

Demystifying Natural Refrigerants

ENERGY-EFFICIENT & SAFE SOLUTIONS FOR AN F-GAS-FREE FUTURE

NATURAL REFRIGERANTS
EMERGING IN
BRAZIL
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FROM FARM
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VIETNAM, UNIDO TEAM UP
TO SHOWCASE
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A strong voice to fast-track natural refrigerants



By Nina Masson



Currently supported by 108 signatories from all over the world, the Natural Voice is the world's most important industry-led statement calling on national governments to fully exploit and acknowledge the potential for natural refrigerants to replace climate-damaging HFCs across industries, applications and regions.

The publication of the Natural Voice Magazine is a significant and proactive step in raising awareness of natural refrigerant technologies currently available in developed and developing countries. With end user and manufacturer interviews alongside case studies, the magazine demonstrates that natural refrigerants – CO₂, ammonia, hydrocarbons, water and air – are energy-efficient, safe and future-proof replacements

for HCFCs and HFCs in heating, air conditioning and refrigeration applications.

The publication of this first edition comes as momentum is picking up worldwide towards reaching an agreement on a global HFC phase-down. Developed and emerging economies are increasingly looking to adopt ozone and climate-friendly gases – with natural refrigerants well placed to step in as the market-ready solution to the challenges we are currently facing.

This edition – entitled 'Demystifying Natural Refrigerants' – aims to shed light on some of the key benefits of natural refrigerants, highlighting their basic characteristics (p. 12) and showcasing their use across the food cold chain (p. 24). The magazine also highlights natural refrigerant installations

in Brazil (p. 17), and other warm ambient temperature regions (p. 14).

At the magazine's heart is an open statement supported by an increasing number of leading global consumer brands, including the Coca-Cola Company (p. 21), HVAC&R system and component manufacturers, industry associations, development agencies, NGOs and research institutes. As a growing chorus of strong voices joins the Natural Voice, we are presented with a unique opportunity to transition away from HFCs under the Montreal Protocol framework. We owe it to future generations to take it.

To sign up to TNV statement, organisations are invited to visit: www.thenaturalvoice.org.

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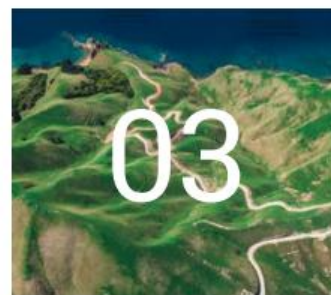
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About The Natural Voice

The Natural Voice is a global call for action supported by industry and other parties that points to the environmental, economic and social potential of natural refrigerants in heating, cooling & refrigeration.
<http://thenaturalvoice.org/>

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The world's only industry websites for the natural refrigerants carbon dioxide (CO₂, R744), hydrocarbons (HCs, R600a, R290 etc.), ammonia (NH₃, R717) and water (H₂O, R718). From the number one publisher of natural refrigerant information, our websites feature a unique mix of News, Products, and Events, attracting 10,000+ regular readers, including CEOs, Technical Directors, Refrigeration Engineers, End Users, Marketing and Sales Managers, Policy Experts and more.

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Escaping the chemical loop: the time to act is now

by Sidi Menad Si Ahmed

WE ARE ON THE EVE OF YET ANOTHER 'HISTORICAL AMENDMENT' IN PHASING DOWN HFCS. AND YET FROM THE MONTREAL PROTOCOL VIA THE COPENHAGEN AGREEMENT AND BACK, HISTORY APPEARS TO BE REPEATING ITSELF – WITH CHEMICALS BEING REPLACED BY OTHER CHEMICALS.

Well-intentioned scientists, professional salesmen and smart advertisements are helping to put on the market so-called 'new' molecules with convoluted formulae and reduced Global Warming Potential (GWP), when in fact these are no more than regenerated controlled substances that have been chemically manipulated and now bear sophisticated trade names. Like the phoenix rising from ashes, these chemicals are given new lives until the regulations call for even lower GWPs – at which time they are re-manipulated accordingly.

Unfortunately we seem to be trapped in a chemical loop from which it is hard to escape, despite the many negotiated amendments to the Montreal Protocol. The very same individuals will tell us how necessary it is to ban substances that just a few years ago were being portrayed as the most suited to protecting the ozone layer or mitigating climate change.

With the exception of natural refrigerants, thus far none of these substitutes have proven to be sustainable or acceptable for the long-term future. How many times have the Parties to the Protocol had to agree on new amounts to replenish the Multilateral

Fund in order to address the needs of developing countries who had no other choice than to bow to the 'diktat' of chemical producers under the cover of generous assistance while accumulating substantive financial benefits?

Does it make any sense to go through second or even third conversions in the name of science, when natural substances have been at hand all along, representing sustainable and long-term solutions?

Natural refrigerants, though gaining ground, are still struggling to emerge as major replacements. It is high time to claim with a loud and clear voice that natural refrigerants are the main answer to both protecting the ozone layer and mitigating climate change, with a long-term vision. The recent agreement in Paris at COP 21 cannot allow any more complacency for intermediate solutions and will call for more ambitious and far-reaching ones.

Natural refrigerants have come a long way and technology has undergone dramatic improvement, including safety. They should 'naturally' impose themselves in major applications as the right response to climate change, sidestepping toxicity concerns.

Moreover, natural refrigerants will not generate stocks of obsolete substances. Stockpiles of used chemicals all over the world are threatening to offset all the benefits gained by the Protocol in protecting the ozone layer so far.

The success of the Montreal Protocol will only be complete when we at last keep away from chemicals.

Today, big corporations are adopting natural refrigerants, paving the way for a major shift. It is the duty of all of us to support this trend and render it irreversible.

Time is of the essence and negotiations on the amendment are taking a crucial turn. We need to spread this message among the Parties before any final decision is taken ■

Sidi Menad Si Ahmed is Chief International Advisor at shecco, formerly Director of the Montreal Protocol branch at the United Nations Industrial Development Organization (UNIDO).

Events Planner America



JULY

1	2016 Purdue Conferences Compressor Engineering, Refrigeration and Air Conditioning, High Performance Buildings	11-14 Jul.	West Lafayette, IN USA	https://engineering.purdue.edu/ Herrick/Events/Conferences

AUGUST

2	Global Sustainability Summit	10-12 Aug.	New Orleans, LS USA	http://www.fmi.org/ sustainability2016/overview

SEPTEMBER

3	International Day for the Preservation of the Ozone Layer	16 Sept.	International	http://ozone.unep.org/en/ international-ozone-day-2016

4	AHR Expo Mexico	20-22 Sept.	Monterrey, Mexico	http://www.ahrexpomexico.com/

Events Planner

Europe



JULY

1	Resumed 37 th Meeting of the Open-ended Working Group of the Parties to the Montreal Protocol	15-16 Jul.	Vienna, Austria	http://ozone.unep.org/en/meetings
2	38 th Meeting of the Open-ended Working Group of the Parties to the Montreal Protocol	18-21 Jul.	Vienna, Austria	http://ozone.unep.org/en/meetings
3	Third Extraordinary Meeting of the Parties to the Montreal Protocol	22-23 Jul.	Vienna, Austria	http://ozone.unep.org/en/meetings

AUGUST

4	12 th IIR Gustav Lorentzen Conference on Natural Refrigerants	21-24 Aug.	Edinburgh, Scotland	http://ior.org.uk/GL2016

SEPTEMBER

5	Sifa, Interprofessional Refrigeration and its Application Tradeshow	14-15 Sept.	Nantes, France	http://www.expo-sifa.com/What-is-SIFA
6	International Day for the Preservation of the Ozone Layer	16 Sept.	International	http://ozone.unep.org/en/international-ozone-day-2016

Events Planner

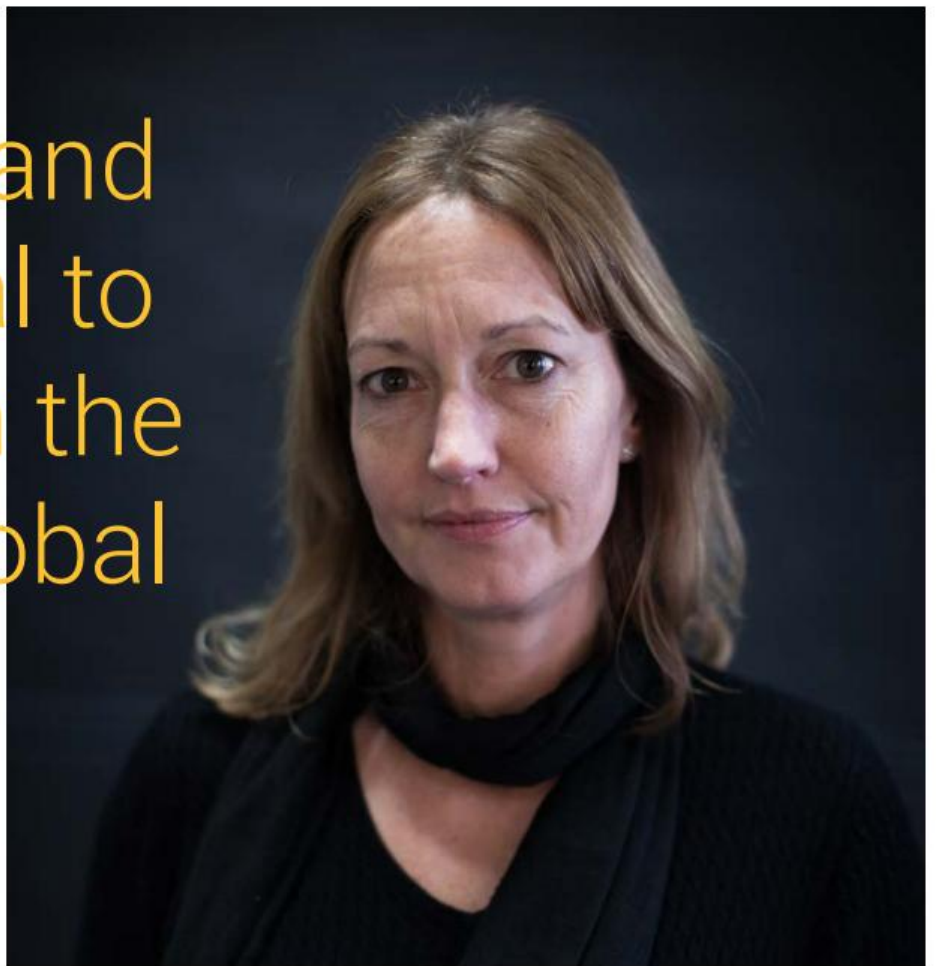
Asia & Oceania

SEPTEMBER

1	ColdChain Expo Eurasia	1-4 Sept.	Istanbul, Turkey	http://www.coldchain-eurasia.com/Home.aspx
2	Global Green Growth Week 2016	5-9 Sept.	Jeju Island, Republic of Korea	http://www.gggweek2016.org/
3	Seafood Expo Asia	6-8 Sept.	Hong Kong	http://www.seafoodexpo.com/asia/
4	Cool Logistics Asia 2016	7 Sept.	Hong Kong	http://coollogisticsresources.com/asia/
5	AIRAH's Future of HVAC 2016 Conference	7-8 Sept.	Brisbane, Australia	http://www.airah.org.au/iMIS15_Prod/AIRAH/Navigation/Events2/AIRAHConferences/The_Future_of_HVAC_2016/The_Future_of_HVAC_2016_Conference.aspx
6	Mostra Convegno Expocomfort (MCE) Asia	7-9 Sept.	Singapore, Malaysia	http://www.mcexpocomfort-asia.com/
7	ASIA Fruit Logistica	7-9 Sept.	Hong Kong	http://www.asiafruitlogistica.com/
8	International Day for the Preservation of the Ozone Layer	16 Sept.	International	http://ozone.unep.org/en/international-ozone-day-2016
9	2 nd International Conference Efficient Building Design: Materials and HVAC Equipment Technologies	22-23 Sept.	Beirut, Lebanon	https://www.ashrae.org/membership-conferences/conferences/2016-2nd-international-conference-efficient-building-design

Ambition and speed vital to turn down the heat of global warming

By Clare Perry



THE stakes are high as world governments gather in Vienna in July for a series of Montreal Protocol meetings to agree a global phase-down of hydrofluorocarbons (HFCs) – the fastest growing source of greenhouse gas emissions and, with climate-friendly alternatives now available, the low-hanging fruit in the challenge to limit global temperature rise to 1.5°C.

As a first test of the Paris climate agreement, it makes perfect sense to look to the Montreal Protocol. Widely hailed as 'the most successful environmental treaty', it has already phased out 98% of ozone-depleting substances (ODSs), putting the ozone layer on the path to recovery by mid-century. In the process, it has avoided more than 135 billion tonnes of CO₂-equivalent ODS emissions.

The imperative to address HFC growth in developing countries could not be clearer – HFC consumption is predicted to grow almost 300% by 2030. A near-term freeze in consumption in developing countries would cap that growth and open markets to low global warming potential (GWP) solutions.

Historically, technology choices within the framework of the Montreal Protocol have been

dominated by the companies that created the ozone hole in the first place, who quickly offered new synthetic solutions even though it was acknowledged that some, such as hydrochlorofluorocarbons (HCFCs), were only transitional and would need replacing. But with the world poised to install 700 million air conditioners by 2030 and 1.6 billion by 2050, we can no longer afford transitional solutions – low-GWP must mean close to zero.

Given the urgency of the climate crisis, it is also now impossible to ignore the energy demand of the cooling industry. Energy consumption for cooling an increasingly populated, urbanised and warming world is set to dramatically increase global energy demand, overtaking the amount used for heating by 2060. As such, simultaneously investing in energy-efficient low-GWP technologies could yield significant climate co-benefits.

For these reasons, natural refrigerants must play a significant role in the future. Multiple studies show propane is the most efficient replacement refrigerant available for air-conditioning – it is also cheap, comes without intellectual property issues and works in high ambient temperatures. China, the world's largest producer of cooling equipment, has

repeatedly flagged the need to address outdated industry standards which prevent the use of flammable refrigerants such as propane and create market barriers to their safe uptake.

How best to tackle this daunting task? It starts with developed countries leading by example and agreeing an ambitious early HFC phase-down schedule. As witnessed in Europe, this accelerates the commercialisation of efficient low-GWP technologies and overcomes barriers to their uptake. Simultaneously, developing countries need to be assured of adequate financing, technology transfer and capacity-building to allow them to commit to an ambitious phase-down, one that arrests HFC growth in the next few years. With sufficient political will, this can be achieved with an amendment to the Montreal Protocol in 2016.

We have as few as five years at current global emissions levels before losing the option to limit warming to 1.5°C. There has never been a more critical time for the Montreal Protocol to prove itself ■

Clare Perry is a Senior campaigner at Environmental Investigation Agency (EIA)

Demystifying natural refrigerants

THE TERM 'NATURAL REFRIGERANTS' IS USED TO CATEGORISE NON-SYNTHETIC SUBSTANCES THAT OCCUR IN NATURE'S BIO-CHEMICAL PROCESSES, UNLIKE 'SYNTHETIC' OR 'FLUORINATED REFRIGERANTS', WHICH ARE MAN-MADE CHEMICALS.

By Klara Skacanova

Today the most commonly used natural refrigerants are ammonia, carbon dioxide and hydrocarbons, such as propane, isobutane and propylene (also known as propene). Water and air can also be used as refrigerants. Indeed both are already being applied in several commercially available applications and continue to be the focus of R&D activities.

Natural refrigerants do not deplete the ozone layer and make a negligible – or zero in the case of ammonia, water and air – contribution to global warming. These products were used as refrigerants prior to the 1950s, before fluorocarbon refrigerants became commonplace. They are now being used more extensively due to their low impact on the environment, good thermodynamic properties, and low cost.

Natural refrigerants offer a 'basket of solutions' with different characteristics that can cover a wide range of temperature needs for different types of application. The high efficiency of natural refrigerants means that they make a lower indirect contribution to global warming too.

The definition of the term 'natural refrigerants' is sometimes debated, given that ammonia, carbon dioxide and hydrocarbons must undergo industrial purification and manufacturing processes in order to be used as refrigerants. However, today there is a well-established distinction between substances whose chemical properties and safety aspects have been studied in their entirety, and fluorinated gases which – given their chemical complexity and comparatively short period of usage – have confirmed and/or have unknown negative effects on ozone depletion, global warming and ecological safety, and are therefore subject to continued debate ■

Carbon dioxide

CO₂ is a non-flammable, non-toxic and environmentally benign natural refrigerant. With a global warming potential (GWP) of 1, CO₂ is the reference value for comparing the direct impact of different refrigerants on global warming. CO₂ as a refrigerant is sourced as a by-product of a number of production methods.

When used as a refrigerant, carbon dioxide typically operates at a higher pressure than fluorocarbons and other refrigerants. Although CO₂ is a higher pressure refrigerant, only in a few parts of a CO₂ system will the pressure be higher than in a conventional system, and special components are available and used for that purpose. It is often claimed that high pressure means risk. However, many commercial applications today work safely at high pressure, including draught beer taps in bars. Moreover, the higher pressure means that CO₂ systems and piping are more compact than current systems, leading to lower material costs.

Ammonia

Ammonia is a colourless gas at atmospheric pressure. With zero ozone depletion and global warming potential, as well as a short atmospheric lifetime, it does not produce any by-products or decomposition products with a negative environmental impact.

Ammonia is known for its higher toxicity, due to which its use is often restricted in areas with public access, but it can normally be used without limits in unoccupied spaces or outside. In occupied spaces, ammonia can be successfully and safely used in indirect systems in conjunction with other refrigerants (often CO₂), where the ammonia refrigerant is safely contained in an unoccupied closed room (or outdoors) and the amount of it is considerably reduced. Moreover, in the event of leakage, ammonia's strong odour of ammonia makes it easy to detect even in very small quantities.

Hydrocarbons

Hydrocarbons are non-toxic refrigerants that have no ozone-depleting potential and a minimal impact on global warming. Hydrocarbons are not just good for the environment, but thanks to their excellent thermodynamic properties, they are as good as or better than HFC or HCFC refrigerants in most applications.

The flammable chemical properties of hydrocarbons are well understood and managed in different applications. More than 700 million hydrocarbon-based domestic refrigerated appliances worldwide serve as proof that hydrocarbons can be used safely. The safety of hydrocarbons (as well as other refrigerants) is governed by international, regional and national standards. Many of these, however, restrict the safe use of hydrocarbons and need to be updated to take account of technological progress.

Water

Water is one of the oldest refrigerants used for refrigeration applications. It is an environmentally safe refrigerant with zero ozone depletion potential and zero global warming potential. It is odourless, colourless, non-toxic, non-flammable and readily available. It is also one of the cheapest refrigerants.

Air

Air is a refrigerant that is environmentally benign, cheap, totally safe and non-toxic. Environmental concerns about ozone depletion and global warming, and increasingly stringent legislation have renewed interest in alternative refrigeration technology worldwide. However, the use of air-cycle refrigeration systems is not new. They were used on refrigerated cargo ships around the turn of the 20th Century.

CO₂ refrigeration technologies for warmer climates in global spotlight

REFRIGERATION SYSTEMS FOR WARMER CLIMATES BASED ON THE NATURAL REFRIGERANT CO₂ WERE ON THE RADAR AT THE ATMOSPHERE CONFERENCE SERIES ON THREE CONTINENTS THIS YEAR, WITH MANUFACTURERS AND END USERS ALIKE SHOWCASING HIGH-EFFICIENCY SOLUTIONS CAPABLE OF TRANSCENDING THE SO-CALLED 'CO₂ EQUATOR'.

By Andrew Williams

HVAC&R experts from hundreds of different companies gathered this year in Tokyo, Barcelona and Melbourne to hear how new technological innovations are bringing high-efficiency CO₂ refrigeration systems to higher ambient temperature regions than had previously been considered technically and economically feasible.

At the outset of ATMosphere Europe in Barcelona, Jonas Schönenberger of Frigo-Consulting argued, "CO₂ transcritical systems should operate in the same way whether they are in a northern European climate or a southern one".

Schönenberger showed how a combination of liquid ejectors, vapour ejectors and heat exchangers together led to an efficiency increase of between 15-25% at Swiss retailer Migros' Mythencenter superstore. With site-specific customisation, the Mythencenter demonstrates that CO₂ transcritical systems can be very successful, he argued.

At ATMosphere Asia in Tokyo, meanwhile, Yukio Yamaguchi of Sanden Environmental Products Corporation demonstrated how

the company's CO₂-CO₂ cascade system with pressure control is achieving excellent efficiencies in convenience stores in high ambient temperature regions.

As a result, Sanden is conducting a demonstration in a hot climate this year to share relevant data. The water-loop system – which can be stopped in winter and features heat recovery supplying hot water – was first introduced into a store in Switzerland, Yamaguchi told ATMosphere Asia participants.

Over in Barcelona, Diego Malimpensa – Business Unit Manager (Retail Solutions) at CAREL Industries S.p.A – identified said the question of efficiency and sustainability in warmer climates as "one final barrier limiting the full deployment of CO₂ transcritical systems".

With this in mind, CAREL and Carrier Commercial Refrigeration Europe joined forces to develop and industrialise a range of modulating ejectors in a bid to put an end to the CO₂ equator. "We're now moving from concepts to real industrial sustainability solutions," Malimpensa argued.



ATMosphere Europe

Presenting a new series of adjustable CO₂ ejectors for commercial refrigeration systems, Sascha Hellmann – project leader for systems development at Carrier Commercial Refrigeration – said that the company's transcritical CO₂ system with the CO₂OLtec ejector rack was capable of reducing the average energy consumption of a total refrigeration system by 13%.

"Carrier provides optimised energy solutions with sustainable refrigeration technologies for every food retail store format," said Hellmann, explaining that the CO₂OLtec system's three working modes were suitable for all seasons.

Torben Funder-Kristensen, Danfoss' Head of Public and Industry Affairs, showed how variable capacity ejectors improve the efficiency of CO₂ as a refrigerant in supermarket applications. Funder-Kristensen explained how fixed, optimised geometry ejectors operating in parallel can vary the capacity by operating only partially. Ejector efficiency can reach up to 25% even in high ambient temperature conditions, he argued.

At ATMosphere Asia in Tokyo, Armin Hafner – a professor in the Department of Energy



2 CO2 System Efficiency Needs To Be At Least Equivalent/Better Than Standard HFC Systems

	Conventional HFC Scroll Pack (R404A)	Mixed Technology Scroll/Semi Booster	Delta
COP MT	4.28	3.88	
COP LT	1.65	1.38	
COP Total ⁽¹⁾	3.69	3.93	6%
Energy MT (kWh)	43,412	48,162	
Energy LT (kWh)	8,808	3,704	
Total (kWh) ⁽²⁾	53,221	51,867	
Yearly Savings (kWh)	Base	1354	3%

(1) Based On Average condensing 25° C
(2) Based On Actual Running Hours

Efficiency Optimised:
Inverters in MT
Scroll & Digital in LT

Integrating HFC & CO2 Claim Offers An Opportunity
To Produce 10% Yearly Savings

ATMOsphere solutions for asia natural refrigerants
9 & 10 February 2016 - Tokyo

Panasonic

ATMOsphere solutions for asia natural refrigerants
9 & 10 February 2016 - Tokyo

ATMOsphere Asia

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→ and Process Engineering at the Norwegian Institute of Science and Technology (NTNU) – demonstrated how ejector technology delivers high system efficiency even at high ambient temperatures. “If natural refrigerant solutions are more efficient than HFCs, then we can eliminate the discussion about efficiency and they will introduce themselves. We need to have a solution: and the ejector is the solution,” he said.

Future CO₂ heat pumps to provide comprehensive heating, cooling solutions

Hafner believes CO₂ is an ideal solution for heat pumps. “CO₂ has the perfect gliding temperature for heat rejection – this is the basic fundamental reason why heat pumps are the perfect match for CO₂,” he said. “Other fluids have to go to very high condensing temperatures to reach the same water temperature.”

He argues that by adding ejector technology, CO₂ heat pumps are able to outperform the other technologies available on the market, even in high ambient temperature conditions. “CO₂ has very good properties, even in very high ambient temperatures, to reject heat to the ground or the air, and this is perfect for the chiller. Another 20% increase in COP can be achieved by adding an ejector,” Hafner said.

Abel Gnanakumar of Emerson Climate Technologies identified cost, efficiency and compactness as the three main priorities for the continued development of CO₂ systems. Emerson’s CO₂ booster system mixing scroll and piston compressor technology is proving very popular in Australia and New Zealand, with Gnanakumar revealing that the firm is also looking to roll it out in Japan and China. “We believe the technology is applicable in Japan. Very close collaboration is required with customers to ensure success,” he said.

Gnanakumar said the company did not find any specific engineering requirements to mix the compressor technology in one pack, which can “easily” be paired with parallel compression and even an adiabatic cooler to mitigate the lower efficiencies in high ambient temperatures.

Kuniaki Kawamura, executive director of Mayekawa, said the company’s NH₃/CO₂ NewTon cascade system was capable of achieving 30% annual energy savings compared to R22 systems, and had been successfully installed in high ambient temperature Pacific regions Thailand, Indonesia and Australia.

In 2013, retail group Lawson started exporting cutting-edge Japanese CO₂ technology to developing countries like Indonesia. Through cooperation with PT Midi Utama Indonesia, a major Indonesia-based retail company, Lawson introduced LED lighting and air conditioners incorporating CO₂ refrigeration systems to stores in the ‘Alfamidi’ minimarket chain.

Lawson, which operates in Japan, China, Indonesia, the US (Hawaii) and Thailand – all regions with warm climates – aims to achieve 20% energy savings across its stores by 2020 (using 2010 as the baseline).

Bringing CO₂ transcritical Down Under

With manufacturers from Europe, Asia and the US looking to make the case for rolling out natural refrigerant technologies in local markets Down Under, ATMOsphere Australia – held on 16 May in Melbourne – showed how CO₂ transcritical solutions are also available for the Australian market.

Bitzer’s state-of-the-art CO₂ transcritical installation at Australian retailer Coles’ Coburg North superstore is a symbol of growing demand for integrated systems

and air conditioning loads supplied through transcritical systems.

Heatcraft Worldwide Refrigeration is also looking to bring CO₂ transcritical to the Australian market. “In Australia we’re looking for installations with ejectors and parallel compression and we’re hoping to have some projects confirmed in the third quarter of 2016,” said Robert DeVentura, the company’s vice-president for global innovations.

Heatcraft’s Australian division launched its first transcritical rack for warm ambient climates at ARBS 2016 – the day after ATMOsphere Australia – and is well placed to bring its range of solutions to market, with existing operations in North and South America, Europe, Asia, and Australia and New Zealand.

“We’re in a good position because we can see a lot of the global trends while they’re happening in the market,” DeVentura said. “We’re excited about the transition towards natural refrigerants occurring and we want to work with end users in all regions to make the transition happen.”

Heatcraft has a strong customer base in Australia and New Zealand but DeVentura said more work still needs to be done to educate and up-skill the industry locally. “As an industry we need to take responsibility and really comprehensively step up our training activities to include CO₂ certification with contractors, educators, suppliers so that they can not only operate the systems but go in and actually diagnose them.”

Exciting times, then, for natural refrigerant technologies – wherever they are in the world



Natural refrigerants emerging in Brazil

NATURAL REFRIGERANTS ARE EMERGING AS THE LEADING ALTERNATIVE TO HCFCs AND HFCs IN THE BRAZILIAN INDUSTRIAL AND FOOD RETAIL SECTORS, HEARD PARTICIPANTS IN A TWO-DAY WORKSHOP HELD IN SÃO PAULO ON 8-9 JUNE.

By Alvaro de Oña

Over 200 experts gathered in São Paulo to share the latest technology trends concerning the use of natural refrigerants for industrial and food retail applications. With Brazil seeking to eliminate 51% of existing HCFCs by 2021, the industry is exploring viable alternatives to ensure a smooth transition – despite the economic crisis currently engulfing the country.

Technologies on show at the event – entitled &R to highlight its clear focus on refrigeration solutions – included solutions based on low-charge ammonia, cascade systems mixing ammonia or hydrocarbons and CO₂, hydrocarbons, transcritical CO₂, and water-based chillers. Training of technicians and engineers, as well as a clearer focus on improving energy efficiency, were identified as top priorities for Brazil in the medium term.

Hosted by the most prominent HVAC&R industry associations (including ABRAVA, ASBRAV and ASHRAE's Brazilian chapter),

CONTINUES ON P.18

Brazilian retailer Atacadão opens all-natural store



CO₂ transcritical system at Atacadão store

The second store to use a transcritical CO₂ system in Brazil opened its doors officially on 16 June in Atibaia, in the state of São Paulo. Having successfully tested the system, store managers expect it to improve the store's energy efficiency and deliver reliable operations in the hot and humid conditions of south Brazil.

Brazilian retailer Atacadão, part of the Carrefour group since 2007, specialises in the 'Cash & Carry' concept. With over 124 stores and 22 distribution centres across Brazilian territory, it is one of the national leaders in its sector. The new store reflects the group's policy to gradually introduce natural refrigerants across all new stores.

"Surely natural refrigerants are going to be the solution for most applications in Brazil," said Mauricio Neto, a consultant helping Atacadão in their refrigeration installations at the store, just days before the opening.

His remarks echo the sentiment of many other Brazilian experts, who see an opportunity to leapfrog from ozone-depleting HCFCs directly to natural refrigerants to update existing installations across the country. The performance and reliability of recent installations with natural refrigerants is therefore crucial to determine the future deployment of the technology on a wider scale in the region.

With a total commercial surface of 6,300m², the store relies on a centralised transcritical CO₂ system. System supplier Advansor provided the two racks, with a refrigerant charge of 150kg each. The system relies on parallel compression, using Bitzer compressors, and direct evaporation.

Complementary to the centralised system, the store counts on large stand-alone refrigeration cabinets with propane (R290) supplied by Austrian manufacturer AHT.

→ the workshop's first day served to explore industrial refrigeration applications and the second day was dedicated to food retail solutions.

Low-charge ammonia: a growing trend in industrial refrigeration

Eric Smith, speaking on behalf of IAR (International Institute of Ammonia Refrigeration) presented IAR 2, the association's recently adopted new safety standard for ammonia. The standard provides clear guidelines to ensure safe installation and handling. Safe handling of the refrigerant is becoming even more important as more low-charge ammonia for packaged equipment enters the market – a trend described as a "game changer" for the food retail sector. Douglas Reindl, Professor at the University of Wisconsin-Madison, meanwhile, gave an overview of incidents and accidents, demonstrating how risks can be minimised through appropriate system design and training.



Celina Bacellar, from Johnson Controls, focused on chillers developed specifically for natural refrigerants, such as compact packaged ammonia chillers. She revealed that an innovative propane-based chiller had recently been installed in Costa Rica, offering excellent performance and reliability. Carlos Suffert, from SPM, presented innovative installations with low-charge ammonia. He cited the case study of an industrial plant that switched from using eight tons of ammonia in a centralised system to a cascade design that requires only 60kg of refrigerant for each circuit.

Speaking from an end-user perspective, René Van Gerwen, former Global Head of Refrigeration at Unilever, called on contractors and suppliers to be more proactive by offering solutions to improve efficiency and sharing know-how. He anticipates more stringent safety standards, a wider uptake of natural refrigerants, and a strong focus on efficiency improvements as major trends for the sector.

Food retail transitioning away from HCFCs and HFCs

The transition away from ozone-depleting substances towards natural refrigerants in the food retail sector was also widely discussed.

Rogério Marson, from Brazilian supplier Eletrofrio, explained how the company is developing a wide range of solutions based on CO₂, either in direct systems or as a secondary fluid, as well as propane in self-standing cabinets and dry coolers, in order to completely eliminate R22 in new installations. Marson also announced that a new store using transcritical CO₂ would open next year in the city of Curitiba in southern Brazil.

Bitzer's Marcos Euzébio, for his part, focused on the performance of CO₂ compressors across the South American continent. He pointed to promising results for ammonia with flooded evaporators (adiabatic cooling) in NH₃/CO₂ systems. Euzébio also highlighted



the importance of training technicians and industry experts as the key to a successful transition away from HCFCs and HFCs.

Additional presentations by Danfoss and Arneg focused on the potential for energy savings first by introducing simple measures, such as putting doors on refrigeration cabinets, integrating automatic controls, and gradually introducing advanced technology like CO₂ systems.

The importance of training for the sector was highlighted once again by Dennis Huehren from GIZ Proklima. He showed how the German association is working hard to provide information about hydrocarbon safety in Brazil, including the free distribution of a dedicated manual in Portuguese adapted to the Brazilian market.

"Clearly, it is essential to take training more seriously. Both for initial qualifications of technicians and engineers, but also as lifelong learning and constant updating of knowledge," concluded Tomaz Cleto, identifying the biggest challenge for a wider uptake of natural refrigerants in Brazil ■



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For the Coca-Cola Company, natural refrigerants are the only way to go



THE GLOBAL BEVERAGE GIANT IS PUTTING NATURAL REFRIGERANTS AT THE HEART OF ITS SUSTAINABILITY STRATEGY – AND IS KEEN TO SHARE ITS EXPERIENCES WITH PARTNERS AROUND THE WORLD.

By Andrew Williams, Charlotte McLaughlin & Nina Masson

The story of the Coca-Cola Company's journey to becoming a non-HFC polluter began at the 2000 Olympic games in Sydney, Australia, where Greenpeace challenged the firm to stop using HFCs in a campaign that cleverly used their own advertising against them. Centred on a polar bear – which has become a powerful symbol of the destructive power of global warming – and using the company colours, the Greenpeace campaign compelled the Coca-Cola Company to act.

And act the Coca-Cola Company most certainly did! Doug Daft, the company's chairman at the time, in 2000 committed the beverage giant to becoming HFC-free for

commercial refrigeration. In 2004, the Coca-Cola Company became a founding member of Refrigerants, Naturally! – an initiative of international companies taking action against global warming and ozone layer depletion by replacing harmful greenhouse gases in point-of-sales cooling and freezing units with climate-friendly natural refrigerants, with the support of partners Greenpeace and UNEP.

Thus began an unlikely partnership between Greenpeace and the world's largest beverage company, which has resulted in a major shift in the way soft drinks are cooled around the globe.

Sustainability holds the key to the Coca-Cola Company's journey

Antoine Azar, global programme director at the Coca-Cola Company, is the current chair of Refrigerants Naturally! For him, sustainability is the foundation stone that gives companies "the social licence to operate". "It is a key pillar in our business," he says.

After spending \$50 million in 2009 in search of a climate-friendly cooling technology, the Coca-Cola Company – by then under the leadership of chairman Muhtar Kent –

CONTINUES ON P.22

→ announced the global objective of phasing out the use of HFCs in all new cold drink equipment by 2015. In 2010, the Consumer Goods Forum – of which Kent was co-chair – declared that all retailer and manufacturer members would begin phasing out HFC refrigerants as of 2015.

Fast-forward to today, and the Coca-Cola Company has installed two million HFC-free units – most of which use the natural refrigerant carbon dioxide. The company uses 230 different CO₂ models adapted to suit the wide variety of locations and situations in which its products are sold. Some of the company's units use propane (R290), but CO₂ is the refrigerant of choice going forward.

The Coca-Cola Company buys over one million units of cold drink equipment annually. Along with its bottling partners, it has already stationed some 15 million vending machines and coolers in more than 220 countries around the world. Replacing all of them with HFC-free units would cut carbon emissions by 52.5 million metric tons over the lifetime of the equipment (typically 10 years) – equivalent to taking 11 million cars off the road for a year, estimate the Coca-Cola Company and Greenpeace.



Azar is confident that the Coca-Cola Company will succeed with its total phase-out of HFCs in most countries. Yet he calls for patience, warning that significant barriers continue to pose challenges in certain countries. He believes a complete phase-out will take time but is achievable in most countries.

"The gap will remain in the lower part of our portfolio, often due to technical barriers – like in Brazil, which imposes import duties," Azar says. Other barriers remain in "very small countries, some islands here and there, but generally speaking they are equipped to be HFC-free," he adds.

"In general, wherever you find a Coke can, you should find an HFC-free Coke can," Azar declares.

Ready for the HFC phase-down

Before the European Union and many other countries committed to phasing down HFCs, the Coca-Cola Company had already pledged to stop using HFCs across its product range. The EU adopted the F-Gas Regulation in 2006, two years after Greenpeace and the Coca-Cola Company had founded Refrigerants, Naturally!

Azar is not afraid of new regulation. "Legislation [like the F-Gas Regulation] will not affect us negatively, as we have been prepared for a while and all our partners in refrigerants are already aware. There will be no business disruption for us."

With major companies like SABMiller, McDonalds, Nestle, Pepsi, Red Bull and Unilever having led the introduction of natural



refrigerants for a long time and having already prepared for such legislation, Azar does not expect a global HFC phase-down to cause major disruptions to their business model.

However, he also expresses hope that regulators will appreciate what the Refrigerants, Naturally! group has been able to achieve. "We are in a phase where there are many companies for which HFC-free technologies work very well, perform well, and they are as efficient if not better. They are cost-effective. So the situation today, look at big companies...everyone is moving to HFC-free!"

Some governments are concerned that in the current economic climate, small companies – and by extension jobs – may be negatively affected by the HFC phase-down. Azar disagrees wholeheartedly with such sentiments. 15 years of following the Coca-Cola Company's journey has shown him that "moving to new technologies will create new jobs". "I don't see a major impact and this is about moving to a better world," he says.

Cost-effective technology

Azar hopes that clear decisions will be made during upcoming rounds of international negotiations on phasing down HFCs, putting the world on a trajectory that is "cost-effective and better for the environment".

To put in place its own HFC phase-down strategy, the Coca-Cola Company made significant changes to its own training procedures and supply chain. But taking such action requires planning, says Azar, calling on the international community to sign off on the new phase-down trajectory as

soon as possible to give companies plenty of time to respond.

"If you have a supplier who is supplying new equipment – whether hydrocarbons or CO₂ – then they are able to train your workers in new technology," says Azar. He concedes that initially this takes time but stresses that the investment soon pays off.

"Any end-user can have access to the same technology as us," the Coca-Cola representative says. Components specifically designed for CO₂ systems, which operate at particular pressures and under specific conditions, have undergone impressive development in recent decades. Features like compressors and controls help to improve system efficiency but add complexity, he says, stressing the need for proper training.

CO₂ effective in warmer climates

Some customers are wary of adopting CO₂ technologies in warmer ambient temperature regions, but the Coca-Cola Company – which has opted for CO₂ as its primary natural refrigerant – has recorded impressive performance all over the world.

"One of the conditions in moving from HFCs to HFC-free is that the new systems need to be as good at energy performance," Azar says. He is pleased to report that in the warm and even tropical conditions of Asia, South America and the Middle East, CO₂ is performing "just as well" as any HFC refrigeration technology ■

Natural refrigerants – from farm to fork

THE COLD CHAIN PLAYS AN IMPORTANT ROLE IN PREVENTING FOOD LOSSES AND DELIVERING FRESH AND SAFE FOOD FROM FARM TO FORK. THE FULL SPECTRUM OF NATURAL REFRIGERANTS – CO₂, AMMONIA, HYDROCARBONS, WATER AND AIR – IS BEING USED TODAY THROUGHOUT THE FOOD COLD CHAIN, IN DEVELOPED AND DEVELOPING COUNTRIES ALIKE.

By Klara Skacanova

Ammonia has traditionally been used as the refrigerant of choice in industrial refrigeration, from food processing to food storage and distribution, and in diverse locations such as breweries and wineries.

While ammonia remains the primary natural refrigerant in industrial refrigeration installations, CO₂ is starting to make significant inroads as a secondary refrigerant in different parts of the world.

NH₃/CO₂ systems offer improved safety due to the lower ammonia charge, while energy efficiency is typically higher than that of traditional ammonia or R22 systems. In China, NH₃/CO₂ systems have been applied in more than 34 projects in different sectors. Current fields of application include ice-making, slaughterhouse processing, logistics and cold storage, aquatic product processing, artificial ski slopes, fruit and vegetable processing, other processed goods, and the ice cream industry.

A good example of an NH₃/CO₂ installation is Kobeya Baking Company's facility in Chiba, Japan. The company converted the previous R22 refrigeration system to an NH₃/CO₂ solution at its 7,034m² frozen dough

production facility. The new system delivered average energy consumption savings of 38-48% in summer and 25% in winter, due to an innovative system design including an inverter-driven air compressor.

Air: A perfect fit for ultra-low temperature applications

Today, at least 54 units using air as a refrigerant have been installed in a number of applications, including chemical process cooling, ultra-low temperature warehouses, and rapid food freezing.

Sea Sky Global's state-of-the-art tuna processing plant, located in Busan, South Korea, features three units that use air as a refrigerant to keep the company's 2,500 tonnes of raw tuna and processed products fresh. A major benefit of the system is that it helps to reduce costs; the system has slashed electricity consumption by 40%. In addition, because air is a harmless gas, there is no need to hire a safety manager, which reduces labour costs.

What's in store for natural refrigerants?

A wide variety of natural refrigerant-only technology solutions are already commercially available

for supermarket refrigeration: CO₂ transcritical, CO₂/ammonia cascade, waterloop with hydrocarbon plug-ins, CO₂ condensing units, hydrocarbon/CO₂ cascade, and more.

CO₂ transcritical technology, which uses CO₂ as the refrigerant for both medium and low temperature refrigeration, has seen the most significant increase across different world regions. Today there are already over 7,200 stores using CO₂ transcritical systems around the world, with the highest numbers installed in Europe and Japan as a result of policy pressure to reduce HFC emissions as well as commitments by retailers.

With 63 CO₂ transcritical stores already in operation today, uptake of the technology is growing in South Africa – primarily driven by retailers Woolworths and Makro. As demand for CO₂ technology grows worldwide, system suppliers in South Africa are confident that the market will continue to prosper.

In warmer ambient temperature regions, there are high-efficiency solutions capable of transcending the so-called 'CO₂ equator' (a geographical line above which CO₂ is considered to be more energy efficient than fluorinated refrigerants). These include parallel compression, adiabatic cooling, ejectors and sub-coolers. CO₂ technology, for example, has been installed in 12 convenience stores in the warm climate of Indonesia. A case study of two stores in Jakarta found that an average of 20% energy savings led to a 15% increase in average sales.

As for light commercial refrigeration, globally there are more than 4.5 million HFC-free units currently in operation, using either CO₂ or hydrocarbon refrigerants. This is a truly global trend driven by global consumer brands, such as Coca-Cola, PepsiCo, Unilever, Red Bull and others.

Greening transport refrigeration

Essential for preserving food on land and at sea, transport refrigeration plays a key role in the food cold chain. A number of natural refrigerant-based systems have been commercialised or are currently being tested for use in road transport and on fishing vessels and cargo ships.

A pilot project on hydrocarbon technology involving Transfrig and Tshwane University has been launched in South Africa to develop a climate-friendly technology for refrigerated trucks using propane as the refrigerant.

The R290 prototype was built at the end of May 2015 and is currently undergoing testing (including for leakage and safety). In order to address R290 flammability issues, the charge size was significantly reduced from 3.5 kg to 0.65 kg. Direct emission reductions of greenhouse gases were achieved, from the previous 6.9 tCO₂eq to just 0.001 tCO₂eq. Estimated fuel consumption is also more advantageous for the R290 system, at 1.0 L/h (compared to 1.2 L/h for R404A unit) ■

COLD FOOD CHAIN INFOGRAPHIC
ON P.26

food chain

- CO₂ carbon dioxide
- NH₃ ammonia
- HC hydrocarbons
- H₂O water
- AIR air
- heating
- refrigeration
- air conditioning



food transport



cargo ships / reefers



fishing vessels / trawlers



refrigerated transport (trucks)



food processing



food / fruits and vegetable processing



wineries / breweries



fish processing

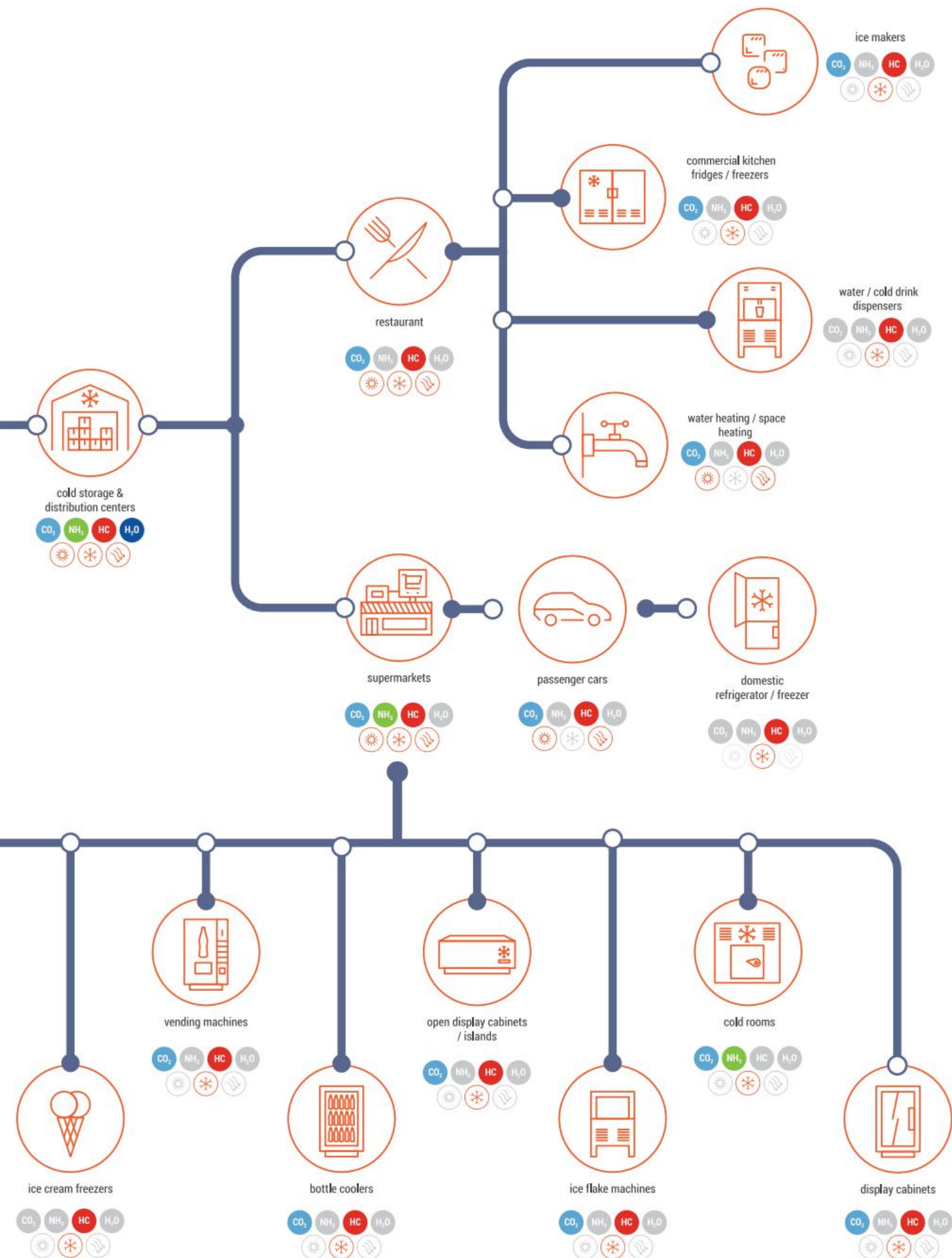


slaughtering / meat processing



central refrigeration systems







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Crossing new frontiers: Carrefour bringing natrefs to warm climates

FOR CARREFOUR, REFRIGERATION PLAYS A KEY ROLE IN DELIVERING ENVIRONMENTAL SUSTAINABILITY OBJECTIVES. RECORDING EXCELLENT RESULTS IN WARM CLIMATES AND BLAZING A TRAIL TO NEW MARKETS LIKE BRAZIL, THE RETAIL GIANT IS PUTTING NATURAL REFRIGERANTS AT THE HEART OF ITS STRATEGY TO BECOME HFC-FREE IN THE NEAR FUTURE – WORLDWIDE.

By Andrew Williams

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

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

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

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

Towards an HFC-free Carrefour

Paolo Martini, Refrigeration & HVAC Manager for International Support at the Carrefour Group, is the man charged with delivering this transition.



Paolo Martini, Refrigeration & HVAC Manager for International Support at the Carrefour Group

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

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

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

CONTINUES ON P.30

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

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

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

Taking European know-how to Brazil

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

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

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

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



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

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

CO₂ equator disappearing

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

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



Transcritical CO₂ system at Atacadão

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

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

He sees continuous innovation in CO₂ technology for commercial and industrial applications, specifically focused on improving the performance of transcritical systems in warm climates, as a major driver of increased uptake of natural refrigerant solutions in Spain – lessons which can be exported to other countries with similar climatic conditions.

"We solved the performance challenges in high ambient temperatures by integrating several elements into the installations. We installed parallel compression, sub-coolers

and ejectors to improve performance when the ambient temperature is high," says Ivan Díaz, Carrefour Spain's national Refrigeration & HVAC manager.

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

Closing the global training gap

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

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

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

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

Innovative industrial refrigeration systems from Japan

WHILE AMMONIA HAS LONG BEEN AN ACCEPTED STANDARD REFRIGERANT, ESPECIALLY IN LARGER INDUSTRIAL REFRIGERATION SYSTEMS, JAPAN-BASED

MAYEKAWA'S NEW GENERATION OF NATURAL REFRIGERANT TECHNOLOGY IS SHAKING UP THE SECTOR.

By James Ranson & Justina Tamasiunaite

Driven by regulatory and technology change, reducing ammonia charges while simultaneously increasing energy efficiency now hold the key to unlocking the full potential of HFC-free systems around the world.

Mayekawa's green innovation

Japanese group Mayekawa's new generation of low-charge, high-efficiency NH₃/CO₂ secondary systems, the NewTon, is challenging traditional ammonia systems. Mayekawa has managed to reduce the ammonia refrigerant charge in their systems to just 25kg, down from an original 300-400kg.

"Our endeavour on natural refrigerant technologies started from the conception that solving environmental issues is a global mission that has to be [solved] this century," said company President Tadashi Maekawa.

President Tadashi Maekawa

"Mayekawa was originally involved in industrial refrigeration, and we chose natural refrigerants not only because they were friendly to the global environment, but also efficient, so our business developed towards the employment of the 'Natural Five'," he added, referring to the company's strategy for becoming HFC-free.

The systems are predominantly manufactured in Japan, where Mayekawa has sold over 800 units. Continuous innovation will be crucial for growth in new markets, where natural refrigerant cascade systems are starting to leave their mark in the industrial sector. "The NewTon series is really an important business for us. Although it has gained ground in the Japanese market, we also need to continue [marketing it] overseas, so that this system will be a standard throughout the world," Maekawa said.

"We also need to introduce more products into overseas markets [...]. While increasing our sales, we will continue to develop a far more advanced NewTon that achieves higher efficiency using a smaller ammonia charge."

To meet the increased demand, Mayekawa will improve its service networks and collaborate with local companies with the aim of launching a smaller NewTon that uses an NH₃ scroll compressor, for the commercial market, in the first half of 2016. In addition, new production lines for NewTon motors will be constructed at the company's Higashi-Hiroshima plant.

"We need to address compressors as well, but we will first enhance the efficiency of the motors. The construction will start [in 2016] and the plant will have a clean room," Maekawa said.

While Mayekawa traditionally services a wide spectrum of industrial sectors, a move into commercial refrigeration and industrial air conditioning could have positive implications for the company's business. "We are going to construct a building that has NH_3/CO_2 air conditioning systems. Also, we are planning to develop NH_3/CO_2 systems for supermarkets and convenience stores," said Maekawa.

Showcasing success stories

Japan's NittoBest Corporation started investigating natural refrigerants in 2010, but decided to take a cautious approach and continue researching all available solutions. In February 2014 the company made its move, installing an NH_3/CO_2 system from another local supplier through its Kyushu Best Foods chain at a facility in Fukuoka Prefecture.

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



Yamagata facility, Nitto Best



Nissui Logistics, Osaka Mashima facility

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

// FOR US, THERE ARE NO OTHER
OPTIONS BUT NATURAL
REFRIGERANTS," HE REPEATED.

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

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

China's policy putting natural refrigerants at the forefront

WITH THE HCFC PHASE-OUT CURRENTLY UNDERWAY, CHINA HAS THE OPPORTUNITY TO LEAPFROG INTERMEDIATE SOLUTIONS LIKE SYNTHETIC REFRIGERANTS. RECENT POLICY DEVELOPMENTS IN CHINA INDICATE THAT THE GOVERNMENT SUPPORTS NATURAL REFRIGERANTS AS A FUTURE-PROOF AND LONG-TERM SOLUTION ACROSS A WIDE VARIETY OF APPLICATIONS.

By Klara Skacanova

Although there is no comprehensive policy to address the production and consumption of HFCs in China, the HCFC phase-out and increased prominence of environmental issues are creating new opportunities for natural refrigerants in a number of sectors.

Amid global discussions on phasing down HFCs and with many countries still unsure as to which alternatives are ready to step in, China has recognised the potential of natural refrigerants to take centre stage – to an extent that leaves little to no room for HFCs in China's medium to long-term vision.

"In China, natural refrigerants can contribute to reducing greenhouse gas emissions and lead to bluer skies," Xiao Xuezhi, Deputy Director-General of China's Foreign Economic Cooperation Office (FECO) – an agency attached to China's Ministry of Environmental Protection – told a gathering of the Ozone2Climate Industry Roundtable held in Beijing in April 2016.

As a signatory to the Montreal Protocol, China has agreed to gradually phase out the production and consumption of HCFCs by 97.5% by 2030, while retaining the remaining 2.5% for servicing existing refrigeration and air conditioning systems during the period 2030 to 2040. Given that China currently manufactures around 92% of HCFCs in developing countries, the phase-out of production will have enormous repercussions internationally.

Achieving the HCFC phase-out compliance targets will be a significant task that requires the involvement of a multitude of industries and sectors, but it also presents opportunities to the market to replace HCFCs with natural refrigerants.

Natural refrigerants recommended as HCFC substitutes

In June 2015, China's FECO published a proposed list of recommended substitutes for ozone-depleting substances. Natural refrigerants – CO₂, ammonia and hydrocarbons – dominate this list in 10 out of 12 applications, which is a clear indication of China's stance in promoting the accelerated adoption of natural refrigerants in as many applications as possible.

FECO worked closely with an expert team to establish the list. "A very important principle was that there should be some successful examples or demonstration projects using the technology in China," said Zhong Zhifeng, Vice-Chief of Division III at FECO.

"Even if it is used widely in other countries, if there are no examples in China we did not include it in the list. Moreover, technologies that have a good potential are not listed either," Zhifeng said.

He further explained that China intends to regularly update the catalogue with additional applications as those alternatives are proven in installations on Chinese territory.

"We think HFCs, especially high-GWP refrigerants, are relatively short-term solutions – or 'transition technology' – and this is why we did not put any high-GWP refrigerants in the list," said Zhifeng.

CO₂ is recommended as a suitable alternative in commercial and industrial refrigeration, as well as heat pumps and mobile air conditioning. "I definitely think [CO₂ heat pump water heaters] will have a very, very good share of the market by 2020," he said.

The use of propane in room air conditioners (RAC) is set to grow, following the conversion of 20 RAC production lines and four compressor production lines to R290. Further conversions to propane are proposed under the Stage II HCFC Phase Out Management Plan.

R290 for water chillers is another area with strong potential. While this application is not yet included in the Catalogue, Zhifeng is convinced that "by 2020 manufacturers will have finished the development of R290 water chillers in China and the technology will be ready for production".

This technology has been widely used in Europe, thanks in particular to favourable European standards compared to the equivalent IEC and ISO standards, whose scope is much more restricting. "The precondition for adoption of natural refrigerant technology is that we need to have better standards to ensure safety – this is the most important aspect," Zhifeng stressed.

Recommended substitutes to HCFCs



The Catalogue should offer guidelines for domestic manufacturers, but also for consumers and policymakers in the long term. While the Catalogue does not impose any regulatory obligations, the government has implied that policy actions to support the introduction of the technologies it promotes will follow.

This was the approach that the government took after announcing its support for the promotion of R290 as a replacement for R22 in residential air conditioners in 2012. Besides helping air conditioner manufacturers overhaul their production lines, the government provided subsidies for the production and marketing of R290 air conditioners as well as introducing a new 'Environmental Protection and Low Carbon Label' in 2015 to incentivise consumers to choose green air conditioners.

Revised standards for broader use of naturals

International and national safety standards are very important, as they regulate the extent to which natural refrigerants can be used in specific refrigeration and air conditioning systems. For example, the Chinese national standard GB 9237 for mechanical refrigeration systems used for cooling and heating is based on the old version of ISO 5149 (for refrigeration systems and heat pumps) and forbids the use of flammable refrigerants. This prevents the use of the majority of natural refrigerants, except for

some very special fields of application. The new version of ISO 5149 allows the use of flammable refrigerants, but limits their scope. China is currently revising national standard GB 9237. If finalised as expected later this year, it would remove many of the barriers standing in the way of natural refrigerants.

China is involved in reviewing international standards, such as IEC 60335-2-40, which regulates safety requirements for residential heat pumps and air-conditioning. The current version of the standard limits the safe use of flammable refrigerants such as hydrocarbons, with discussions ongoing to increase the charge limits.

China also plans to revise national standard GB 4706.32, which allows the use of propane but limits the charge to a point that R290 can only be used in smaller air conditioners. A new national safety standard for CO₂ in cold storage has also been drafted and now is being scrutinised by industry. The standard should be finalised in the second half of 2016



Governments, polluters increasingly accountable for environmental issues

In 2015, China revised its Environmental Protection Law for the first time in 25 years. The update imposes significantly greater controls and reinforces the responsibilities of corporations and local government bodies with regard to environmental protection. It heightens the monitoring and level of punishment of lawbreakers while simultaneously encouraging the public and media to help report corporations that fail to comply with the law.

In addition to imposing stricter controls and punishments, the Environmental Protection Law offers incentives to companies that comply with the new regime, or to companies working in the environmental technologies sector. These companies can be awarded tax breaks and fiscal assistance to help further improve the environment.

The updated Environmental Protection Law sends a clear message to the industry in China and abroad – China is getting serious about protecting the environment. The industry has reacted positively to the new environmental law and its requirements, reporting increased demand for R&D staff in HVAC&R of 38.7% in May 2014 (compared to the previous year). The industrial upgrading of environmentally friendly technology makes economic sense, according to the Foreign Economic Cooperation Office of the Ministry of Environmental Protection, which argues that the shift to climate-friendly refrigerants gives China the chance to compete with other countries in the HVAC&R sector. As a result, the Ministry of Environmental Protection has specifically encouraged the industry to pay attention to newly developing fields, such as heat pumps.

Vietnam, UNIDO team up to showcase hydrocarbon future

WITH ITS INNOVATIVE FINANCING SCHEME AND AN EFFECTIVE MIXTURE OF POLICY SUPPORT, TECHNOLOGY TRANSFER AND AWARENESS-RAISING, A SOON-TO-FINISH UNIDO PROJECT IN VIETNAM IS PAVING THE WAY FOR WIDER UPTAKE OF SMALL HYDROCARBON REFRIGERATION SYSTEMS IN THE FISHERY AND COLD STORAGE SECTORS WORLDWIDE.

By Nina Masson

The United Nations Industrial Development Organization (UNIDO) initiated the project, entitled 'Reducing greenhouse gas and ozone-depleting substance emissions through technology transfer in industrial refrigeration', in 2014.

The project sought to address three clear challenges.

Firstly, Vietnam, a country whose industrial refrigeration sector was heavily reliant on R22 – a climate-damaging HCFC – needed to move away from ozone-depleting substances in favour of zero ODP and very low GWP equipment that can be easily installed at reasonable cost using standardised components for easy repair or replacement. A transitional move to HFCs was ruled out from the beginning, to avoid lengthy and costly adaptation processes that would ultimately end in another phase-out of HFCs sometime in the future. HFC-free refrigerants, therefore, were the natural choice for Vietnam, which has signalled its official stance in support of a phase-down of HFCs under the Montreal Protocol.

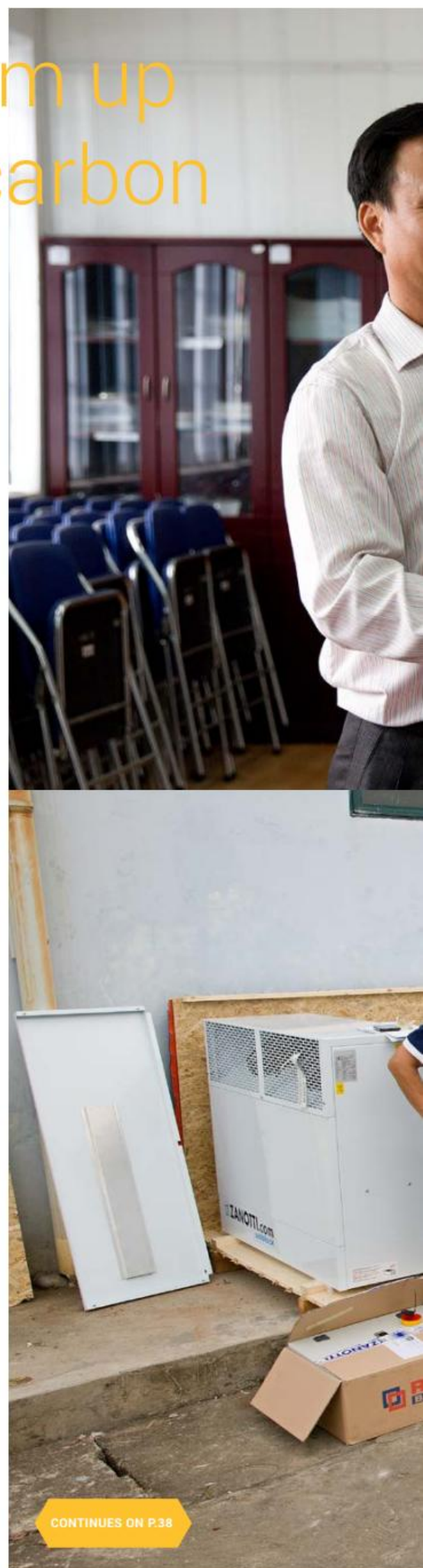
Secondly, Vietnam's outdated regulations and standards governing the use of non-fluorinated gases, namely natural refrigerants like hydrocarbons (R290, R600a), ammonia or carbon dioxide, needed to be updated to

allow for the effective, safe and profitable use of these alternatives. This had to go hand in hand with more effective control and phase-out of HCFCs, as well as more efficient use of energy across the country.

Finally, Vietnam had to face one of its biggest challenges: making end users aware of the availability and technical viability of entirely HFC-free solutions beyond the mere 'quick fix' of replacing R22 with high global warming potential (GWP) HFCs like R404A or R407A. Instead, the country set out to encourage cold storage operators to opt for the natural refrigerant propane (R290), which would be a much better long-term choice for the environment and their pockets alike.

Innovative finance mechanism

The solution to addressing all three challenges at the same time lay in an innovative project scheme and financing mechanism leveraging the power of an international organisation (UNIDO), a national government (Vietnam) and industry partners for technology transfer and communication (Zanotti, shecco) to deliver the best results. The project's three components – policy and regulatory support, technology transfer, and awareness-raising and capacity-building – were designed to reinforce each other in providing the necessary tools for the successful use of hydrocarbons in industrial refrigeration systems.



CONTINUES ON P.38



Partners for more sustainable refrigeration: UNIDO and Vietnam



Arrival of the new R290 refrigeration units



Installing hydrocarbon systems in Vietnam's cold storage sector

→ As a potential model to emulate for future effective Public-Private Partnerships, the two-year project was only partly funded by the Global Environmental Facility (GEF). Using co-financing contributions from the two industry partners, the Vietnamese government and UNIDO, the project was conducted in a cost-effective manner while delivering high-quality results.

And yet the project went still further. To promote the effective and sustained uptake of R290 equipment, Vietnam decided to test the viability of R290 pre-packaged refrigeration systems in four project sites across the country, before offering soft loans and funds to other operators of cold storage facilities willing to install similar systems in their companies.

"Innovative financing mechanisms play an important role in supporting enterprises to convert their systems to alternative technologies with zero ODP and low GWP. Financial support under soft loans from linked commercial banks and the Vietnamese Environmental Protection Fund [...] are among the solutions to help enterprises go for natural refrigerants," says Nguyen Thi My Hoang, national project coordinator on behalf of the Vietnamese government.

Pilot projects showcase propane applications for Vietnam

Following field trips to cold stores throughout the country in 2014, R290 (propane) demonstration units were installed in four Vietnamese companies. A full conversion at the Phu Minh Hung Seafood Joint Stock Company, with a total of nine R290 refrigeration units, was complemented by partial conversions in three other cold storage sites featuring another 16 hydrocarbon units.

The firm's fish and seafood processing facilities demanded cooling capacities in the range of 20 to 200T. The chosen solution, a 5 horse power (HP) refrigeration unit by Italian manufacturer Zanotti, convinced with its compact, lightweight design, its fully automatic and adjustable settings, and its high reliability. The ease of installation and option of directly mounting it on the cold store wall panel without additional support structures helped to reduce installation costs and time, and allow it to operate continuously without the need for significant maintenance.

The equipment, containing just 1.6 kg of hydrocarbon refrigerant per unit, reduce the risk of fire to a minimum, while providing the necessary cooling capacity for keeping small cold room temperatures to -20 degrees Celsius at ambient temperatures of 35 degrees Celsius. Compared to larger ammonia-based systems, the hydrocarbon units were expected to reduce installation costs to a fraction of those of NH3 systems.

By July 2015, all the R290 systems had been manufactured by Zanotti and delivered to the four companies, who expected to see more reliable refrigeration and stable cold room temperatures capable of delivering higher quality products, alongside a shorter payback time due to lower operating and installation costs.

Energy efficiency at heart

Fast-forward 11 months and those expectations have not just been met, but exceeded by far. With average energy efficiency gains of 20-25%, the four pilot projects – one of which has even achieved energy savings of up to 42% compared to the previous R22-based system – are serving as

a model to follow for the conversion of more cold stores across the country

Information material, brochures, workshops and additional funding are now in the pipeline to ensure high knowledge levels among cold store operators lead to an early, safe and viable transition away from R22. The prospects are promising, given that the hydrocarbon units do not cost much more than R22 and HFC equipment with similar cooling capacities.

Gaining in confidence, Vietnam's government is now envisaging the use of natural refrigerants in other sectors, according to Nguyen Thi My Hoang. To facilitate this, the country has issued new regulations on controlling and phasing out HCFCs and introduced a law on the efficient use of energy, while planning additional funding to support the uptake of natural refrigerants elsewhere.

UNIDO and its national partners are positive that natural refrigerant systems like the hydrocarbon units tested, using only standard components that are currently available on the market and that are flexible enough to suit other purposes, will have a great future not only in Vietnam but also elsewhere. Their joint communiqué therefore concludes that, "taking these advantages into consideration, it is highly probable that [...] similar R290 units will have a considerable market share worldwide in the coming years" ■

Regulatory developments driving uptake of natural refrigerants in Japan

THE USE OF NATURAL REFRIGERANTS IN JAPAN IS STRONGLY INFLUENCED BY A VAST ARRAY OF GOVERNMENT POLICIES AND INITIATIVES THAT HAVE DRAMATICALLY ACCELERATED THE INTRODUCTION OF NATURAL REFRIGERANT TECHNOLOGY AND MITIGATED THE GROWTH OF OTHER ENVIRONMENTALLY FRIENDLY SOLUTIONS AT HOME AND IN NEIGHBOURING SOUTH ASIAN COUNTRIES.

By Justina Tamasiunaite

In April 2015, the Japanese government introduced new policy measures for reducing emissions of fluorinated gases. The main drivers of this regulatory revision were a dramatic increase in emissions of fluorinated gases as well as high leakage rates from commercial air conditioning and refrigeration equipment.

Revised F-Gas Law: greater push for natural refrigerants

With the revised F-Gas Law, the Japanese government expanded the scope of f-gas measures from their previous focus on recovery and destruction to include the whole lifecycle, including f-gas manufacturing, maintenance and leak checking, the promotion of low-GWP/non-fluorocarbon refrigerants in designated products, and destruction and recycling.

Manufacturers and importers of certain refrigeration and air conditioning systems will be requested to reduce the climate impact of their equipment by deploying non-fluorinated gases or other refrigerants with a lower Global Warming Potential (GWP) by certain target years, depending on the product category. Weighted average GWP values of entire production and imports will be taken into account to measure compliance by manufacturers.

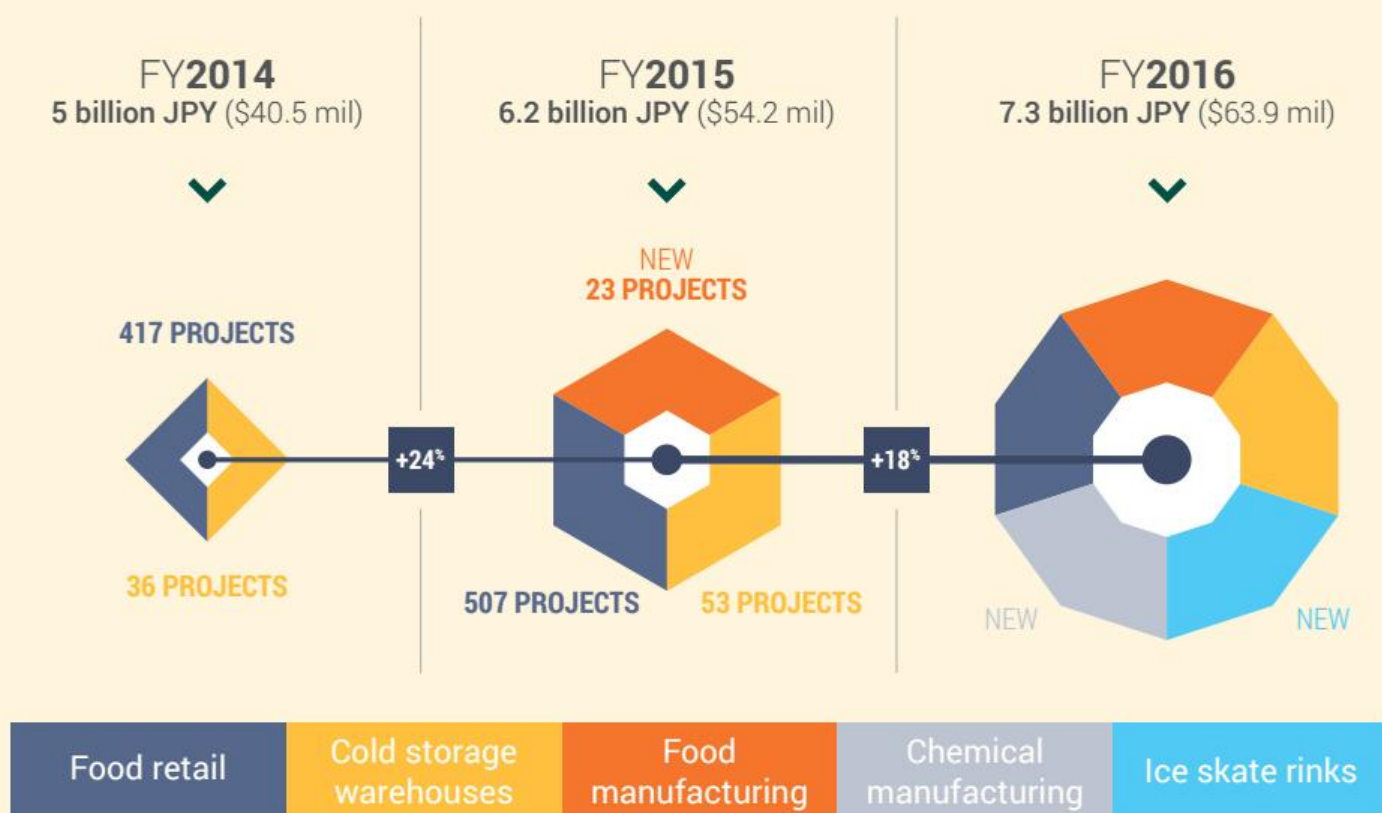
Other relevant policies driving natural refrigerants

The Japanese Act on the Rational Use of Energy (ARUE), established in 1979 to help tackle the oil crisis, is now considered one of the most important measures driving the reduction of greenhouse gas emissions as well as improving energy security. Under ARUE, products that have the greatest impact on energy consumption, such as air conditioners, refrigerators and vending machines, are obliged to meet updated targets under Japan's so-called 'Top Runner' programme.

To meet these targets, energy-efficient natural refrigerants are being adopted in various applications to help reduce energy consumption. One key example of how this has pushed the market towards natural refrigerants is the introduction of isobutane for domestic refrigerators, which is now a standard in Japan. Hot water heat pumps are another example of how ARUE benefits natural refrigerants, as the application was included under its scope in 2013.

CONTINUES ON P.40

Japan's subsidy growing in scope and budget



→ Japan's 'Top Runner' programme, adopted in 1999, introduced a set of energy efficiency standards for energy-intensive products, including small appliances and motor vehicles.

As of 2015, 21 product categories were eligible for the 'Top Runner' label. The scheme encourages companies to develop more efficient models and compete for a 'Top Runner' award.

The award of Top Runner status is complemented by the ability of Japan's Ministry of the Environment (MOE) to disclose the names of companies that fail to meet energy efficiency targets, as well as issue recommendations and orders. However, as of yet, no enforcement actions have been taken as targets have either been met or exceeded.

Meanwhile, the High Pressure Gas Safety Act regulates the production, storage, sale, transportation and other matters related to the handling of high-pressure gases. The outdated classification of CO₂ as an 'active gas' under the Act limits the availability of large capacity systems and increases the cost of CO₂ solutions for supermarkets and industrial refrigeration applications.

Although exemptions for fluorinated refrigerants and ammonia exist, the regulations governing the use of CO₂ and hydrocarbons are more stringent. This means that official permission must be obtained to install equipment with a capacity above 40-50 horsepower, thereby representing a significant barrier for end users.

JPY 7.3 billion in subsidies for natural refrigerant technology in 2016

"Technology using natural refrigerants has improved in efficiency and safety, but has not yet spread widely. To address this situation, the Ministry of Environment financially supports installations of high-efficiency equipment with natural refrigerants," said Motoyuki Kumakura, director of the Office of Fluorocarbons Control Policy in the Ministry of Environment.

In 2005, the MOE initiated a subsidy scheme for commercial and industrial projects using natural refrigerants. In the period 2005-2013, the scheme was available for renovation, earthquake reconstruction and advanced technology projects, aiding a total of 242 projects in this phase.

As of 2014, the subsidy scheme has undergone a substantial revision coupled with a funding increase, resulting in a dramatic upturn in the number of projects receiving aid. Since 2014 the subsidy has been the major driver of growth in the number of CO₂ stores as well as NH₃/CO₂ cold store facilities in Japan.

This subsidy aided 583 projects in 2015, most of which were in food retail. The scope of the scheme has widened, with the food manufacturing sector added in 2015, and chemical manufacturing and ice rinks included as of 2016. In addition, the budget allocated for the subsidy has been growing year-on-year. It increased by 24% in 2015 and by an additional 18% in 2016. The 2016 budget of 7.3 billion yen bodes well in terms of both the number of projects that will potentially receive help and the Japanese market for natural refrigerant technology.

Japan supports natural refrigerant technology internationally

In Japan, the Act on the Protection of the Ozone Layer through the Control of Specified Substances is making an effective contribution to phasing out the production and consumption of CFCs and HCFCs. In addition, the HCFC phase-out target for 2020 is pushing supermarkets and cold storage warehouses to convert their facilities from R22 to natural refrigerants such as CO₂ and low-charge ammonia (NH₃), through the wider adoption of secondary NH₃/CO₂ systems.

As for international discussions on a global phase-down of HFCs, Japan argues that the Montreal Protocol needs amending to better protect the environment. The government provides support for implementing projects in developing countries through the country's Joint

Crediting Mechanism (JCM). The energy savings and f-gas emission reductions achieved by such projects translate into emission reduction credits under the JCM and count towards meeting Japan's greenhouse gas reduction targets. One project sanctioned under the scheme is bringing CO₂ transcritical refrigeration technology to Indonesia.

Towards wider adoption of natural refrigerants in South Asia

Japan is one of the world's biggest producers of HVAC&R equipment, and as such is a valuable exporter. Technology exchange is common with nearby regions such as South-East Asia, where demand for natural refrigerant products is growing. Indeed, several Japanese companies already operate in countries such as China and Indonesia.

Thanks to the Indonesian Eco-Project, Panasonic's CO₂ CVS technology is now being used in 13 Alfamidi (an Indonesian retailer) and Lawson stores in Indonesia. The installations supported by the Japanese government demonstrate the desirability and applicability of Japanese technology for CVS. In addition to Panasonic, Sanden is also fitting several stores with CO₂ solutions, increasing competition within the market ■

For more details about Japan policy, read the
GUIDE to Natural Refrigerants in Japan
- State of the Industry 2016



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Going global with hydrocarbons

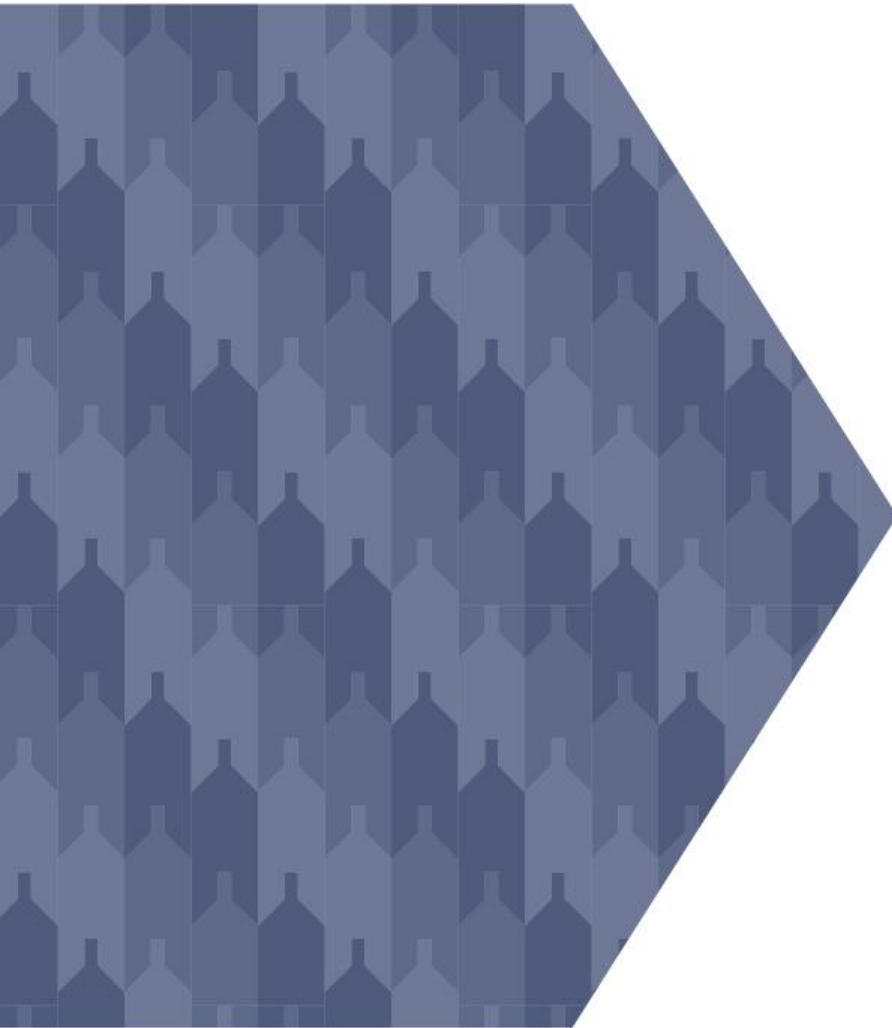
RESTRICTIONS ON CHARGE LIMITS AND A LACK OF TRAINED REFRIGERATION TECHNICIANS ARE AMONG THE KEY REMAINING BARRIERS TO THE WIDER INTRODUCTION OF HYDROCARBON-BASED TECHNOLOGY IN HERMETICALLY-SEALED COMMERCIAL REFRIGERATION EQUIPMENT AROUND THE WORLD.

By Klara Skacanova

The use of hydrocarbons, such as propane and isobutane, is already widespread in domestic and light commercial refrigeration applications. With more than 700 million domestic refrigeration units using hydrocarbons and 4.5 million HFC-free light commercial refrigeration units worldwide – most of which use hydrocarbons – there is broad acceptance of the technology's viability, excellent energy efficiency performance, and safety.

Nevertheless, challenges remain in terms of introducing hydrocarbons in certain types of plug-in commercial refrigeration equipment as well as in particular world regions. Among these diverse challenges are safety standards and regulations, perception of risk, level of technology awareness, and cost. Given the success of hydrocarbon-based technology, the wide availability of commercialised products and companies working with the technology, most of these hurdles can be alleviated quickly.

Embraco, a Brazil-based compressor manufacturer, sees hydrocarbons as the best long-term solution for light commercial applications at both low and medium pressures. The company ranks among the global pioneers in developing environmentally-friendly products and in offering a full product line of hydrocarbon compressors. Embraco believes that the challenges can be overcome by addressing current safety standards, and by increasing efforts to improve practical and theoretical knowledge of hydrocarbons among refrigeration technicians.



Hydrocarbon training in the Gambia

Seeking to improve the skills of refrigeration technicians in the Gambia, Embraco provided two refrigeration training systems using isobutane (R600a) for a project led by the United Nations Industrial Development Organisation (UNIDO), in cooperation with the Gambia Technical Training Institute (GTTI) and Italian training provider Centro Studi Galileo.

“On these systems, the Gambian technicians will complete their theoretical and practical training with the relief of the systems operating parameters, the evaluation with an indirect method of eventual refrigerant leaks, and the verification of working conditions on their restart,” said Renzo Casamassima, Embraco’s Technical Support and Application Lab Leader.

Embraco is looking to engage with other projects in Africa. With 80 million inhabitants and an established production facility for refrigerant-grade hydrocarbons, Nigeria is a promising country for projects that promote natural refrigerants. Previous experience from China shows that establishing refrigeration plants and compressor manufacturing in Africa would help make the region self-sustaining with regard to next-generation, future-proof technology.

Revision of standards underway

At global level, existing standard IEC 60335-2-89, governing the safety requirements of hermetically-sealed commercial refrigeration equipment, limits the charge of any flammable refrigerant. For hydrocarbons, it sets a charge limit of 150g per refrigeration circuit. Marek Zgliczynski, Embraco’s Manager of Commercial Refrigeration Product Engineering, argues that this limit has no scientific foundation and instead was simply lifted from a previously existing standard regulating the safety of residential refrigerators and freezers.

Zgliczynski chairs the IEC/SC61C subcommittee, an international committee that is currently revising the charge limits for flammable refrigerants under IEC 60335-2-89. The revision is still ongoing, but he revealed that the proposals currently on the table could increase the charge limit for hydrocarbons to 1kg provided that additional safety requirements are met.

“The revised standard will be a basis for all the world to go for natural refrigerants in smaller-size plug-in refrigeration units,” he said.

Even with a charge limit of 150g, however, it is possible to cover most hydrocarbon applications. John Prall, a technical support engineer at Embraco, explained that increasing the permitted charge limit would allow certain applications requiring higher charges – which today normally use several 150g refrigeration circuits – would be able to use a single circuit with a single compressor, delivering cost reductions. This would potentially encourage more African and Asian countries to consider these sustainable and affordable solutions ■

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European knowhow: Bringing natural refrigerants to Brazil

CO₂ INSTALLATIONS ARE PROLIFERATING IN BRAZILIAN SUPERMARKETS – PARTLY THANKS TO EUROPEAN KNOWHOW IMPORTED TO SOUTH AMERICA. EMERSON CLIMATE TECHNOLOGIES IS ONE OF THE MANUFACTURERS DRIVING BRAZIL'S SWITCH TO NATURAL REFRIGERANTS.

By Nina Masson & Andrew Williams

"Sooner or later HFCs are going to go. We want to make the market prepared for this big change," says Higor Almeida, business manager (retail solutions) at Emerson Climate Technologies in Brazil.

Warmer climates can benefit from CO₂

Like their European counterparts, Brazilian companies are increasingly turning to natural refrigerants in response to more stringent regulation of f-gases. Today there are around 80 subcritical CO₂ installations in Brazil.

Subcritical is a system using CO₂ at low pressure to keep something cold, and is generally used in warmer climates. It combines the benefits of CO₂ with another refrigerant such as ammonia, which ensures that the system is fully natural refrigerant-based.

Emerson Climate Technologies – headquartered in Sidney, Ohio but with offices and subsidiaries all over the world – is drawing from the company's global experience with natural refrigerants when introducing new technologies in Brazil. Before entering the market with subcritical solutions, Brazilian staff received help from European colleagues who had already introduced these systems several years before.

"It is still a small number, but the growth rate is very fast," says Almeida, predicting that within two to three years, Brazil is going to

be "full of subcritical applications". He hopes that medium-temperature applications will soon follow.

According to Almeida, the transition to natural refrigerant solutions is being driven by large, global food retailers and by component, rack and case manufacturers, "who try to bring new technologies to differentiate themselves from others".

CO₂ transcritical systems will take more time

While the number of CO₂ subcritical installations in Brazil is growing, Almeida nonetheless sounds a cautious note. Installing transcritical technologies in Brazil is more difficult because they operate at higher pressure and are more complex, requiring additional components to ensure that they can deliver in warmer climates. One advantage of transcritical systems over their subcritical counterparts, however, is that they are more efficient.

"We need some initial tests and pilot projects. We need to learn more about the technology and train our technicians," he says, noting that it may take 5-6 years to change the Brazilian market towards a wider rollout of CO₂ transcritical.

However, Emerson plans to harness the knowledge of their European team to make this a reality. "Someone will fly from Europe

to help us in Brazil with our first projects and installations and to train our people. This is one of the big advantages of a global company: we can use our worldwide experience for development in areas like South America," says Almeida.

Supporting local customers

In Brazil, Emerson Climate Technologies has developed a full range of compressors and components to satisfy customer needs. It offers several hydrocarbon (which are also natural refrigerants) and CO₂ solutions together with a complete monitoring system, which can improve both thermodynamic and electrical efficiency.

Emerson has one inventory in Brazil, based in Sorocaba, a small city close to São Paulo. Products are imported from the company's factories around the world: CO₂ compressors come from Europe, for example, while electronic systems come from Europe and the US.

"Even though we're not manufacturing in Brazil, we have a big technical team to support local customers. We can serve our customers with technical support engineering, sales, and after sales locally, which is really important for our South American clients," Almeida concludes.



Higor Almeida, Emerson's Business Manager

Short takes

By Charlotte McLaughlin & Justina Tamasunaite

PROPANE, WATER USED AS SOLE REFRIGERANTS IN NEW COSTA RICAN PLANT

By Charlotte McLaughlin

La Roche – one of the world's largest biotech companies – has committed to making energy savings and reducing environmental impact at its new distribution centre in Costa Rica.

Central to the strategy of La Roche, a leading medicine and biotechnology company, are high environmental standards and increased efficiency. Their new 5,000 square-metre distribution centre is located in the 'Ultrapark', a science and IT business park in La Aurora de Heredia in Costa Rica. There are already plans to increase the project by 2,200 metres.

The new building is designed to save more than 40% in water and energy consumption. The electrical equipment, meanwhile, has been awarded 'Energy Star' status in recognition of impressive energy efficiency performance.

Central to La Roche's strategy for being a climate-friendly company is their use of natural refrigerants. The new facility uses propane, an environmentally friendly natural refrigerant, as the refrigerant for cold storage. The building also cleverly incorporates water, another natural refrigerant, for air conditioning.

Radhakrishnan Castillo, CFO of Roche Central America and the Caribbean, is excited by the new technology. "We are pleased to say that Roche Central America and Caribbean is the first subsidiary of the pharmaceutical in Latin America that uses this type of air conditioning, according to global corporate regulations. This system is part of one of the four pillars upon which our new Service Center, environment, and joins the pillars of collaboration, and innovation being conceptualised. Together they will guide us in our mission to do now what patients need later." ■

BRITISH, INDIAN FIRMS PREPARE TO DEPLOY SOLAR REFRIGERATION IN HEALTHCARE CENTRES

By Charlotte McLaughlin

Vaccine coolers using isobutane and solar power in India are particularly suited to remote areas.

Dulas, a UK renewable energy and solar refrigeration firm, has joined forces with Sunintown, an Indian sustainability company, to supply solar-powered refrigerators across the Indian marketplace.

Specialising in safely storing vaccines, blood and pharmaceuticals, Dulas often works in remote, off-the-grid locations, which support health and vaccination programmes throughout the developing world.

This is especially critical for India, as much of the country does not yet have good transport links. Healthcare centres often operate in locations that have limited or no access to electricity.

These fridges using isobutane (R600a), a natural refrigerant similar to propane (R290), are environmentally friendly and have no carbon footprint. This makes them perfect for India's commitment to the COP21 international agreement on climate change and Prime Minister Modi's recent pledge to work for an agreement to phase down HFCs.

This partnership with Sunintown will allow Dulas, a company that has been deeply committed to lowering emissions via renewable technology for 30 years, to get a foothold in the Indian market. They have now begun installing some of these fridges and are training technicians and healthcare professionals to properly operate and maintain them.

Sunintown's Business Development Manager Sheshnag Chitlur told the Solar Server website that, "with the move in India to rapidly increase the use of solar technology, coupled with the rising demand for vaccines, there is a market need for energy independent quality cold chain equipment" ■

INDIA TO AMEND SAFETY STANDARDS TO ALLOW GREATER USE OF HYDROCARBONS

By Justina Tamasiunaite

The Bureau of Indian Standards is considering amending refrigerant standards in order to enable wider use of hydrocarbons in India.

In 2015, the Bureau of Indian Standards (BIS) proposed to adopt international standard ISO 5149: Refrigerating systems and heat pumps – safety and environmental requirements, as India did not have any safety standards for refrigeration systems.

However, safety requirements under ISO 5149 are too restrictive towards the use of natural refrigerants like hydrocarbons. The standard indicates that the charge size of hydrocarbons must not exceed 350-360g, matching a cooling capacity of approximately 1.5 tonnes.

An amendment of the standard by BIS would permit Indian manufacturers to increase their production lines to hydrocarbon air conditioning systems with higher cooling capacity. This would allow greater and faster uptake of hydrocarbon-based technology in India.

Enabling wider use of natural refrigerants like hydrocarbons is also central in the discussions being held under the Montreal Protocol. India has recently made a commitment together with the US to cut heat-trapping climate pollutants known as HFCs. Both leaders, India's Narendra Modi and the United States' Barack Obama, have agreed to aim for early ratification of the Paris Climate Agreement and work towards a global agreement to phase down HFCs under the Montreal Protocol ■



SELF-STANDING PROPANE CABINETS ENTER BRAZILIAN STORES

By Justina Tamasiunaite

During the 'E&R Workshop on Commercial and Industrial Refrigeration' in June, Brazilian commercial refrigeration system manufacturer Eletrofrío presented self-standing R290 cabinets for Brazilian supermarkets.

Today, R404A is the standard refrigerant used in self-standing cabinets in Brazil. However, it is being replaced by systems using R290 with a refrigerant charge less than 150g.

Eletrofrío, a leading Brazilian commercial refrigeration system manufacturer with 70 years of experience, is producing 100 self-standing cabinets per day. The number of propane cabinets is increasing fast in Brazil, according to the company.

"Propane is invading the market. The trend is to have 70% of self-standing units running with propane," said Rogerio Marson Rodrigues, Engineering Manager at Eletrofrío Refrigeracao Ltda. Brazilian supermarkets are driving this strong preference for propane units, he stressed.

Eletrofrío's dry-type coolers with R290 are able to reduce the amount of refrigerant used by almost 80% compared to R404A systems, as well as reducing leakage rates by 99%.

Eletrofrío, a company that cares about preserving the environment, is determined to use natural refrigerants in its systems and sees future potential for these systems in Brazil. "The world is moving forward – why should refrigeration be any different?" asked Rodrigues ■



Natural Refrigerants, including hydrocarbons, ammonia, carbon dioxide, water and air have negligible global warming potential, and no ozone depletion potential. Natural Refrigerants are already the predominant option or can readily replace fluorinated gases in many sectors today. We call upon National Governments to acknowledge their potential to address direct emissions globally.

Natural Refrigerants have been known for decades as low-cost substances offering a technically viable and efficient solution for refrigeration, heating and cooling applications. They can be used safely applying industry best practice. We call upon National Governments to remove inappropriate obstacles, including national and international trade barriers and revise safety standards, codes and legislation that restrict their use without merit.

The Manufacturers and Users of refrigeration, heating and cooling equipment are convinced that Natural Refrigerants offer unexploited potential for developed and developing countries. We call upon National Governments to provide financial and non-financial support for the research and promotion of Natural Refrigerants and equipment based on these substances, as well as to facilitate a technology transfer from developed to developing countries, to fully exploit their ecological, economic, and social potential.

Effective action on fluorinated gases is a 'low hanging fruit'. We call upon National Governments to agree on an ambitious schedule for the reduction of hydrofluorocarbons in developed and developing countries under the Montreal Protocol without further delay. The signatories of this Statement stand ready to support Natural Refrigerants as a future-proof solution, and call upon National Governments to do the same.

Join 108 signatories at

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