R1270) chillers will grow in the fish processing industry as end users become more comfortable with these systems.

Darren Powlett, SRS Frigadon’s business development manager, says end users are more confident working with hydrocarbons than many system installers.

Powlett believes the refrigeration industry had been hesitant to adopt the company’s hydrocarbon chillers – which use Bitzer and GEA Bock compressors – due to the flammability of the refrigerant.

He argues that this is changing fast, with end users driving adoption of hydrocarbons. “It’s easier for us to send directly to the final customer,” Powlett says.

Propane chillers are used more for high temperatures, with propylene serving the low-temperature side.

SRS Frigadon recently installed a chiller at Peterhead fish market near Aberdeen, Scotland. The firm is also receiving orders from the seafood and fisheries sectors in the United States and Australia.

“In North America we have installed a chiller in the US. [Now in] Australia there is maybe one for shellfish [cold storage] in Perth Airport,” Eric MacGregor, managing director of Versatile Refrigeration – a supplier of Frigadon chillers in the US – told *Accelerate Europe*.

The marine sector, then, looks set to sail into the future with natural refrigerants. ■ CM & PA



FrioNordica's Managing Director Per R. Samuelsen

Spreading the natref message to Australia, New Zealand

HVAC&R industry leaders attending the second-ever ATMOsphere Australia 2017, held on 2 May at the beautiful Luna Park conference hall overlooking Sydney Harbour, discussed how the latest natural refrigerant-based technologies help to phase down HFC consumption.

—By Andrew Williams & Devin Yoshimoto

Following last year's inaugural ATMOsphere Australia conference in Melbourne, participants in this year's event were unanimous in their desire to raise public awareness of natural refrigerants and their contribution to a more sustainable HVAC&R sector in Australia and New Zealand.

"We need to work with all levels of the industry to see what levels of support are required. We need to work with you to see what the requirements are, what can be done, and who should be doing them. It's too early to make any promises. Let's work together on it," Patrick McNerney, director of the International Ozone Protection and Synthetic Greenhouse Gas Section, Department of the Environment and Energy, Australia, told the Luna Park audience.

Spreading the natural refrigerant message

Among the hot topics of the day among the 205 participants were the state of training, the need to boost collaboration, and the impressive progress of natural refrigerants in Australia and New Zealand over the past year.

"The biggest thing we can do for the industry is to have Australian society know that we exist and show them that it's a brilliant trade," said Steve Smith of TAFE NSW, a leading Australian provider of vocational education and training courses.

Kim Limburg, CEO of the Australian Refrigeration Mechanics Association (ARMA), encouraged attendees to engage with local educational institutions as individuals.

"Offer yourself, your experience, and your knowledge. Show them how exciting the industry is," she said.



End users pushing forward with natref systems

Challenges in rolling out natural refrigerant technology in Australia and New Zealand include the availability of components, ensuring there are enough trained technicians and installers, and the need to operate efficiently in the warm ambient climate.

End users and suppliers who presented at the conference showed a focus and determination in continuing to move forward with their natural-refrigerant installations.

"By 2020 we will install 10 natural systems. Our target is to reduce carbon emissions to 10% below 2015 levels. Natural refrigerants are going to be a key part of that mission," said Michael Englebright, head of engineering at Woolworths, a leading Australian retailer with stores throughout its home country and New Zealand.

Such rapid growth was strongly supported by the system and component suppliers in attendance.

"We think there will be around 40 supermarkets in New Zealand operating transcritical CO₂ by the end of 2017," said Brian Rees of McAlpine Hussmann, a leading supplier and installer of commercial refrigeration solutions.

Mike Baker, managing director of AJ Baker & Sons, was in agreement. "We believe we'll be up to 25 transcritical CO₂ system installations in Australia by 2020."

End users talked about the main benefits and drivers of their decision to adopt natural refrigerants.

Robbie Mayer, managing director of food importer and wholesaler F. Mayer Imports – whose Banksmeadow, Sydney plant is fitted with two all-CO₂ racks – said: "Our customers were impressed to know that we run a green refrigerant plant."

Tim Hill, director of construction for the Australian arm of US wholesaler Costco, remarked: "We would like to future-proof our installations going forward, as much as possible. Total cost of ownership is more important to us than initial cost."

These are exciting times, then, for natural refrigerants in Australia and New Zealand. ■ **AW & DY**

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The Church of Saint John at Kaneo, Lake Ohrid

Ammonia, CO₂ driving change in Europe

The organisers of the 7th IIR Ammonia and CO₂ Refrigeration Conference – held on 11-13 May 2017 in the Balkan town of Ohrid – dream that growing competition between both these refrigerants will deliver long-term natural refrigerant solutions.

–By Charlotte McLaughlin

The IIR Ammonia and CO₂ Refrigeration Conference takes place in Ohrid, a small resort town on the hilly shores of Lake Ohrid, one of Europe's oldest and deepest lakes.

Risto Ciconkov, president of the conference's organising committee, first proposed the idea to the International Institute of Refrigeration (IIR) back in 2005. Now in its 7th edition, the biannual event is growing strong.

"This conference is international, with participants usually coming from more than 35 countries. However, this event has an echo here and in neighbouring countries as well," Ciconkov told *Accelerate Europe*.

Prior to 1990, Eastern Europe traditionally used ammonia refrigeration technology for cold stores and in key sectors like food processing, breweries and the dairy industry. But with the end of the Cold War and the Montreal Protocol targeting CFCs, HFCs were looked upon as the future.

"The main reason was wrong information about ammonia technology being old. People said that new, modern HFC refrigerants should be used," Ciconkov explains.

He believes that hosting such a high-profile conference in Ohrid has helped to change this. He has been able to draw on his key contacts as a professor at the Mechanical Engineering University in Skopje.

"I convinced one investor here to build his meat processing factory and a big cold store with an ammonia/CO₂ system. More and more people involved in refrigeration now know about technologies with natural refrigerants thanks to this conference," he says.

To encourage more participants from developing countries to take part, the conference organisers work hard to keep costs down. "This is a unique IIR conference where about 40% of participants are from less developed countries," he says.

Professor Ciconkov is proud of the work that his small but efficient team has done over the past 12 years to prepare the seven conferences.

Traditionally, CO₂ has predominantly been used in commercial refrigeration. Now it is starting to expand to other sectors, including industrial refrigeration where ammonia has been dominant, according to Ciconkov.

Also, "some new research has paved the way for ammonia in smaller (commercial) systems, where CO₂ has been the emerging technology," he says.

If this leads to more competition between natural refrigerants, the professor sees HFCs and HCFCs playing an ever-decreasing role in industrial applications throughout the world.

"The competition between ammonia and CO₂ systems is desirable. Both systems are sustainable. It means long-term solutions," he points out.

The topics of the conference include modern ammonia and CO₂ systems, improving energy efficiency, technical guidelines and safety regulations.

"I would also emphasise the presentations by the keynote speakers: by Andy Pearson on 'Mega-trends in industrial refrigeration', and Pega Hrnjak and Robert Lamb, who cover low-charge ammonia refrigeration systems," Ciconkov says.

"On CO₂ technology, presentations by Armin Hafner on 'Integrated CO₂ systems for refrigeration, air conditioning and sanitary hot water' and by Sergio Girotto on 'Improved transcritical CO₂ refrigeration systems for warm climates' stand out," he adds. **■ CM**

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ATMO Japan 2017 showcases reinvigorated Japanese natref market

As the global HFC phase-down gathers pace, participants in the first-ever ATMOSphere Japan conference – held on 20 February in Tokyo – heard how policy changes and technology developments are creating new opportunities for natural refrigerants in Japan.

–By Devin Yoshimoto

Among the main themes of the first-ever ATMOSphere Japan were the low-charge ammonia revolution, the status of CO₂ refrigeration as a standard solution for food retail, and propane making inroads as a viable refrigerant for light commercial applications in Japan.

The one-day conference welcomed 188 attendees representing a wide range of stakeholders in the natural refrigerant industry: system manufacturers, component suppliers, retailers and consumer goods brands, academics and industry experts, as well as legislative representatives and policymakers.

Policy trends for natural refrigerants in Japan

Representatives of Japan's Ministry of Economy, Trade and Industry, the Ministry of Environment and shecco CEO Marc Chasserot discussed the impact of Kigali on Japan's official stance towards natural refrigerants.

Atsuhiko Meno, director of the Fluoride Gases Management Office at the Ministry of Economy, Trade and Industry, remarked, "we feel comfortable that

[Japan] will be able to achieve the HFC phase-down targets set by Kigali. However, we still feel that f-gas reduction and control measures must be even tougher".

"We also feel that Japan has an opportunity to take the initiative in terms of technological development. We, as a government, would like to support that effort."

End users show sense of urgency, climate change awareness

ATMOSphere gathered more than 20 end users including the convenience store chain Lawson, COOP Aomori, Nestlé Japan, and A-colle.

Lawson is currently the world leader in CO₂ transcritical refrigeration systems installed in convenience stores. It is aiming to hit 2,800 installations by February 2018.

"As a food retailer who relies heavily on refrigeration systems, we have to put some serious thought into what type of technology we will be introducing in new stores this fiscal year," said Shinichiro Uto, responsible for store development at Lawson.

"The refrigeration systems we install, going forward, should not have a lasting negative impact in the future. That, I think, is the most important factor to consider."

Other presentations showed an increasing awareness of environmental impact and climate change.

"I live in northern Japan, where there is usually a large amount of snowfall. However, this year there was very little snow," said Kenji Tamura, from COOP Aomori in northern Japan.

"We eventually decided to go HFC-free knowing that there could be further environmental regulations in the coming years."

The conference also served as a platform to showcase cutting-edge natural refrigerant technology case studies and to launch new and innovative products, including Panasonic's 30 HP CO₂ cascade system, an all-new CO₂ condensing unit from Mitsubishi Heavy Industries, and Mayekawa's CO₂/NH₃ package for small facilities and supermarkets. ■ **DY**

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Denmark: A leader on f-gas regulation

In 2001 Denmark became one of the first countries in the world to introduce taxes on HFC gases, five years before the introduction of the EU's first F-Gas Regulation. Since then, other countries including Spain and Norway have followed suit.
Accelerate Europe reports from Copenhagen.

—By Marie Battesti, Charlotte McLaughlin & Andrew Williams

Back in 1996, Svend Auken – the Danish environment minister at the time – expressed the hope “that in ten years, not a single fridge, freezer or cooling plant will be built in Denmark that requires HFCs or other greenhouse gases”.

The first step towards realising Auken's dream came in 2001, when Denmark became the first country to tax HFCs. The original tax rate of 100 DKK (approximately €13) per tonne of CO₂ equivalent was increased in January 2011 to DKK 150 (approx. €20) per tonne of CO₂-eq.

Legislation to ban certain f-gases in many applications was first introduced by Denmark in 2002. That law only permits exemptions “in exceptional circumstances”. A general ban on the import, sale and use of new products using greenhouse gases in three classes – HFCs, perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) – is also in force today.

Imports of bulk HFCs have fallen steadily in recent years. In 2000 the figure stood at 1,000 tonnes per year. By 2010 it had come down to 350 tonnes.

Going further than the EU F-Gas Regulation

Denmark's current regulatory approach combines the Montreal Protocol, the EU's F-Gas Regulation and national legislation (Statutory Order No. 9), which together help facilitate the transition away from HVAC&R technologies based on f-gases.

In 2015 the EU's new F-Gas Regulation entered into force. Yet the European Commission allowed Denmark to maintain more

stringent national legislation than mandated under the EU F-Gas Regulation. It based this decision on the fact that national provisions “take into account the existence and technical and economic availability of the alternatives to the banned applications in Denmark”.

Denmark's f-gas landscape therefore currently includes a mixture of quotas, usage bans, and technical support and containment training to limit the amount of HFCs that end up in the atmosphere, Mikkel Aaman Sørensen from the Danish Environmental Protection Agency (EPA) told *Accelerate Europe*.

Sørensen explained that a “ban on equipment above five tonnes of CO₂-equivalent, which corresponds to approximately to 1.3 kg of R404A” was considered. He added that the change would have had an effect “especially on condensing units (CDUs) and small chillers”. As this in turn would mainly affect small-scale enterprises in rural areas, it was decided not to pursue this in spite of the high cost efficiency.

Funding research into natural refrigerants

The Danish government has used the HFC tax to support the research and development of alternative, low-GWP refrigeration technologies.

When the original Danish f-gas regulation entered into force in 2002, the Danish government invested some DKK 20 million (approx. €2.7 million) into new projects.



This led to close co-operation between private companies and the Danish Technological Institute (DTI).

Danish firm Advansor and DTI worked together on a project called 'Low-GWP alternatives to HFCs in refrigeration,' allowing the CO₂ rack manufacturer to demonstrate what was possible with CO₂.

Advansor's Charlotte Dalhoff Dalbøge told *Accelerate Europe*: "The purpose of the project was to describe the possibilities of using alternative technology objectively and to compile the latest results regarding the development of alternative technology."

The Danish EPA has also established a 'Knowledge Centre for HFC-free Cooling' at the DTI. The centre cooperates with consultants and universities to provide the Danish HVAC&R industry with knowledge of HFC-free systems.

It also offers up to five hours of free advice to end users, such as shopkeepers and supermarket users. In addition to offering training and consultancy services to companies and public authorities, DTI manages one of the world's most modern laboratories suitable for testing CO₂ components and systems, as well as advanced computer software development.

"For about 10 years, the Danish Technological Institute has been involved in CO₂. Today we consider ourselves to be one of the leading institutes in the field. We are now in a position to help companies all around the world that are looking for ways to substitute HFCs for efficient CO₂ systems," Claus S. Poulsen, the centre's manager, told *Accelerate Europe*.

Another project, the voluntary KMO scheme, sees the Danish EPA work with the Refrigeration Installers Association to collect and reclaim or eliminate recovered HFCs.

The scheme aims to reduce consumption of HFCs. Almost all Danish HVAC&R companies are members of the Refrigeration Installers Association.

Criteria for participating in the KMO scheme include possession of equipment for recovery and employment of a skilled workforce in possession of approved certificates from specific courses. Only Refrigeration Installers Association members can buy refrigerant from wholesalers.

KMO scheme participants take what the Danish EPA calls the "musketeers oath" – a promise to take back spent substances that have been used by end users. The EPA believes this has been very effective.

The government is also looking at other ways to support alternative technologies. Sørensen told *Accelerate Europe* that 2.5 million DKK (€336,132) funding for a "system for recycling [...] flammable HFC refrigerants" is under consideration. He argues that the proposed system will generate 48 kilotonnes (50 DKK (€6.2)/tonne) in CO₂ savings.

Denmark is also looking at allocating one million DKK (approx. €134,470) to developing hydrocarbon-based chillers, Sørensen said. ■ MB, CM & AW



HFC tax driving natref innovation in Spain

A hefty tax on the use of HFCs from the Ministry of Environment is triggering unprecedented growth of natural refrigerant-based HVAC&R technologies in Spain. *Accelerate Europe* reports from Madrid.

- By Alvaro de Oña

In October 2013, the Spanish government approved a new tax applicable to the purchase of fluorinated refrigerants, foams and aerosols with a high global warming potential (GWP). The tax was designed to be a key instrument in helping Spain to comply with its obligations under the EU's F-Gas Regulation, and to reduce overall greenhouse gas emissions.

Guillermo Martínez López, from the climate change section in the Ministry of Environment, has been closely following progress in the market for HFC alternatives. *Accelerate Europe* met him in his Madrid office on the eve of 'Climatización & Refrigeración 2017' – Spain's biggest HVAC&R trade fair – held in the Spanish capital from 28 February to 3 March.

Part of his Ministry role is to oversee implementation of the EU's F-Gas Regulation in Spain, and to coordinate a stakeholder group on commercial refrigeration. The group includes industry representatives and meets regularly to discuss issues of common interest.

"Originally, we saw strong resistance to the tax from the [HVAC&R] industry," Martínez told *Accelerate Europe*. "By now, most people have accepted the tax and are working to implement alternatives based on low-GWP gases in the market."

Tax rates, based on a progressive scale depending on the GWP of the gas in question, have been growing steadily since 2014. By now, for example, manufacturers purchasing R134a must budget for €26 per kilogram (kg) in taxes, and up to €77 per kg in the case of R404A. The resulting pressure to develop alternatives is intense.

Alongside to the tax, the Ministry of Environment is looking at ways to incentivise the development of alternatives based on low-GWP gases.

To support greenhouse gas emission reduction projects developed in Spain, the government has launched a call



for projects to be funded by the Carbon Fund for a Sustainable Economy (FES-CO₂). The 6th edition of the so-called *Proyectos Clima* will fund projects that help facilitate the transition away from high-GWP refrigerants to low-GWP alternatives.

"We're proud to show successful case studies and examples with *Proyectos Clima*, as proof that it is feasible to move on to alternatives in a cost-effective way," Martínez declares.

Last year, for instance, Heineken was awarded a grant under this initiative to replace its HFC-based coolers and bottle coolers with propane (R290).

Innovations entering the market

The need to develop alternatives to traditional HFC-based systems was a hot topic at *Climatización & Refrigeración 2017*. Brand new CO₂ transcritical systems and condensing units for commercial refrigeration, CO₂ heat pumps for sanitary hot water, low-charge ammonia systems, and propane solutions for commercial refrigeration were among the innovations launched at the trade fair.

Much of this innovation is taking place on the Iberian Peninsula. Exkal, the leading manufacturer of refrigeration cabinets in Spain, is living proof of this. Exhibiting a whole new range of cabinets for CO₂ transcritical systems as well as hydrocarbon-based cabinets at the trade fair, Exkal is quickly developing its know-how in natural refrigerants. "We work with all industry leaders to develop expertise in the field. For us sustainability is very important," Exkal Managing Director Alfonso Antoñanzas told *Accelerate Europe*.

"At *Climatización* we're cooperating with leading manufacturers and suppliers, such as Advansor or Danfoss, inviting them to share their knowledge and take part in presentation sessions hosted by Exkal," Antoñanzas said.

As for promising avenues for future developments, the direction seems to be clear. "There are recent developments in Spain on CO₂. With innovations such as ejectors, we saw the potential to be competitive with CO₂ also in warm climates," he concluded.

Condensing units were also a major trend at the trade fair, with Panasonic exhibiting for the first time its brand new low-capacity CO₂ unit (2 HP). Portuguese company Centauro, which is already regularly supplying CO₂ gas coolers for the European market, launched a new CO₂ condensing unit designed for small store formats. SCM Frigo, meanwhile, was exhibiting its CUBO₂ units for small and medium capacities at Beijer Ref's booth.

Competition to provide centralised CO₂ transcritical systems – currently dominated by Carrier in Spain – looks set to intensify, with new products from Lennox, Pecomark and Eliwell making debuts at the trade fair. Pecomark's system, especially designed for warm climate conditions, incorporated the latest generation of multi-ejector technology by Danfoss. Spanish manufacturer TEWIS also presented a new CO₂ transcritical rack, while parent company Zanotti exhibited its range of CO₂ solutions, propane chillers, and cascade options.

An innovative low-charge ammonia system with a maximum refrigerant charge of 10 kg, ready to be deployed in a cascade configuration with CO₂, also featured at the trade fair. Developed by Spanish company Grupo Disco, the system targets food retailers looking for a ready-made solution that performs well in high-ambient temperature conditions.

CO₂ heat pump water heaters also appear to be gaining traction in Spain, with companies Eurofred and Tecno exhibiting new models based on Italian know-how from Enex and enerblu respectively. Eurofred has seen promising preliminary results in terms of operating efficiency. "Based on the results from existing installations in hotels and large buildings, we believe that our CO₂ heat pumps have the potential to gradually replace traditional gas boilers for installations with high demand for sanitary hot water," Eurofred's Industrial & EE Product Manager José López told *Accelerate Europe*.

Other propane chillers, hydrocarbons-based cabinets, and traditional large ammonia systems for industrial refrigeration completed the range of natural refrigerant-based solutions on offer at the show.

With around 80 CO₂ transcritical stores already in operation in the country, and other solutions based on a combination of other natural refrigerants such as ammonia or propane, the know-how and innovation in natural refrigerants for commercial refrigeration is experiencing rapid growth in Spain.

Given the impact of the tax rate, innovation to provide natural refrigerant-based options for other applications that currently use HFCs may also proceed quickly. ■ AdO

New report sheds light on natural refrigerants training

A perceived lack of training among technicians and installers is often cited as a barrier to wider uptake of natural refrigerant-based technologies. But a new report shows that training is in fact readily available for those who need it. *Accelerate Europe* reports.

—By Andrew Williams

Packed full of exclusive interviews, industry surveys and data analysis, the *GUIDE to Natural Refrigerants Training in Europe 2017* – published on 8 May by the market development department at shecco, the publisher of *Accelerate Europe* – is the most comprehensive investigation of Europe's training landscape to date.

The GUIDE analyses survey responses and opinions from over 340 participants on a range of topics, including:

- ▶ Major trends in training on CO₂, hydrocarbons and ammonia in Europe.
- ▶ Figures for participation in training courses and growth prospects.
- ▶ Analysis of barriers and drivers of natural refrigerants training in Europe.
- ▶ Comparative analysis of supply and demand for training in Europe.

Survey participants identified the need to comply with legislative requirements at global, regional and national level as one of the biggest drivers of natural-refrigerant training uptake. The cost of investing in training – both in terms of attending and offering courses – was singled out as the biggest barrier, closely followed by a perceived lack of available facilities in some parts of Europe.

Manufacturers, universities and government can all play a role in addressing this. "Many local associations

are setting up training courses in CO₂ applications and alternative systems, and this has to be implemented more and more. Actually the government should support these trends in order to put professionals in the position to handle the new refrigerants safely," says Giovanni Dorin, marketing manager at compressor manufacturer Dorin.

Among the GUIDE's highlights is a directory of natural-refrigerant training currently on offer in Europe. The directory matches readers to the most suitable training providers, from a list of almost 200 located throughout Europe, according to their needs.

Growing demand for natural-refrigerant training

From state-of-the-art training centres provided by companies like Carrier and BITZER to EU-funded projects and free online resources, the GUIDE is a one-stop shop for all training initiatives that support the development of natural refrigerants.

"CO₂, in particular, is clearly a major area of development for the future. BITZER is supporting this with its focused carbon dioxide training course, based at the company's headquarters in Germany," says Kevin Glass, the company's UK managing director.

The industry survey conducted for the GUIDE found that 98% of natural-refrigerant training providers offer

theoretical training, and 80% offer practical training. 82% of them offer CO₂ training, 63% offer hydrocarbons training, and 55% offer ammonia training.

As natural refrigerants become more popular, the training offer is expected to increase. "The industry leads, and we follow along. [...] As the industry introduces all of these natural refrigerants, the training sector will catch up and it will mingle in. I do think it's just a matter of time," says Jason Clark, senior training consultant at the Grimsby Institute of Refrigeration.

Peter White, director of British installer and maintenance company Polar Pumps Ltd., observes that this is already happening. "50% of those we train are for ammonia, and this seems to be growing. The industry is changing as refrigerants have gone from CFCs, HCFCs, HFCs and now on to HFOs," he told the GUIDE.

"People want a bit of security. Ammonia has been here since forever and it will stay here forever," White says.

With a diverse range of training options already out there, Advansor Managing Director Kim G. Christensen believes that motivated people will have no trouble finding the course they need. "The story that there isn't enough CO₂ training in Europe is a lie," he says.

To read the *GUIDE to Natural Refrigerants Training Europe*, visit publication.shecco.com. ■ AW

Towards an EU Ecolabel for food retail

A landmark report from the SuperSmart project calls on the European Union to introduce an Ecolabel for food retail stores in Europe.

—By Andrew Williams



Next steps

SuperSmart, an EU-funded project under the Horizon 2020 research programme, runs from 2016 to 2019, bringing together nine partners from eight European countries. Beyond drafting the criteria for a future EU Ecolabel for Food Retail Stores, the project also offers free training on how to make stores more energy-efficient.

Stakeholders involved in building, maintaining and optimising heating, refrigeration and cooling systems are welcome to apply for a tailored in-house session or a public workshop via the 'Get Involved' button on the SuperSmart website:

www.supersmart-supermarket.info

Amid regulatory pressure on retailers to reduce the environmental footprint of their activities, a landmark report from the SuperSmart project calls on the European Union to introduce a voluntary Ecolabel for food retail stores in Europe.

The report – entitled 'Development of the EU Ecolabel criteria for food retail stores' – sets out the environmental, technological and social aspects involved in building, equipping and maintaining Europe's future food retail stores.

"This new report is a first concrete step to convince the EU Ecolabelling Board that a voluntary but ambitious label for the food retail sector will drive innovation," says Nina Masson, chief strategy advisor for special projects at shecco and a co-author of the report.

The report – to which shecco, the publisher of *Accelerate Europe*, contributed a chapter on market trends and available certification schemes for sustainable buildings – outlines the scope, definition and legal framework for the potential new label. It also offers market analysis and an overview of existing technical Life Cycle Assessment studies.

Reducing food retailers' environmental footprint

Food retailers leave a significant environmental footprint across their value chain. The report reveals how voluntarily fulfilling a set of criteria under the new Ecolabel would help them to reduce this.

"Driven by regulatory change, food retailers and their partners for refrigeration, cooling, heating and integrated energy management are challenged to think ahead," Masson says.

"They might use this future EU Ecolabel as a way to showcase their efforts towards their customers, and make sure they stay ahead of the curve for technology choice, environmental management best practices, and a lifecycle approach," she adds.

With EU legislation such as the F-Gas Regulation and the Eco-Design Directive obliging food retailers in Europe to become more sustainable throughout the value chain, natural refrigerant technologies are just one of the innovations that can help them to reduce the environmental footprint of their stores.

Among the categories in existing Ecolabel criteria, the report suggests including in the new food retail scheme waste, eco-labelled products, lighting, general management, and other services. ■ AW



Colruyt puts ammonia at heart of new factory

In deciding between a combined heat and power (CHP) plant or a heat pump to save energy at its new meat processing facility, leading Belgian retailer the Colruyt Group decided an ammonia heat pump was the most efficient option. *Accelerate Europe* reports.

—By Andrew Williams & Charlotte McLaughlin



Cross the bridge from the train station in the small town of Buizingen, just south of Belgian capital Brussels, and you cannot miss the row of wind turbines lining the canal alongside the Colruyt Fine Food factory.

The Colruyt Group's official target is to reduce its relative CO₂ emissions by 20% by 2020 compared to 2008 levels. To help achieve this, in 2014 the Group adopted the official target of using 100% natural refrigerants for all its cooling needs. Its own energy company, Eoly, operates wind turbines, solar panels and CHP plants.

Colruyt Fine Food's new meat processing facility, located on the Buizingen site, opened in September 2016.

Having been cut down to size and cleaned elsewhere, pieces of meat arrive in the building for processing into sausages, bacon, smoked meat, meatballs in sauce and packaged sliced meat. The products are packaged on site and sent to a central fridge in nearby Halle for distribution to supermarkets.

"We had two ideas. One was a heat pump and the other was a combined heat and power (CHP) plant," Project Engineer Kristof Lauwereys told *Accelerate Europe*.

The facility operates in two eight-hour shifts: from 6:00-14:00, and from 14:00 to 22:00. During the night, production shuts down for the plant to be cleaned with hot water at 55°C.

Hot water is also required for the production process and air-handling units.

The site's hot water consumption, together with the fact that most of its electricity demand is already satisfied by wind, ultimately led Lauwereys to opt for a heat pump over CHP.

"Our electricity production is more sustainable with a wind turbine than with CHP, because the CHP still needs to use gas," Lauwereys explains.

"The heat pump that is installed here is 1 MW. During peak periods, we do use a small amount of gas, but not that much. During the day, the heat pump runs on three compressors with a frequency drive, making 200-250 kW. During the night, at its peak during the cleaning process, it peaks at a little over 1 MW," he says.

From factory to shop

Upon arriving at the factory, the meat is briefly stored in fridges at 2°C before processing begins. "We have one freezer for peak moments, but usually we always produce fresh meat," Lauwereys says.

At the end of the process, the meat is kept in fridges at -6°C to -10°C for 8-10 hours. "We leave it in there long enough to freeze a bit but not entirely, so that it can be easily sliced," he explains.

▶ To speed up the process during peak moments, the meat is placed in shocking cells for up to 20 minutes at -25°C to -30°C . "That's why we need a subcritical CO_2 system too. The rest of the time, the meat stays at an ambient temperature of -2°C to $+2^{\circ}\text{C}$," Lauwereys says.

Ammonia ticks all the boxes

Mayekawa (Mycom) provided the cooling system, the heat pump and the eight compressors. "There is 3,500 kg of ammonia in the cooling system and 850 kg of ammonia in the heat pump. For this big cooling capacity, ammonia is the best," Lauwereys argues.

Colruyt worked with local installer SKT, based in Ieper (Ypres) in West Flanders, to put together the system. "They build a lot of cooling projects with ammonia," he says.

At the Buizingen facility, the ammonia heat pump satisfies most of the HVAC&R demand. "Ammonia produces most of the cooling. We have three little cooling productions with CO_2 . In this factory, we need very low temperatures to shock the meat," Lauwereys explains.

The ammonia heat pump is also used to upgrade low-temperature heat produced as a by-product of the cooling process to high-temperature heat that can be used in other processes.

"We don't want to work with Freon. We don't believe in it any more," he declares.



Addressing safety concerns

No ammonia enters the production zones, where the majority of the staff members are based. "The ammonia is housed separately from the people. Only the glycol goes into the factory," Lauwereys says.

Access to the machine room is restricted via an electronic badge system. Only technicians and project engineers qualified to work with ammonia are allowed to enter.

Belgian law does not require round-the-clock monitoring of ammonia installations onsite. Instead, it is monitored at the Colruyt Group's Belgian security centre. The staff there will call the technicians if necessary.

In the event of a leak, safety procedures kick in automatically. "We have six detectors and we constantly monitor the amount of ammonia that is in the air. But sometimes if there is a leak, the amount increases. If it gets too high, ventilation units will automatically start extracting the ammonia and pushing fresh air back in," Lauwereys says.

All the pipes in which ammonia circulates are brazed. The brazing is regularly checked to assess degradation. Ammonia is lighter than air, so in the event of a leak, it rises up and out of the building with the help of the ventilation system.

"Any leak is detected directly and fixed as quickly as possible," he says. ■ **AW & CM**



Project Engineer Kristof Lauwereys (L) and Cooling Technician Ronald Decoster (R), Colruyt Group

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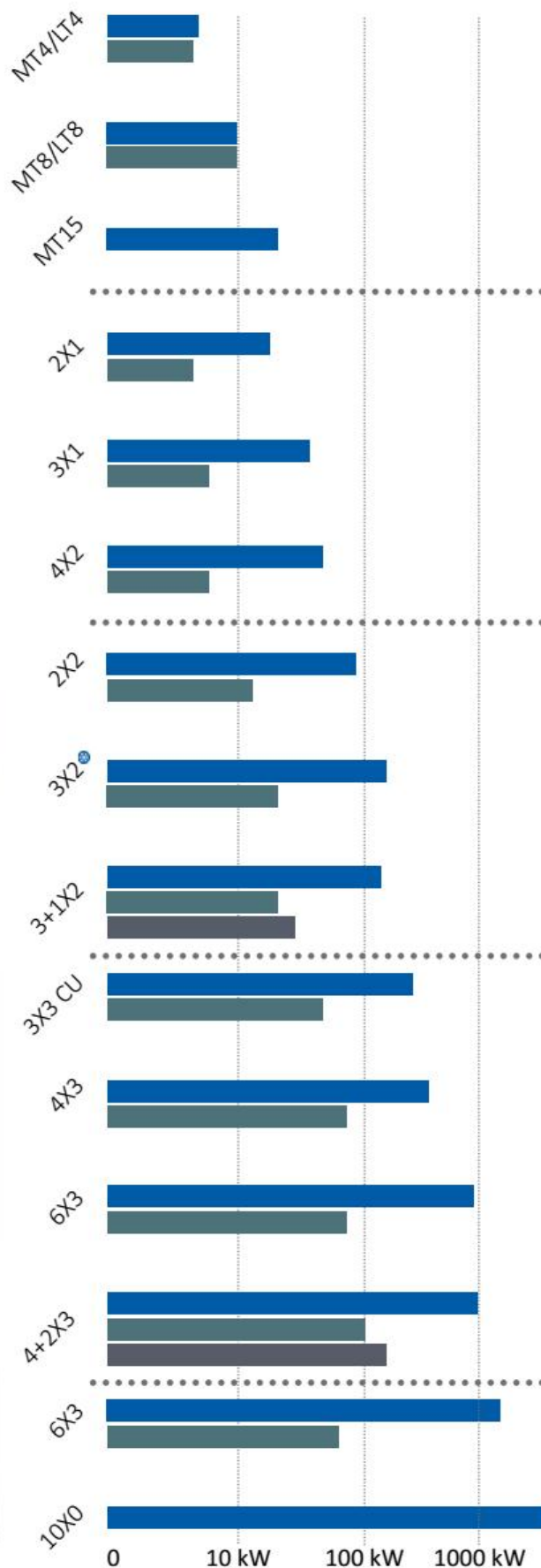
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AHT's new Vento Green refrigerated shelf at Euroshop 2017

AHT banking on propane for food retail

The Austrian company sees propane as a flexible, energy-efficient and cost-effective choice for retailers looking for future-proof cooling solutions. It already has over one million propane-based food and beverage retail cabinets in operation worldwide. *Accelerate Europe* reports.

—By Andrew Williams

Having used propane for over two decades already, AHT Cooling Systems GmbH remains 100% committed to this natural refrigerant as a means of reducing the energy consumption and environmental impact of its retail cabinets. *Accelerate Europe* spoke to Reinhold Resch, vice-president (research and development) at the Austrian firm, to find out more.

Over one million propane-based AHT cabinets are already operating in retail stores worldwide. “We think propane is the best solution on the market for supermarket units,” Resch says.

At the EuroShop retail tradeshow in Düsseldorf, Germany in March, AHT presented its newest environmentally friendly cooling solutions for supermarkets. Chief among these is the new Vento Green refrigerated shelf, which took pride of place at AHT’s booth. Produced in Austria, it naturally uses propane as the refrigerant.

The company has focused solely on providing propane solutions since 2000, when it supplied the Olympic Games in Australia. It did its first test installations in the mid-1990s. “The decision to go for propane was very easy for us. We focused on two important things – one is the environmentally friendly gas, and the other is low energy consumption. Propane fulfils these two points very well,” Resch says.

Did AHT consider alternative hydrocarbons to propane, such as isobutane? “No, not at that time, because we were also keeping an eye on the service organisations. As long as we only have one refrigerant, it’s easy for them to handle all this,” the company vice-president says.

“The decision was to go for the strongest and best refrigerant available in those days, with the focus on those two important points – low energy consumption and the most environmentally friendly solution,” Resch explains.

Opting for a plug-in solution dispenses with the need for both external production of the cold and a secondary circuit to transport it.

Resch is also confident that propane is powerful enough to support larger cabinets as well as smaller ones. “We cover everything: from the smallest ice-cream chest to the biggest supermarket freezer,” he says.

Firm commitment to plug-in solutions

Asked whether AHT would consider moving away from its sole focus on plug-ins to produce fixed cabinets compatible with remote refrigerant circuits, Resch answers with a firm “no, never”.

“There is a simple reason for this. AHT is famous for its flexible, modular, independently operating, industrially produced cabinets. We started this technology in the early 1980s. We wanted to keep this sense of AHT, because our clients loved having this – because they were also then flexible in their stores,” he says.

Resch is convinced that independent plug-in cabinets are the way to go. Their leakage rates are less than 0.1%. “This is why we decided to stay in modular plug-in solutions, rather than going for a remote solution whereby you externally ‘produce the cold’, and then have to transport it with a fluid like glycol,” he explains.

In remote systems, AHT considers the energy required to pump coolants such as glycol through the pipes to be wasted energy. By focusing on plug-in cabinets, “we can lower the total energy consumption of the supermarket to a level that nobody can reach with other technologies,” Resch argues.

Towards a higher charge limit

Standards by the International Electrotechnical Commission (IEC), a worldwide body that proposes rules governing how to use electrical, electronic and related technologies, influence the development of the market by providing manufacturers and customers with guidelines as to what is safe to use and buy.

An IEC working group on household and similar electrical appliances is currently working to increase the charge limit on hydrocarbons. The limit is expected to change from 150g to

▶ a higher level; this could shift the market towards bigger, more efficient hydrocarbon cabinets once it is adopted by the full IEC.

The 26 working group members – comprising 13 countries, including Germany, New Zealand, Japan, and the United States – are expected to decide for a higher level by 2018.

AHT is keen to see hydrocarbon charge limits increase. “We’re working very strongly with different organisations to go for a higher limit,” Resch says, adding: “Today we have 150g. Maybe in the future it will be 350g, 500g or even 1kg. For us that would be a big step forward,” Resch says.

“My personal expectation is that there will be a move, but we don’t know yet to what level,” he adds.

As the global HFC phase-down continues, AHT sees hydrocarbons increasingly competing with CO₂ to become the natural refrigerant solution of choice for other, smaller-scale applications – such as bottle coolers and vending machines.

Resch argues that CO₂ is generally less energy efficient than propane, particularly in high ambient temperature regions.

He identifies noise levels as another factor giving propane the edge. “Most CO₂ compressors are noisier than hydrocarbon ones. In the sizes we need, it’s also much easier to find manufacturers offering hydrocarbon compressors than it is for CO₂,” he argues.

HFOs mired in regulatory uncertainty

Some supermarkets are turning to new synthetic refrigerants – so-called HFOs – as alternative refrigerants to HFCs in view of the global HFC phase-down.

AHT, however, is not tempted to go down this route. “One of the simplest reasons is that HFOs are again chemical substances. Nobody knows exactly what will happen with HFOs 50 years from now,” Resch says.

“50 years ago, everybody thought that HFCs were the best solution. They were even called ‘safe refrigerants’. It is very difficult to predict what will happen with HFOs in the future” because their long-term impact on the climate is not yet fully understood by scientists, he argues.

Resch also points out that the structure of standards governing the use of HFOs is not yet clear. Despite steps being taken to address this – for example, by introducing the A2L category of refrigerant – HFOs nonetheless remain flammable. “And then you have to do the same things as you do with propane,” Resch says.

“Why would I change from propane, where I can find as many components as I need, all over the world, to HFOs – where I don’t have all this available?” he wonders aloud.

“HFOs are not a good alternative, and they’re not a suitable alternative for us. They’re like a fourth alternative to the HFCs being offered on the market – you have hydrocarbons, CO₂, ammonia and only then HFOs,” Resch argues.

He points out that there are currently more components available for natural refrigerant-based HVAC&R systems than for HFO installations.

Asked what obstacles are stopping hydrocarbons from taking over completely as the plug-in solution, Resch replies: “The charge limit, for example.”

Another is the wide range of applications for refrigeration equipment in the marketplace. “The spectrum of different uses for refrigerants is very wide. I’m only looking at the retail sector. I’m not sure if hydrocarbons are the best solution for every other application as well,” he says.

Why don’t all supermarkets adopt 100% hydrocarbons? “I don’t understand why they’re not – that’s my honest and frank answer! All supermarkets are able to use hydrocarbons – from the smallest kiosks right up to hypermarkets,” Resch argues.

For AHT, the sky is the limit. “There is no limitation to hydrocarbons, nor for plug-in units. So far, the biggest installation we’ve done is almost 200 cabinets in one supermarket – and they do not have any heat problems. No chocolate melts!” ■ AW

AHT Cooling Systems, based in Rottenmann, Austria, is a leading global manufacturer of plug-in commercial cooler and freezer systems, delivering an innovative product range to many of the world’s biggest supermarket and discount store chains as well as ice cream and drink producers worldwide.



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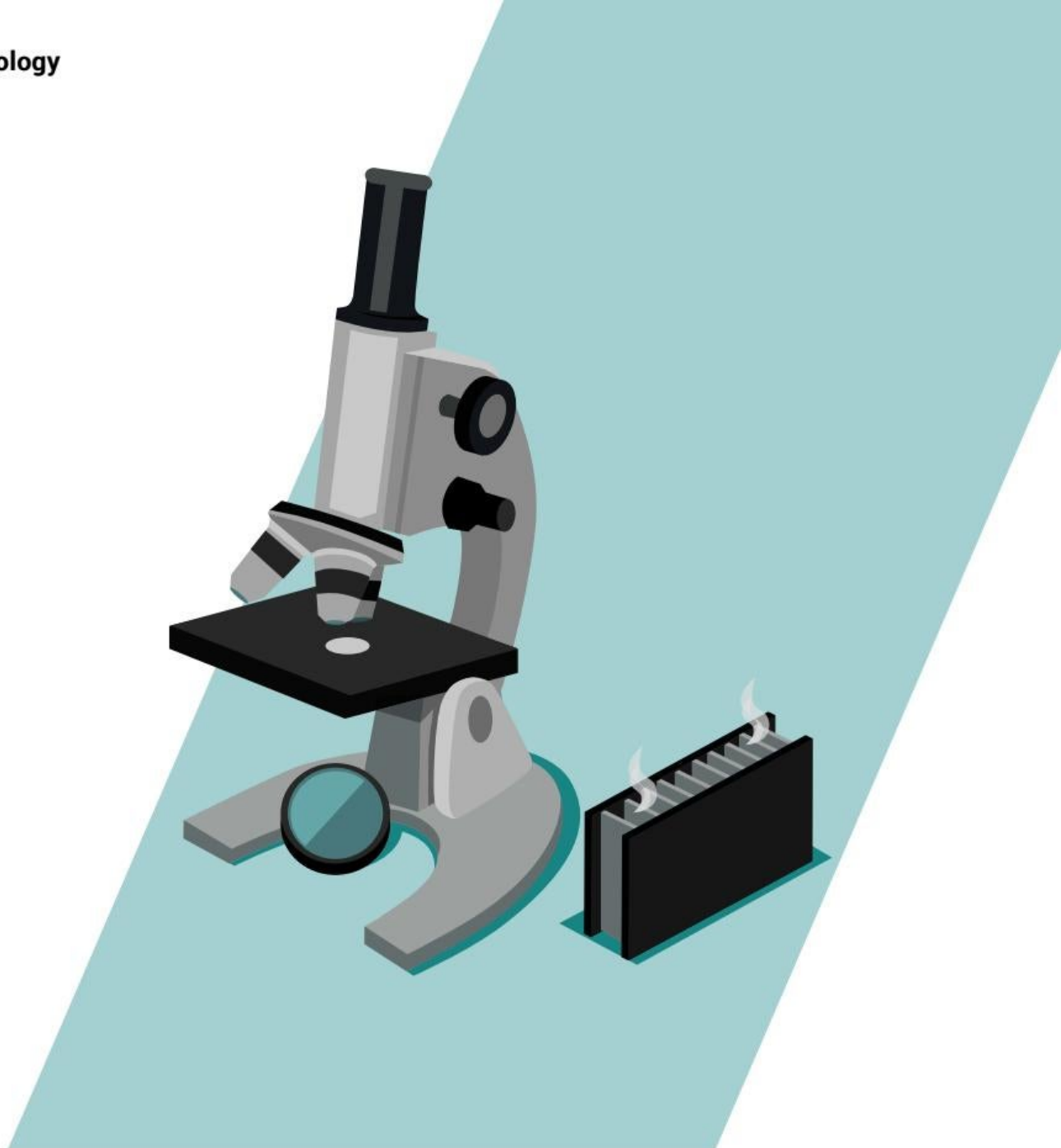
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Propane heat pumps under the microscope

For heat pumps to be more successful they must be efficient, have a low environmental impact and be economical to buy. Propane heat pumps meet all these requirements. So what can be done to boost their uptake?

Accelerate Europe reports.

– By Charlotte McLaughlin & Nina Masson

According to the European Commission, heating and hot water alone account for 79% of total final energy use in EU households. Space and process heating, meanwhile, accounts for 70.6% of EU industry's energy consumption. Reducing this, therefore, can help to slash energy bills for consumers and businesses alike. Heat pumps are one way to do this.

Heat pumps: a route to regulatory compliance

To comply with the EU's F-Gas Regulation on phasing down HFCs, alternative refrigerants will need to be used in heat pumps. Natural refrigerants will play a crucial role here.

Some European countries are putting even more regulatory pressure on industry. On 1 January 2016, new rules on constructing new buildings entered into force in Germany. New buildings must now meet a maximum primary energy requirement that is 25% lower than the previous threshold.

It does not explicitly ban fossil fuel heating systems, but in practice it would be nearly impossible to meet the new requirements with an oil or gas boiler. This means that people will have to find alternative ways of heating their homes. Heat pumps can be part of the solution.

Efficiency – propane's trump card

Propane has a very low global warming potential (GWP) of three and boasts zero ODP (ozone depletion potential), plus is an efficient refrigerant to boot.

A recent paper on hydrocarbons by European natural refrigerant advocates Eurammon asserts that propane is extremely efficient thanks to its unique thermodynamic properties.

"Propane, for example, is considered to be one of the most efficient refrigerants," the Eurammon paper states. "Due to their beneficial properties, hydrocarbons also have the potential to develop new areas of application."

A EU-funded research project, the 'Next Generation Heat Pumps working with Natural fluids' (NxtHPG for short), looks at ways of reducing the environmental impact of heat pumps to help them fulfill their true potential.

"One very important issue must still be solved, i.e. the use of refrigerants with zero Ozone Depletion Potential and very low Global Warming Potential. HFC refrigerants, nowadays massively employed, have a very high GWP," reads the NxtHPG project's final report.

The project developed five reliable, safe, high-efficiency and high-capacity heat pumps (prototypes with a capacity of around 50 kW) using hydrocarbons and CO₂ – very efficient heat pumps that had a "10 to 20% increase on Seasonal Performance Factor (SPF) compared to current HFC and HFO equivalent equipment," according to the NxtHPG report.

Two of the heat pumps use hydrocarbons as the refrigerant – cases one and two – and both achieve very high coefficients of performance (COP) far exceeding the market standard.

For example, case one (see 'Box') achieves a COP of 3.43, which is 20% higher than the comparable reference unit provided by Spanish manufacturer CIATESA, whose COP is 2.96.

In case two, the COP was 11.1% higher (with a COP of 4.47) than CIATESA's comparable reference unit (whose COP is 4.02).

The prototypes that were developed under the project will be sold commercially.

The researchers behind the project are optimistic that the market will change. They write, "it should be noted that propane experienced three-digit growth in 2014 in light commercial equipment (vending machines, remote display cabinets)".

► Case One is a 40 kW hydrocarbon air-to-water heat pump (HP) for the production of hot water for heating, also covering low demand for domestic hot water (DHW) with the use of a desuperheater. The unit is reversible on the refrigerant circuit, providing either heating in winter and cooling in summer.

► Case Two is a 60 kW geothermal hydrocarbon HP for hot water production for heating also covering low demand for DHW with the use of a desuperheater. The unit is reversible on the refrigerant circuit, providing either heating in winter and cooling in summer.

► Case Three consists of a 50 kW HP CO₂ booster from a neutral water loop, (10-30°C) – for example, recovery of waste heat from condensation (25-30°C) or sewage water (10-15°C) producing DHW at up to 60°C.

► Case Four is a 30 kW air-to-water CO₂ HP for sanitary water production at 60°C or up to 80°C for high temperature applications.

► Case Five is a 50 kW air-to-water CO₂ HP for heating applications. It targets the replacement of old gas boiler heating systems.



Frankfurt Messe, home of ISH

Source - Messe Frankfurt Exhibition GmbH / Jochen Günther

However, despite their efficiency and cost-effectiveness, propane heat pumps have faced an uphill battle.

The use of hydrocarbon-based heat pumps used to be commonplace in Europe before the Pressure Equipment Directive (PED) was adopted; until 2004, R290 heat pumps represented more than 50% of the residential heat pump market.

The PED required components – including compressors for hydrocarbon-based equipment – to fulfill additional requirements, which increased the cost of equipment to the extent that manufacturers had to remove products from their portfolios.

“Another significant factor is the increasingly strict requirements that are specified within European and international safety standards that make it difficult to design systems with a competitive market price,” according to an Environmental Investigation Agency report by Professor Michael Kauffeld, published in May 2012.

The times they are a-changin’

Fast-forward to the present, and manufacturers are less concerned about the PED. Roger Johnsson, product manager for exhaust air heat pumps and ventilation at Swedish company NIBE, thinks most manufacturers are already compliant.

“We meet the requirements defined by the household standard 60335-1 [...] and the related 60335-2-40 (for heat pumps). [And we are] exempt from the Pressure [Equipment] Directive as it is covered by the Low Voltage Directive,” Johnsson says.

In a clear sign of the transformation underlying the heating and cooling sector in Europe, brand new propane heat pumps saw the light at a big German trade show in Frankfurt.

ISH – the Bathroom Experience, Building, Energy, Air-conditioning Technology, and Renewable Energies tradeshow, held on 12-16 March 2017 – showed off R290 models from manufacturers like Heliotherm, Glen Dimplex, Alpha Innotec, and NIBE.

The most eye-catching heat pump on show was the so-called “world’s most efficient geothermal heat pump, thanks to the use of R290,” according to Rudi Bellingier, who works in sales support at Heliotherm. Its seasonal coefficient of performance (SCOP) reaches a record high of 6.7.

The AIT (Austrian Institute of Technology) research institute and Germany’s TÜV (an international certification organisation) tested the heat pumps in early 2016. The first units were sold in mid-2016.

Heliotherm’s primary motivation for investing in propane technology was “the energy efficiency advantages it brings,” Bellingier told *Accelerate Europe*.

Glen Dimplex, a consumer electrical goods firm headquartered in Dublin, Ireland, also presented a new R290 heat pump at the show – the System Zero HP.

“The unit can be used for both heating and cooling,” says Volker Rühle, director of international sales – heating & ventilation at Glen Dimplex.

“It’s no secret that we are actively looking into R290, because we see propane as one of the refrigerants of the future.”

– Roger Johnsson, NIBE



▶ NIBE has also been producing an exhaust air source heat pump with R290 since 1998. The exhaust heat pump works by taking the heat from waste air leaving the building, pumping it back in to provide heating and hot water.

The latest models use 400g of the refrigerant R290 and are for outside placement.

NIBE’s Johnsson says: “We are not talking about the refrigerant when we talk to our customers. We want to offer the best products, and R290 allows us to do so.”

Johnsson believes that the climate change dimension will become more significant for consumers as the EU’s f-gas phase-down continues. “We believe customers will become more aware of the environmental dimension of the refrigerant being used,” he says.

“The lack of components can of course also be a reason why not that many unit manufacturers offer units with natural refrigerants,” he warns.

He feels NIBE is well positioned to take on this challenge, with nearly 20 years of experience in natural refrigerants. “It’s no secret that we are actively looking into R290, because we see propane as one of the refrigerants of the future.”

Germany-based company Alpha Innotec (AIT) also presented a heat pump model using propane. Andreas Schrof, area sales manager at AIT, says the company’s 20 years of experience in developing R290 in heat pumps has paid off. “The system is our most popular product overall,” Schrof says.

With a very silent operation at 61 dB, AIT’s heat pump is available in 5 kW, 7 kW and 9 kW models, which can then be combined into two units to achieve a total combined capacity of 18 kW. It provides cooling as well as heating.

The product AIT presented at ISH – the alira LWDV air-water heat pump – uses inverter technology, something new in the European heat pump market.

“We have an industry-leading position for natural refrigerant-based heat pumps, which we intend to keep. To our knowledge, we are the first to launch an R290 heat pump using inverter technology,” Schrof says.

“The R290 heat pump price is [also] fully comparable with models of similar capacity and sound levels, so there is no cost disadvantage for the customer,” he says.

The ISH tradeshow served as further evidence of growing interest in hydrocarbon-based technologies for heating and cooling applications.

Propane, then, is increasingly looked upon as the refrigerant of the future for heat pumps. ■ CM & NM ▶

ALDI Nord to fit 10 propane heat pumps

In cooperation with discount supermarket chain ALDI Nord, Viessmann has produced a propane-based energy system – the 'ESyCool green' – to heat and cool 10 of the discount retailer's stores.

"We are delighted that the ALDI Nord Group is using our holistic ESyCool concept to achieve more climate and environmental protection," says Dr. Frank Schmidt, head of the refrigeration systems division at Viessmann.

Launched at EuroShop 2017, the 'ESyCool green' is a highly efficient energy system that controls and optimises energy flows in supermarkets. 'ESyCool green' operates with heat pumps linked to optimised refrigerated cabinets and cold rooms, as well as an integrated ice energy storage unit and photovoltaic system.

Viessmann first fitted the system – based on natural refrigerant propane – in 2015 in an ALDI Nord store. Over a 12-month test period, the health and safety and energy efficiency of the entire installation was measured. After recording significant energy savings, the firm fitted two newly built ALDI Nord stores in Schleswig-Holstein with the ESyCool system in late 2016 and early 2017.

ALDI Nord making greater use of natural refrigerants

Christian Fleck, managing director of the ALDI regional subsidiary in Scharbeutz, says: "Part of our modernisation process is making our stores more energy-efficient and sustainable. To do this, we are making greater use of environmentally friendly and natural refrigerants."

"We want to significantly increase our in-store usage of energy generated through our photovoltaic panels and cold/warm power packs and ensure the panels are in tune with our needs," Fleck says.

ALDI Nord is investing significantly in efficient cooling and heating using heat pumps.

"Through comprehensive use of the ESyCool concept, we are helping to make retail a climate-neutral environment," says Rayk Mende, head of corporate responsibility for the ALDI Nord Group.

10 ALDI Nord stores will be fitted with the innovative cold-warm air system.

Based on results so far, ALDI Nord can expect energy savings of around 15% and a significant reduction of lifecycle costs in comparison with conventional refrigeration systems.



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(L) Hayato Sakamoto, Assistant Manager, Aero-Dynamic Machinery Department, Machinery Division and (R) Takahiro Hirao, Senior Manager, Aero-Dynamic Machinery Department, Machinery Division

The world's first water-refrigerant turbo chiller

Kawasaki Heavy Industries (KHI) is ready to launch the world's first commercially available water-refrigerant centrifugal chiller for use in air-conditioning applications. *Accelerate Japan* reports.

— By Devin Yoshimoto & Jan Dusek

Sometimes complex solutions come from simple questions. As global momentum continues to snowball towards finding alternative refrigerants to HFCs, some companies are rethinking their entire approach by asking very basic questions.

Hayato Sakamoto is assistant manager in the Machinery Division of Kawasaki Heavy Industries (KHI). When he and his team saw the global market start to shift towards using more environmentally friendly refrigerants, they asked themselves the question:

"Is there an ultimate refrigerant that does not heat the planet, deplete the ozone layer, or present the risk of combustion or toxicity?"

"The answer is yes – water."

After several years of development and testing, KHI is now ready to market the world's first commercially available water-refrigerant centrifugal chiller for use in air-conditioning applications.

"For the air-conditioning industry, systems using water as a refrigerant have been an eternal theme. Although there were other manufacturers who worked on development, no-one could invent a feasible product, because their solutions were several times larger than existing systems with the same refrigeration capacity," says Takahiro Hirao, Senior Manager in the Aerodynamic Machinery Department, Machinery Division.

KHI, however, has never been the type of company to shy away from engineering challenges – especially if the work leads to breakthroughs that have the potential to change the world.

Development of the water-refrigerant turbo chiller

Kawasaki Heavy Industries has had a long history of solving technical challenges by leveraging knowledge across different technical fields.

KHI does this through what it calls matrix management – a corporate manufacturing philosophy which encourages researchers to internally share issues with experts in other fields to look for the best technical solutions, rather than having departments working independently from one another.

One of the most recent examples of this is the release of Kawasaki's new Ninja H2R/H2 motorcycle. The motorcycle has been able to achieve the company's highest performance benchmarks to date. This was achieved by incorporating industrial technology – from KHI's work with gas turbines – in the motorcycle's research and development process.

Why is this so important? Because this gas turbine knowledge was the same source of inspiration that led to overcoming the challenges of working with water as a refrigerant. Hayato Sakamoto told *Accelerate Japan* how KHI overcame those challenges.

Two-stage compression, high speed motor

Using water as a refrigerant presents two main challenges. First, the use of water requires the achievement of a significantly higher-pressure ratio between the condenser and the evaporator, compared with standard HFC chillers.

"Unlike HFCs, which exist in the form of gas under normal atmospheric conditions, water is a liquid, and its pressure needs to be reduced in order to change phases from liquid to gas," Sakamoto explains.

Second, because water exists as a liquid in normal atmospheric conditions, it has a much larger volume than HFC gases. This means that, in addition to increasing the performance of the compressor, the size would also have to increase.

"Using water as a refrigerant," Sakamoto says, "multiplies the volumetric flow rate 100-fold, necessitating the use of a large compressor, which inevitably makes the chiller larger".

To improve the compressor performance while minimising its size, KHI developed a high-speed motor and a two-stage compressor, leveraging knowledge gained from fluid analysis technology in the development of KHI's gas turbines and steam compressors.

The proprietary high-speed motor achieves a high rotation speed by using fine control of magnetic force.

"The motor is integrated with the compressor and is placed in the refrigerant atmosphere. Therefore, the motor's coil is coated with resin for insulation and to make it waterproof. Because the motor is connected directly with the compressor, there is no need for a speed-increasing gear or oil," Sakamoto explains.

In addition to the high-speed motor, KHI adjusted the number and shape of the impeller blades. They developed a two-stage compressor by placing an intermediate cooler in between the two-stage compression process to keep the temperature low inside the compressor.

These compressor enhancements allowed the system to achieve a seven-fold pressure ratio between the evaporator and the condenser. In addition, it allowed the compressor to remain small yet perform well enough to overcome water's large volumetric flow rate when used as a refrigerant.



Kawasaki water-refrigerant turbo chiller

Optimal component arrangement

The final touch came from arranging all the components inside a single enclosure before vacuum sealing it, which further enhanced the system's performance and efficiency.

This, however, was no easy task.

"At the beginning of the development process, we made a prototype with just a quarter of the current capacity to examine if water refrigerant is even viable for turbo chillers. Back then we had difficulties just making the inside of the system a vacuum, causing us to fail to achieve expected results," Sakamoto recalls.

"To make it smaller, we needed to lay out the components in a very complicated manner, just like putting together the pieces of a jigsaw puzzle. And the complex structure caused another challenge: internal energy loss," he reveals.

In order to increase the efficiency of the system, Kawasaki had to minimise the air leaking from the motor. This was done by "enclosing the motor inside the entire system and connecting it directly with the compressor".

This means that the evaporator, compressor, motor, and other primary components are all packaged within the vacuum container.

Once the optimal arrangement of the components had been found, KHI was finally ready to put the system into action and measure its operating performance.

Water-refrigerant turbo chiller in operation in Kobe, Japan

In 2013, KHI installed the chiller at its Kobe Works facility in Kobe, Japan. The chiller powers the six-story office building's centralised air-conditioning system – providing cooling for a total of 5,000m².

The water-refrigerant chiller, along with secondary absorption chillers, supplies air conditioning for a canteen on the first floor and offices from the second to the fifth floors. The sixth floor has meeting rooms, which are air-conditioned by packaged systems.

Sakamoto details the water-refrigerant chiller's typical operational day.

"Before 6am, the chilled water and the cooling water are saturated at the ambient temperature. At 6am, the system controller starts the chilled water pump, the cooling water pump, the cooling tower fan, and finally, the turbo chiller."

"The compressor gradually increases rotational speed to the set value to avoid surge phenomena in the compressor. After the compressor reaches the set value, the chiller starts to control the chilled water temperature."

"During stable load conditions, the chiller controls the chilled water temperature at $7 \pm 0.3^\circ\text{C}$."

"The system then supplies chilled water at 7°C to air handling units on each floor."

The entire system is operated on a daily start-and-stop basis, with chilled water stored every morning automatically before the load starts to increase.

The load then begins to increase around 8am and peaks in the mid-afternoon, when the first floor canteen opens from 11:30am to 2pm.

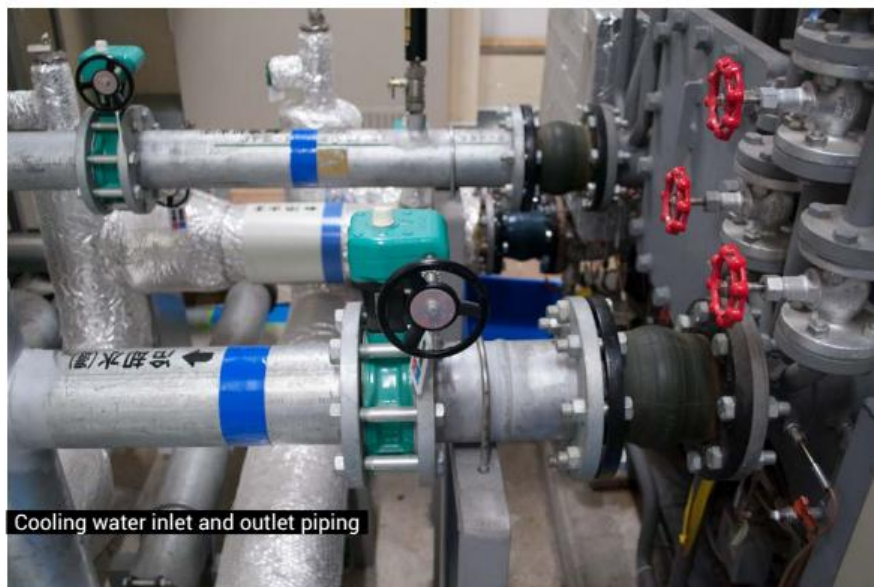
"If the load exceeds 352 kW, one of the absorption chillers starts to run. In this case, the number of system units changes from one to two and the required load for the water-refrigerant chiller itself drops sharply from 352 kW to 176 kW."

Before testing the system, one of the major operational concerns of Sakamoto and his team was how the chiller would handle sudden load changes.

"We were concerned about whether or not the chiller would be able to keep up and maintain the chilled water's required temperature," says Sakamoto – the reason being that "the inertia of the compressor rotor is much larger than HFC chillers due to the compressor's large size".

However, the team observed that the chiller was able to maintain the chilled water temperature at $7 \pm 0.5^\circ\text{C}$ even if the load required for the chiller changes sharply.

"Finally, the chiller stops operating at 9pm and the cycle starts again the next morning."



Cooling water inlet and outlet piping

Results

As of June last year, the chiller had operated for a total of 4,260 hours and the team had confirmed the chiller's ability to handle temperature and load fluctuations as well as the compressor's ability to avoid surge phenomena.

The water-refrigerant turbo chiller is "performing well, just like our initial estimation, delivering COP 5.1, which is comparable to existing HFC systems, throughout three years of operation," says Sakamoto.

"Assuming a service life of 15 years, the amount of HFC reduction would be 575 CO₂-tons."

Why water?

Looking to the future, there is no doubt that the speed of technological development with respect to natural refrigerants will only accelerate. But the question is, do we want to use this opportunity to come up with mere stop-gap solutions, or seize the chance to find a long-term solution?

"We regard water as the ultimate refrigerant, because it has no ozone depletion potential nor greenhouse gas effect. Also, it is neither combustible nor poisonous. So, we hope to promote it globally in the future," says Takahiro Hirao.

Market awareness and adoption of natural refrigerant technology is a must for the water-refrigerant turbo chiller to succeed. Kawasaki has a long-term vision, but at the end of the day, there needs to be an overall awareness and willingness to choose natural refrigerant technology.

Asked what must still be done to create these conditions, Sakamoto replies: "Improving efficiency and reducing product costs by manufacturers is important."

"In addition, since GWP regulation is less strict in the air-conditioning market, I believe a favourable environment for natural refrigerants will be formed if more strict regulations are imposed on HFCs in that sector."

Pioneer's pride

Challenges undoubtedly remain for the introduction of the water chiller.

Nevertheless, as one of a few pioneers who work on natural refrigerant technology in the air-conditioning market, Sakamoto and his team show strong conviction for their product.

"Our system is as small as existing systems while delivering a comparable performance. This is a breakthrough. We hope our customers recognise this and consider using our product," he says.

"Don't be afraid. Let us make it prevail together."

If innovative companies like Kawasaki are able to overcome the challenges of using water as a refrigerant through technology and innovative engineering, it only serves to show that the possibilities of natural refrigerants are limitless.

As global competition continues to increase, and innovative companies continue to push for this technology, it remains to be seen what can be achieved when we take the time to step back and ask ourselves simple questions. ■ DY & JD



System Specs

The turbo chiller has been used for air-conditioning in Kawasaki's Kobe Works office since 2013. Here are the specifications of the system currently in use:

Turbo chiller capacity: 352 kW

High-speed motor rating: 110 kW

Secondary absorption chiller capacity: 422 kW

Stand-by absorption chiller capacity: 422 kW

Chilled water inlet temperature: 12°C

Chilled water outlet temperature: 7°C

Cooling water inlet temperature: 30°C

Cooling water outlet temperature: 35°C

Size: 2.5m x 2.5m x 2.6m

Net weight: 8.0 t

Coefficient of Performance: 5.1

No. of cooling towers: 3

No. of buffer tanks: 1



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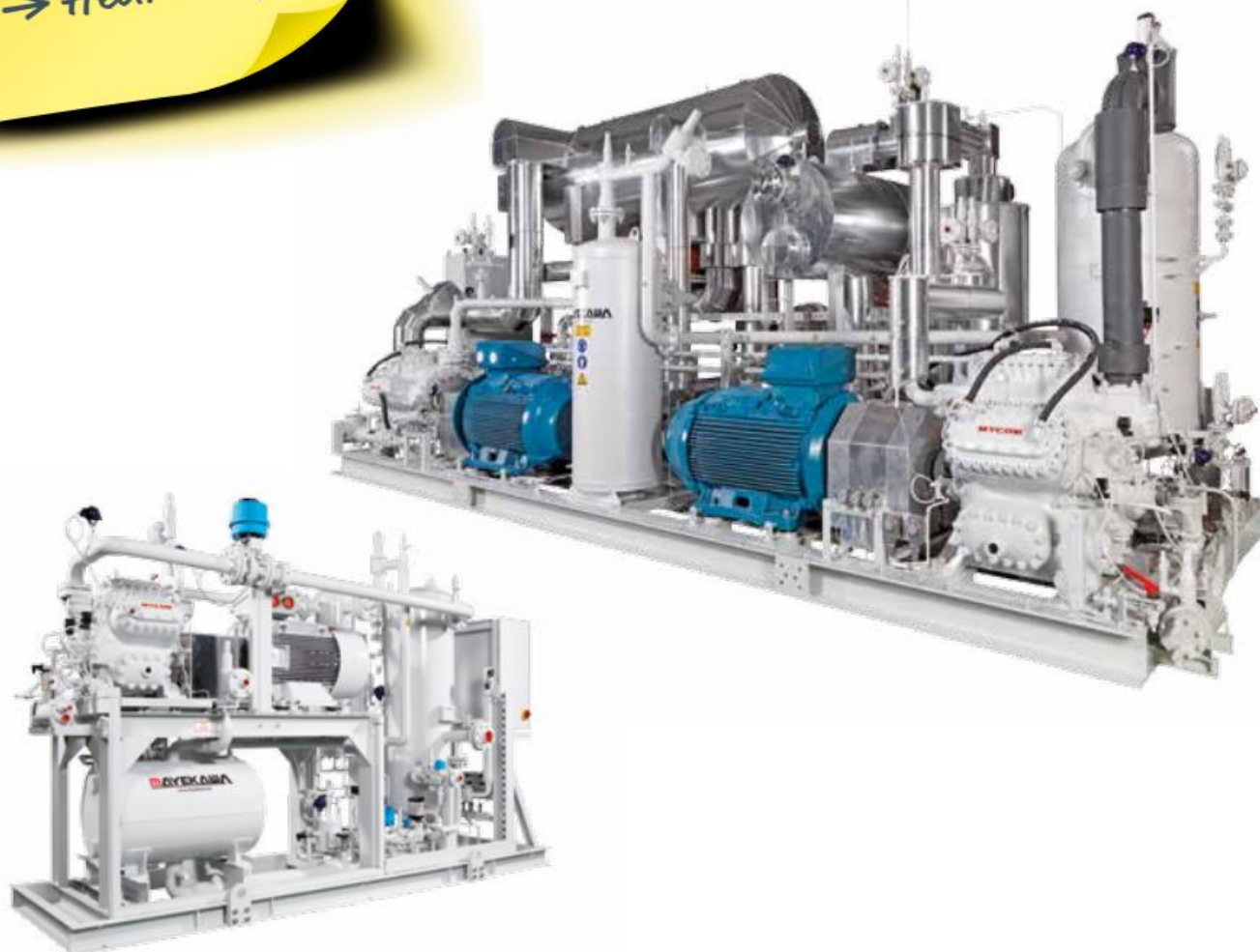
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