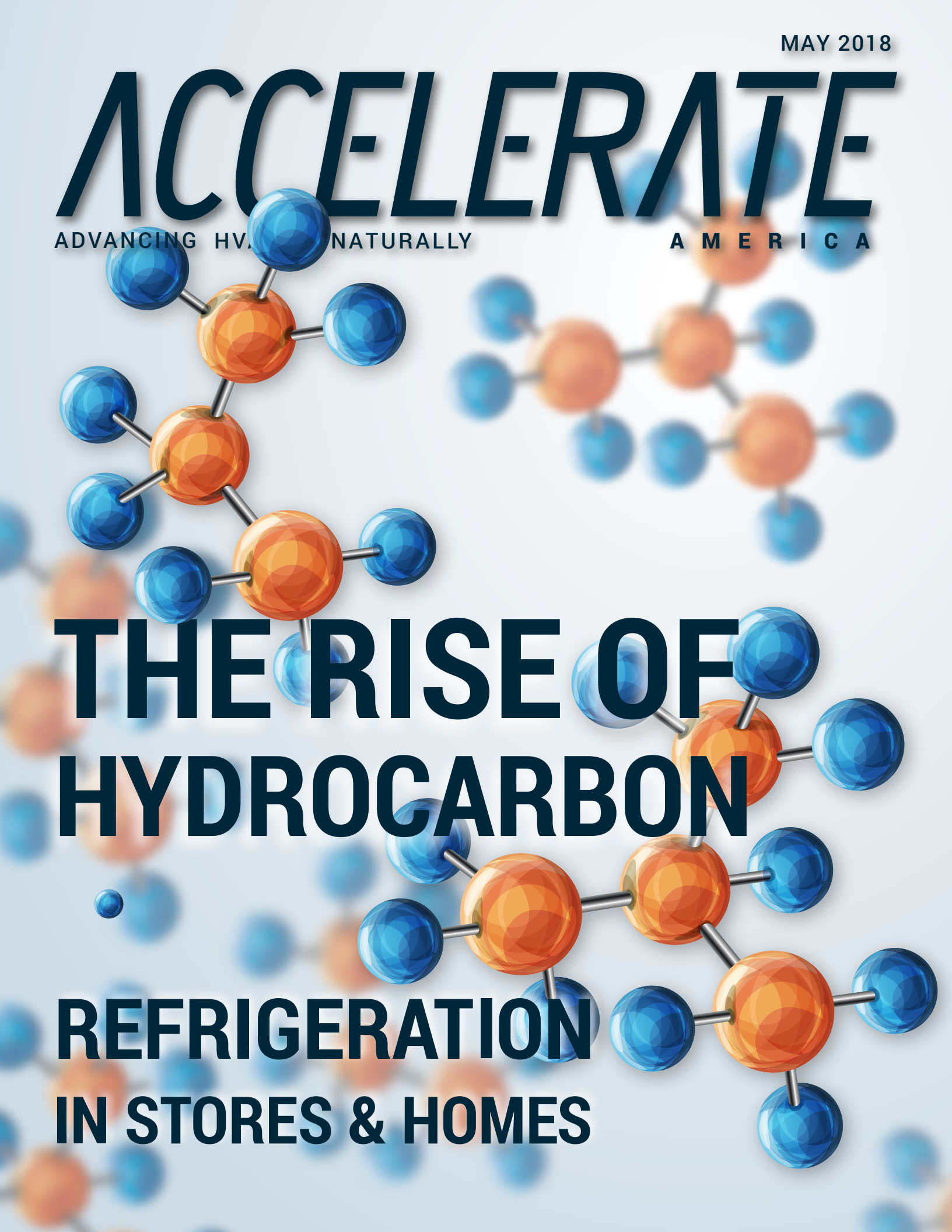
MAY 2018

ACCELERATE AMERICA

ADVANCING HVACR NATURALLY



THE RISE OF HYDROCARBON REFRIGERATION IN STORES & HOMES

Competition Among Naturals

— by Michael Garry

Accelerate America and its publisher, shecco, advocate for natural refrigerants as the best long-term solution for the HVAC&R industry because of their superiority to synthetic halogenated refrigerants in environmental impact and operational performance.

However, among the three primary natural refrigerants – CO_2, hydrocarbons and ammonia – we don't favor any particular gas. It all depends on which one is best suited for a particular application.

But now we are seeing a growing competition among natural refrigerants as to which one is, in fact, best in particular sectors.

In the industrial sector, for example, ammonia has long been king, increasingly in low-charge configurations. But CO_2 has emerged, not just as a collaborator with ammonia in cascade systems (see page 16), but as a stand-alone player in transcritical systems.

In March, at the IIAR Natural Refrigeration Conference & Expo – where ammonia has traditionally reigned – a slew of companies showcased CO_2 transcritical technology in the exhibit hall. (See page 42.) CO_2 is being positioned as a "no (ammonia)-charge" alternative, better even than low charge. As a non-toxic gas (except when it displaces air), CO_2 circumvents the toxicity burden that ammonia carries.

But it's still early days for CO_2 in the industrial space, and it has its own challenges, such as lower efficiency in warm climates (though new technology is addressing that). Moreover, low-charge systems may prove to be the answer to many of the safety and regulatory issues associated with ammonia.

In the food retail sector, another contest is brewing, between CO_2 and hydrocarbons, particularly propane. This time CO_2 is not the challenger but the refrigerant being challenged.

First in Europe and more recently in North America, supermarkets looking for a future-proof natural solution have primarily opted for centralized transcritical CO_2 systems. However, over the last few years self-contained propane cases have been popping up in thousands of stores in the U.S. and Canada, primarily at the checkout lanes or in spot locations, to supplement the main display cases linked to a centralized system.

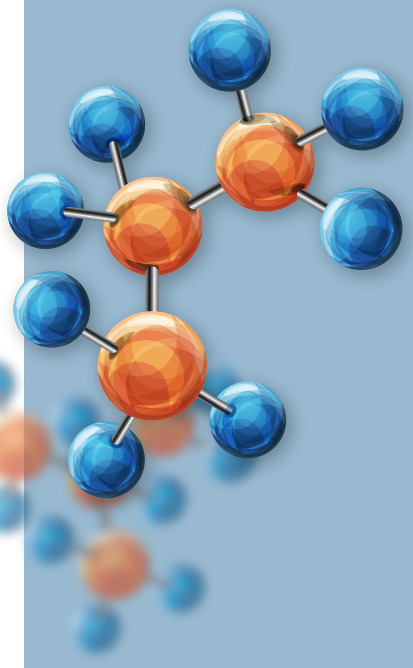
In this supplementary role, a relatively small number of self-contained propane cases are being employed. But some stores are beginning to use propane cases to a much greater degree – for half of their refrigeration needs or more – which we explore in this month's cover story on page 32.

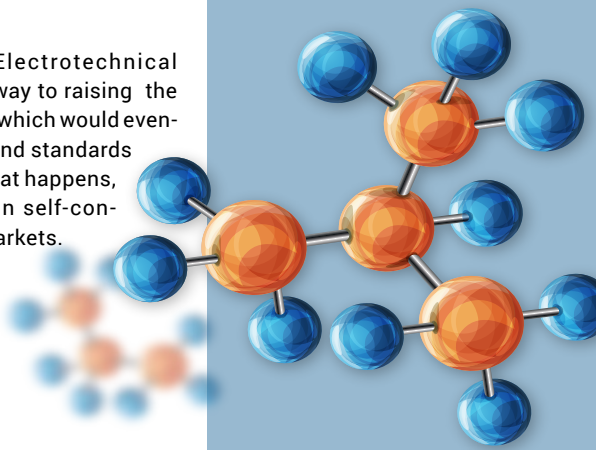
Self-contained cases offer two key advantages over central systems – simplicity and flexibility. The former makes installation and maintenance much easier while the latter facilitates merchandising changes. Those are powerful incentives for food retailers to consider.

Of course, hydrocarbons have an Achilles' heel, which is their flammability, which in turn limits the charge allowed in commercial cases to 150 g. This small charge is not enough to cost effectively build many open-case configurations.

However, the International Electrotechnical Commission (IEC) is well on its way to raising the charge limit for propane to 500 g, which would eventually be adopted by regulatory and standards bodies in North America. Once that happens, there could be a real upsurge in self-contained propane cases in supermarkets.

Let the best refrigerant win.





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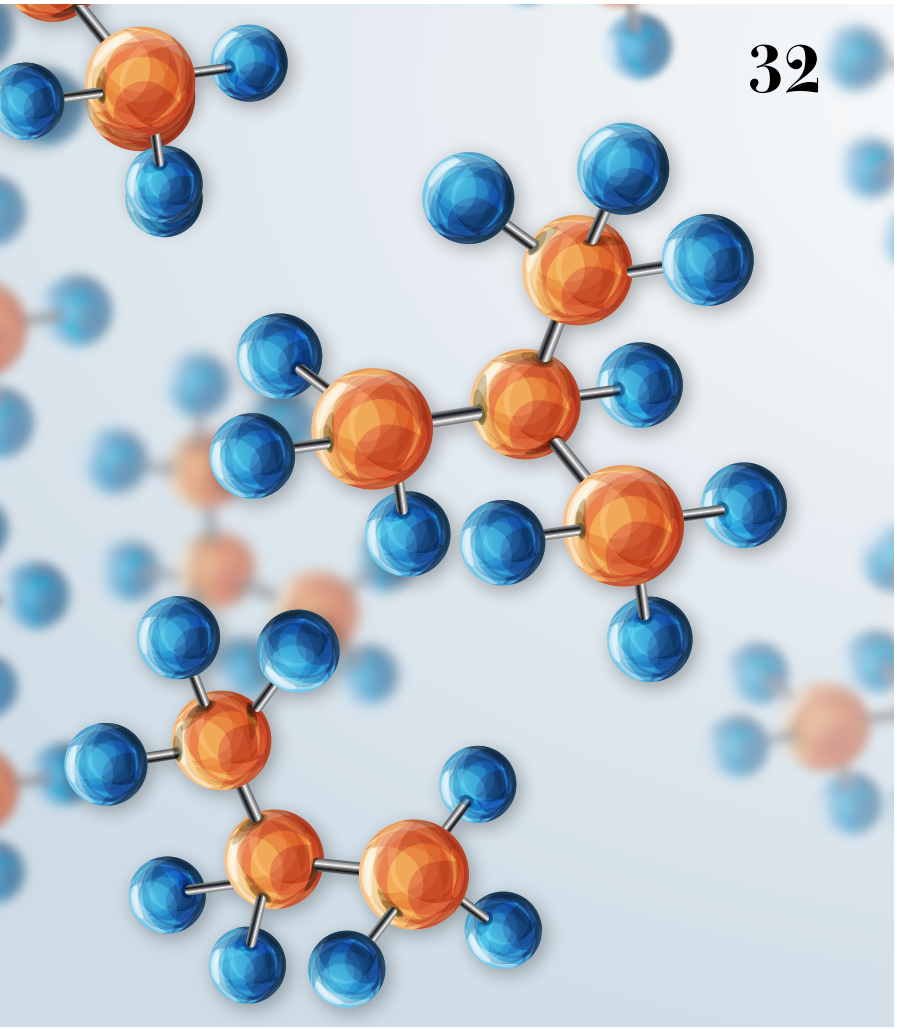
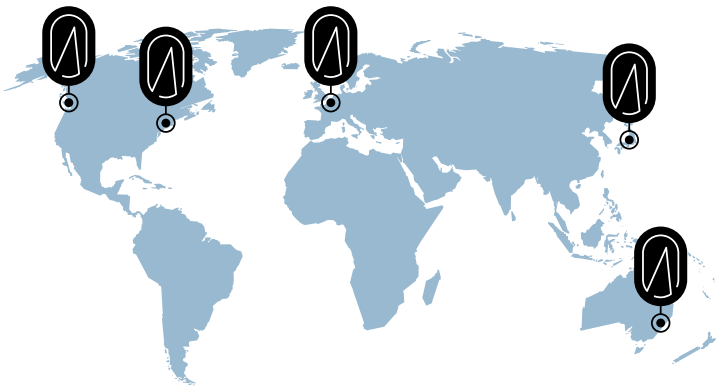


MAY 2018

ACCELERATE
ADVANCING HVAC&R NATURALLY
AMERICA



About *Accelerate America*

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

http://acceleratena.com

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

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PUBLICATION DATE:
January 10

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CO_2 in industrial refrigeration
AD SUBMISSION DEADLINE:
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PUBLICATION DATE:
October 8

* Publisher reserves the right to modify the calendar.

LETTERS TO THE EDITOR

NATREFS: THE WAY TO GO

Here at Grifols Pharmaceutical Inc. in Clayton, N.C., we take pride in what we do, and we try to do the right thing. Thus, I am writing this to let you know that I have been a subscriber to your publication for about four years, and have pointed out several of your articles to our Engineering Group.

Accelerate America has made a substantial impression on my life and has caused me to advance my career with a new thought process; that is, I have done my very best to promote natural refrigerants in our workplace and have tried very hard to express my concern about the negative impact that Class I and Class II regulated refrigerants have on our environment.

As a result, recently our Grifols Engineering team has designed and purchased two GEA NH_3 compressor packages to cool portions of one of our new facilities. To me, this is a major breakthrough. The Grifols Engineering Group – including Ed Leibrock, project engineer and Wayne Beaver, project engineer – has taken full responsibility for this installation and has accepted the fact that ozone-depleting refrigerants are no longer the way of the future.

To me, this is truly a milestone and should be recognized as such. I thought perhaps you would like to know that it all happened because of your articles in *Accelerate* publications with the suggestion that natural refrigerants are the way to go. I also feel fortunate that our Engineering Group at Grifols has taken the time to listen to my concerns and take them into serious consideration.

Dan Carter
Refrigeration and HVAC Supervisor
Grifols Pharmaceutical Inc.
Clayton, N.C.,

THE VALUE OF ARM-LC

In regard to "Paving the Way for Low-Charge Ammonia," (Accelerate America, April 2018), I think developing the ARM-LC (Ammonia Refrigeration Management-Low Charge) guidelines is the responsible reaction that IIAR needed to have as low-charge ammonia systems have hit the streets.

ARM-LC was needed because I don't see anyone really striking a good balance just yet when it comes to managing the safety of their low-charge systems. What I mean is that either users are doing nothing, or they're treating their low-charge ammonia system as if it had 250,000 lbs of ammonia in it.

The reality is that the general duty clause (from the EPA and from OSHA) does require owners to be proactive in ensuring that their systems are safe, but owners who are used to adhering to full PSM/RMP regulation tend to bring that baggage forward and apply it directly to low-charge systems – which, of course, is an unnecessary burden.

Even though ARM LC is just a recommendation for one way to comply with the general duty clause, it should give those that would otherwise tend to "overdo it" a safe place to fall back to, while for those that may otherwise do nothing, it should give them a condensed model to consider how they might apply it to their unique situation.

Caleb Nelson
VP of Business Development
Azane
Missoula, Mont.

LETTERS ARE WELCOMED!

Accelerate America invites readers to submit letters to the editor at michael.garry@shecco.com. They can be about a recent article; an industry issue that readers would like us to cover in greater detail; or the value of *Accelerate America* and ATMOsphere America in educating the industry about natural refrigerants, including what we can do better. Letters may be edited for clarity or length.

THE GROWING DEMAND FOR COMFORT COOLING

1.6 BILLION
New air conditioners to be installed globally by 2050

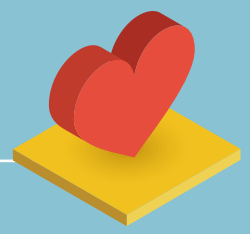
$24 BILLION
Value of global air-conditioning market by 2020

15% CAGR
(Compound annual growth rate) for global data-center cooling to 2021

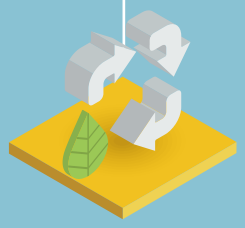
>1˚C
Temperature rise in outdoor urban environments from air-conditioning waste heat

AREAS OF IMPACT

CLIMATE ACTION
Low-energy cooling solutions with alternative refrigerants reduce climate impact.



GOOD HEALTH AND WELL-BEING
Access to low-cost cooling reduces heat-related illnesses and deaths.



AFFORDABLE AND CLEAN ENERGY
Renewable innovations that reduce power demand for cooling help to transition to a low-carbon energy system.

shecco Base

Source: Global Opportunity Report 2018, Keeping It Cool section, by United Nations Global Compact, DNV GL and Sustania

MAY

15-17

Future Leaders eXperience
Louisville, Ky

FMI's Future Leaders conference provides a training program for retailers, wholesalers, and suppliers in food retail, including an interactive learning experience for 600+ attendees within all titles and job functions.

www.fmi.org/futureleaders

#FMIFutureLeaders

19-22

National Restaurant Association (NRA) Show
Chicago, Ill.

The NRA Show showcases the latest innovations in food and beverage and facilitates networking with over 66,000 foodservice professionals from around the world.

https://show.restaurant.org

22-25

North American Rink Conference & Expo (NARCE)
Columbus, Ohio

NARCE is an annual educational conference and trade show for ice rink industry professionals.

www.usicerinks.com/narce

25

Danfoss CO_2 Introductory Training, One-Day Class
Baltimore, Md.

Topics covered include: system manager, case control, computer set-up and rack control.

https://bit.ly/2FgwHSx

@Danfoss_US

JUN

10-12

International Dairy Deli Bakery Association (IDDBA) 18
New Orleans, La.

Annual industry event attracts over 10,000 industry professionals, including buyers, merchandisers and executives, as well as 800 exhibitors.

https://bit.ly/2dlbdl1

#IDDBA18

12-14

ATMOsphere America
Long Beach, Calif.

The preeminent event covering natural refrigerants in North America, ATMOsphere America features 15 educational sessions with leading end users, manufacturers, policy makers and industry experts, along with exhibits from major providers of natural refrigerant technology.

http://www.atmo.org/America2018

#ATMOAmerica

14

Garden City Ammonia Program (GCAP) Ammonia Safety Day
Kansas City. Kan.

Participants include engineering, safety, environmental, process engineering, operations, mechanical and utility maintenance.

https://bit.ly/2HWXYPr

23-27

2018 ASHRAE Annual Conference
Houston, Texas

The technical program covers professional development, research, fundamentals and applications, systems and equipment, system management (controls) and some specific design arenas (such as residential buildings and cogeneration plants).

https://www.ashrae.org/conferences/annual-conference

25-27

Global Cold Chain Expo
Chicago, Ill.

Event is geared toward retail, foodservice, processing, production, distribution, logistics, and transportation representing frozen, refrigerated, ambient and fresh operations. It will be co-located with the United FreshTEC Expo.

http://www.globalcoldchainexpo.org

25-27

United FreshTEC Expo
Chicago, Ill.

Event features the technology used to harvest, package, process, trace, or deliver fresh products, including fresh produce, healthy foods and floral. It will be co-located with the Global Cold Chain Expo.

http://www.unitedfreshshow.org

AMERICA IN BRIEF

CoolSys Acquires Axiom Energy

CoolSys, parent company of a slew of HVAC&R outfits, has announced the acquisition of Axiom Energy Solutions, Savannah, Ga.

With this acquisition, CoolSys, Brea, Calif., is planning to integrate the energy-efficiency, lighting and control resources of Axiom with its CoolSys Energy Solutions division. "Both companies are widely known for their expertise and services within the retail grocery sector," said CoolSys in a statement.

In addition to Axiom and Energy Solutions, CoolSys also owns Source Refrigeration & HVAC, Advanced Refrigeration Systems, Certified Refrigeration & Mechanical (CRM), Legacy Air, RSI and Service Refrigeration Co.

Source is known for its work with natural refrigerants, including transcritical CO_2 systems and an ammonia/CO_2 cascade system. ■ CM

Source Capital Acquires M&M

Source Capital, an Atlanta-based private equity firm specializing in lower middle-market companies, has announced its acquisition of M&M Refrigeration, based in Federalsburg, Md.

M&M designs, builds, manufactures and services industrial refrigeration equipment and control systems for cold storage, food processing and other industrial applications. A pioneer of ammonia/CO_2 cascade systems, it has installed them at more than 65 locations worldwide. In January M&M introduced a line of low-charge ammonia packaged systems called Pure Refrigeration. (See page 48.)

The terms of the deal were not disclosed.

"We will continue to serve our customers and bring cutting-edge products to the industry while honoring the core values that our company was built on," said M&M's CEO Duane Marshall, in a statement. ■ MG

Mars Commits to Natural Refrigerants

In an update to the Consumer Goods Forum's "Refrigeration Booklet," published last month, U.S.-based food manufacturer Mars states its commitment to natural refrigerants.

Since the end of 2016, Mars has "converted more than one-third of its total factory refrigeration gas inventory to natural refrigerants," the booklet notes.

"It's time for transformational change to tackle the threat of global warming," said Grant F. Reid, CEO of Mars. "At Mars, we've set a science-based target to reduce our greenhouse gas emissions across our value chain by 67% by 2050. One way we're making meaningful progress is by transitioning to natural refrigerants."

All of Mars' ice cream factories use natural refrigerants like ammonia and CO_2. In addition, 15 of the company's Wrigley Confectionery Segment factories have also started using natural refrigerants.

The CGF booklet also contains updated case studies from the retail group Ahold Delhaize, Japanese retailer Lawson and U.K. retailer Tesco.

"The addition of these new case studies to our Refrigeration Booklet demonstrates that our members remain committed to this important CGF initiative," said Ignacio Gavilan, sustainability director for CGF.

Tesco states in the booklet that its "strategy for the last 10 years has been to reduce leakage and move to natural refrigeration systems where possible and we have over 250 stores installed to date across our group." ■ CM

Canada Launches HFC Phase-Down

The government of Canada on April 16 launched an HFC phase-down plan to limit its consumption by 85% by 2036, in line with the Kigali Amendment to the Montreal Protocol.

Mirroring the Amendment, the plan starts in 2019 with a 10% cut to "baseline" levels of HFC consumption, which are calculated using the consumption of HFCs and HCFCs from 2011 to 2013.

The plan also puts caps on the GWP of gases that can be used in specific applications. The continuing reductions and caps are expected to bolster the transition to low-GWP alternatives like natural refrigerants.

The full plan was originally announced in October 2017 with regulations amending the existing Ozone-depleting Substances and Halocarbon Alternatives Regulations; the amendments highlighted the phase-down of bulk HFCs, prohibitions on HFCs in certain types of equipment, and minor modifications to the HCFC provisions in the Regulations.

Much of the regulation focuses on bulk imports of HFCs since HFCs are commonly imported into Canada in bulk for use in the manufacture, servicing and maintenance of refrigeration and air-conditioning equipment, and in the manufacture of foam-blowing products.

Allowances will be distributed based on an individual importers' share of Canada's total HFC consumption in 2014 and 2015. The overall percentage of HFC reduction from the baseline, which is slightly different than under the Kigali Agreement, will be 10% (2019), 40% (2024), 70% (2030), 80% (2034) and 85% (2036).

Under the second part of the plan, various end uses will only be able to employ refrigerants under a certain GWP limit, ranging from 150 (domestic refrigeration and motor vehicle air conditioning) to 2,200 (centralized refrigeration system, among other uses) ■ CM

Exploiting CO_2

Packaged NH_3/CO_2 cascade refrigeration systems can serve large industrial applications.

– By André Patenaude

The large industrial refrigeration market is no stranger to the use of natural refrigerants. For decades, ammonia (aka NH_3 or R717) has been the backbone of many cold storage applications. More recently, the increasing uptake of CO_2 (R744) in commercial applications has led refrigeration manufacturers to look for ways to exploit this emerging natural refrigerant in industrial applications. The technology to combine the benefits of both refrigerants and facilitate this transition is now coming of age.

With excellent performance, efficiency and ultra-low environmental impact, in many ways NH_3 is the closest thing to the perfect refrigerant. However, it has one major caveat: toxicity. In recent years, tighter regulations from the Occupational Safety and Health Administration (OSHA) have sought to improve the safety of NH_3 systems. Operators are now required to provide documentation for systems charged with at least 10,000 lbs of ammonia, per OSHA's Process Safety Management of Highly Hazardous Chemicals (PSM) standard.

For these reasons, operators and manufacturers alike began looking for ways to leverage ammonia's efficiency while lowering system charges to limit the potential for exposure to workers and products. Enter NH_3/CO_2 cascade technology, a system architecture that has been successfully deployed in many commercial applications with HFCs on the high side.

To make the transition to the large industrial market, manufacturers first needed to find a way to deliver high-tonnage refrigeration capacity while keeping ammonia charges low to help mitigate safety concerns, ease documentation requirements and, if possible, avoid the potential for exposure in any occupied spaces. They also needed to address other prevailing concerns about the use of NH_3/CO_2 cascade systems, including:

- Complexities related to installation, commissioning, operation and servicing requirements.
- Potential heat-exchanger leaks of CO_2 and NH_3 that can allow them to mix and create ammonium carbamate, resulting in system failure.
- Maintaining uptime during the transition from a legacy system to a new cascade system.

Self-contained systems

Meeting high-tonnage cold-storage requirements while addressing the known operational challenges of ammonia and CO_2 has required manufacturers to expand upon existing cascade architecture. Among the leading ways to achieve this is a self-contained system that integrates an entire NH_3/CO_2 cascade system into a modular refrigeration unit.

Designed to be located on the rooftop or next to a building of a cold storage facility, this modular refrigeration unit combines CO_2 and NH_3 compression technologies and electronic controls in a cascade system that contains two independent CO_2 and NH_3 circuits with separate condensers and evaporators (including a shared cascade heat exchanger).

The NH_3 portion of the cascade system provides the high stage of the refrigeration cycle, utilizing a small-displacement, very low-charge, single-screw compressor and a condenser that sits on top of the unit and uses ambient air to cool it; liquid ammonia evaporates in the cascade heat exchanger. This design meets the low-charge NH_3 requirement (fewer than 500 pounds) while keeping the NH_3 stage completely separate from conditioned space.

The CO_2 portion of the system utilizes high-pressure, reciprocating compressors and the cascade heat exchanger as a condenser, where the NH_3 chills and condenses the CO_2 into liquid. The liquid CO_2 cools air that is then pumped into the facility's ductwork, keeping the NH_3 stage isolated on the roof and leveraging the non-toxic natural CO_2 to deliver high-tonnage refrigeration in the conditioned space. (The CO_2 itself may alternatively be pumped into an evaporator in the refrigerated space.)

To help alleviate potential ammonium carbamate concerns, the CO_2/NH_3 helix-style heat exchanger features stainless-steel construction for corrosion resistance and long life. Multiple helical coils in a compact design allow for expansion and contraction of tubes during large changes in temperature and pressure with very low strain and stress — thereby reducing the risk of failure and leaks while delivering a large heat-transfer surface in a small volume.

The self-contained, modular unit essentially serves as the system's mechanical room, enabling installation and efficiencies typically not found in traditional systems. Existing facilities can even install this system while their legacy system is still running. Installers simply position the unit at the desired rooftop location and connect the ductwork; commissioning can potentially take place in as little as a few days. Then, as soon as the facility manager is ready, he/she can simply shut down the old system and let the new system assume refrigeration duties —minimizing or often eliminating any disruption in cold-storage operations.

The simplicity of this drop-in, plug-and-play design also lowers maintenance requirements while improving serviceability throughout the lifecycle.

Addressing retrofit and greenfield challenges

From regulations and sustainability objectives to energy efficiency and operating costs, cold storage operators are faced with increasingly complex refrigeration decisions. Natural refrigerant systems such as the modular NH_3/CO_2 cascade unit help industrial cooling businesses address many of these challenges, regardless of their operational requirements.

For example, many brownfield facilities are facing retrofits in the near future, typically because they're either using an aging high-charge ammonia system or an HCFC-based system (such as R22). New, all-natural systems provide opportunities to avoid the risk and documentation requirements of high-charge ammonia systems and help offer a seamless transition away from R22 refrigeration and its associated challenges, including the rising cost of refrigerant, known environmental concerns, and the global phase-out due in 2020.

New greenfield facilities seeking to completely avoid these complexities may find that NH_3/CO_2 cascade system architectures help meet many of their long-term operational requirements, including low-charge ammonia; simple pre-designed, pre-packaged systems; environmentally friendly and efficient technology; compliance to future regulations; and market acceptance.

For operators simply looking to expand on their existing facilities, a modular approach offers a no-fuss alternative without the complexity of trying to integrate a new refrigeration system into an existing one or expanding a current engine room.

Natural refrigerants drive innovation

The spread of natural refrigerant systems into industrial cooling is further proof of their viability across the gamut of refrigeration markets and applications. From low-charge propane in stand-alone systems to a variety of CO_2 architectures in food retail to the introduction of NH_3/CO_2 systems in cold storage, the market continues to seek the advantages that natural refrigerant systems can provide. As manufacturers continue to answer the call, look for naturals to be featured in more refrigeration innovations in the coming years. ■ AP

"For operators simply looking to expand on their existing facilities, a modular approach offers a no-fuss alternative."

André Patenaude is director of food retail marketing and growth strategy, Cold Chain, Emerson.

How to Sell NatRef Systems

Focus on why natural refrigerants are so much better for the planet, safety, facilities and reputations before talking about costs

– By Steve Jackson

Steve Jackson is co-founder and president of PermaCold Engineering an industrial refrigeration engineering and installation firm founded in 1993 in Portland, Ore. PermaCold focuses on engineering energy-efficient, environmentally safe systems.

All of us – well, readers of *Accelerate America* at least – already know by heart the key reasons for engineering more-efficient industrial refrigeration systems that employ natural refrigerants. Protecting the planet and ensuring a healthy future for our kids and grandchildren is something everyone can agree on. It's certainly a compelling selling point. Unfortunately, for my engineering company and others promoting "green" industrial refrigeration designs, it often isn't enough.

A variety of other factors can muddy the message our sales teams are trying to convey: perceived cost, resistance to change, misunderstanding the capabilities of modern CO_2 systems, or even simple laziness. It's easier to just stick with what you know.

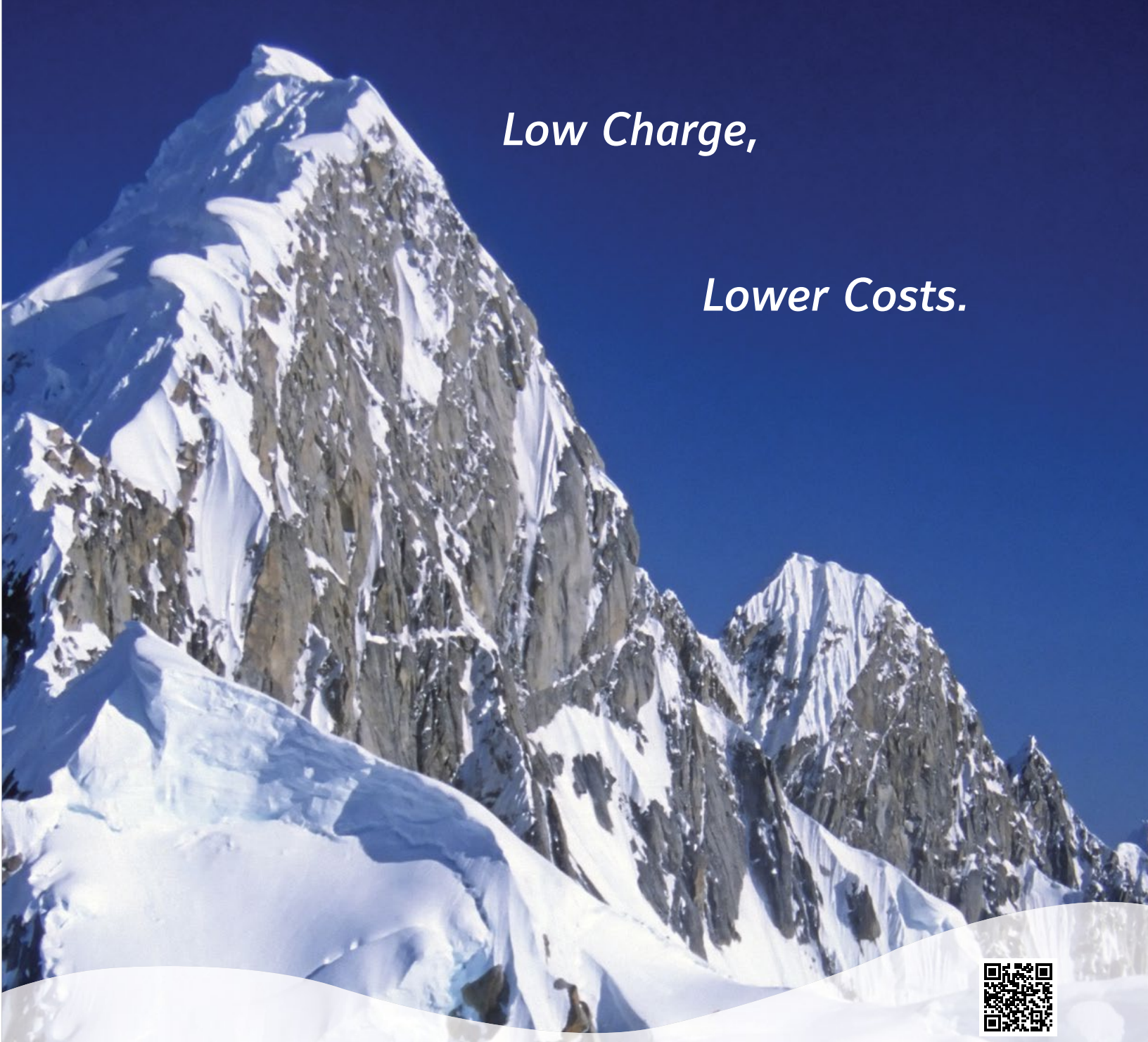
It's not only frustrating when our message about the value and need for natural refrigeration isn't getting through. It can also be costly – for the planet, yes, but also for our own bottom line and success if we lose that project to a less-progressive competitor. After all, we can't change the world if we aren't getting the work! So, how can we successfully argue our case and overcome pushback? Here are some messaging tactics, and specific selling points, that our company is using to get clients on board with natural refrigerants.

Focus on value and values – not cost

I've found that most businesses actually do care about their impact on the planet, and they want to do the right thing. But we might never know we have that advantage because customers will so often focus immediately on price. They're already convinced natural refrigeration will cost too much, or they don't want to allow our engineering team the extra time to examine their system in detail to concretely demonstrate why our approach is the best choice. Instead, they "just want the number, and right now" to kick off their decision process.

But every engineering firm knows that any number you give them at that stage isn't a real one. It's going to change – regardless of whether it's a familiar approach (e.g., traditional but toxic) or one converting to naturals. Emphasize that reality, and ask them to put aside cost, just for a moment, to fully understand and consider the benefits and ROI of a natural refrigerant system. Ask for them to simply hear you out, and most people will.

Cost is, and will probably always be, the biggest pushback. So, appeal to their values first, the myriad benefits second, and cost only after you've already convinced them that an old-school, traditional system is against their best interests and values. You can overcome one of the major reasons for pushback – fear of the unfamiliar or different – by clearly explaining how it's not going to be a different system, just a better one. The same engineering principles apply; we're simply using a (better, safer) gas.



> *I've found that most businesses actually do care about their impact on the planet, and they want to do the right thing.*

Cite the many benefits of natural refrigerants to lay the groundwork for their eventual decision, which will "pre-persuade" them the eventual price is more than justified. Here are some:

- CO_2 is now a fully proven technology, and systems are incredibly safe and reliable. Piping, welding techniques, pressure-management technology – all are vastly improved compared to the first CO_2 systems that earned a bad reputation.

- That reliability means natural refrigeration systems are incredibly durable and high-performing – their investment will last far longer.

- Synthetic refrigerants leak, they're toxic, and they hurt the planet. So your client's business will be making a difference in the world – and they can promote their decision to do the right thing.

- Federal regulations are – likely very soon – going to mandate the switch to natural refrigerants. Just like the ozone issue led to the Montreal Protocol, it's inevitable that Freon and the like will be phased out, so why wouldn't your client make that choice now and benefit from it?

- If they have a corporate responsibility code – and most companies pride themselves on it – then cite their own words as a key reason that this is an investment reflecting their own values and beliefs.

Long-term payback

You can cap off your argument by bringing it back to cost at the end, but NOT about justifying the (always higher) total cost of a natural system. Rather, talk about the affordability and long-term payback/ROI for switching to a more energy-efficient and resource-saving system. Show them how their bottom line will benefit just as much as their reputation. You can cite the following factors that will pay off vs. traditional refrigeration systems:

- Less horsepower for natural systems means immediate and long-term energy savings. We further reinforce that message by recommending LED lighting as part of the overall facility with a "total system" approach – even more energy saved plus further reductions in load due to near-zero heat input.

- Additional resource and cost savings for smaller, more efficient refrigeration include less piping, insulation, and many other materials in construction, plus reduced need for water and sewage.

- Finally, greatly improved reliability means safer employees, and long-term reductions in maintenance requirements provide savings on time, parts and headaches.

For decades, industrial engineering firms like mine have not really had to "sell" at all. For the most part, designs were pretty much template, cookie-cutter, "it's always been done this way" affairs. My firm built our reputation on bringing actual engineering back into the process, and the move into high-efficiency systems and natural refrigerants emphasizes that value to help us sell. There are plenty of sales tactics you, too, can use to overcome customer objections or fears, but most important is to not let their minds lock onto PRICE first. Get the customer focused right off the bat on why natural refrigerants are so much better for the planet, for safety, for their facility, for their reputation, etc. and then get back to numbers.

We like to end with: "You know it's a better system and the right thing to do. So now, what can you afford for this better system, and let's work from there to make it happen." More often than not, it will. ■ SJ

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DOE Touts Partnerships with Private Sector

The agency's research arm likes to work with companies that can bring new energy-efficient technology to market

– By Michael Garry

Tony Bouza, U.S. Department of Energy's Emerging Technologies Group

The U.S. Department of Energy (DOE), through its Better Buildings Alliance and Buildings Technologies Office, is engaged in research on the efficiency of natural refrigerant systems, sometimes partnering with OEMs.

One example of this is the DOE's research partnership with Hillphoenix, described in a Better Buildings Alliance webinar on advanced refrigeration earlier this year by Tony Bouza, technology manager in DOE's Emerging Technologies Group. (The webinar also included the National Renewable Energy Laboratory – see page 24.)

The research focused on Hillphoenix's transcritical CO_2 systems, including an efficiency evaluation. The system was found to consume 25% less energy than existing systems, with 78% lower greenhouse-gas emissions, he reported.

"We helped them bring this product into the marketplace by testing," said Bouza.

Bouza noted that transcritical systems are sometimes perceived as consuming more energy than other systems. "But that isn't the case when they're properly designed," he said. "At least in the lab, we were able to demonstrate these energy savings."

Bouza described the DOE's energy-efficiency research as divided into short- mid- and long-term projects.

In the short term, DOE is evaluating low-GWP alternative refrigerants, including climate impact and hot-climate performance, he said. Mid-term, the agency is looking at "systems that can handle these low-GWP refrigerants."

Long term, the DOE's strategy is to develop non-vapor compression systems – "systems that move away from using a GWP refrigerant at all," said Bouza.

Non-compression technologies, he acknowledged, "are a little bit next-generation and a major departure," at least a decade, and for some applications two decades, from commercialization. "But as the government, we take a higher-level risk," he added.

Bouza stressed that the DOE does not engage in "basic science" – what Bouza called "low-TRL (technology readiness level) projects – preferring to work on systems closer to market-ready.

And while most of DOE's research efforts in HVAC&R have centered on residential applications, Bouza said he hoped the webinar would lead to more opportunities in the commercial space, and invited interested parties to contact him at antonio.bouza@ee.doe.gov.

MAGNETOCALORIC RESEARCH

Another example of collaboration between DOE and the private sector was a DOE-funded project with General Electric on the use of magnetocaloric materials for refrigeration, a non-compression scenario.

The project grew into a Cooperative Research Development Agreement (CRDA) under which "GE didn't get any money from us but they received the skillsets to help develop that technology to the next level ," said Bouza. "We hope in the near future for that technology to make it into the marketplace."

This partnership, he added, again shows that "we're more than just working with researchers in the lab. We always try to work with manufacturers, people that are able to bring these technologies into the market."

On the pure research side, the Oak Ridge National Laboratory in Oak Ridge, Tenn. – one of DOE's 10 affiliated national labs – is pursuing R&D on defrost technology and novel designs for compact flooded evaporators in commercial refrigeration applications, he said. The lab is also looking at magnetic refrigeration, mostly for residential applications though "it could be applied in some small scale to commercial units," said Bouza.

In partnership with ASHRAE and AHRI, DOE is studying safe charge limits for flammable refrigerants, both A2L and A3 refrigerants, in HVAC applications.

The DOE also actively leverages resources from entities outside the U.S. "Because one of the things that you realize first is sometimes we're not the leader. Sometimes we may be following the lead of other countries in some areas." ■ MG

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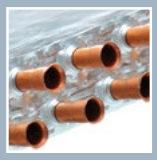

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NREL Probes High-Efficiency Fan Motor

In a test at a Walmart store, a condenser system using a high-efficiency motor consumed 30% less energy than a legacy condenser system

– By Michael Garry

Michael Deru, NREL

Among its many research activities, Golden, Colo.-based National Renewable Energy Laboratory (NREL) has conducted pioneering research into refrigeration technology; this includes some recent work on high-efficiency motors in air-cooled condensers, done in partnership with Walmart and Software Motor Corporation.

The research looked at large outdoor commercial condensers with up to 18 to 20 fans, each with its own 1.5-hp motor, explained Michael Deru, researcher, V-Mechanical Engineering, at NREL, one of 10 affiliated national labs under the U.S. Department of Energy (DOE).

He spoke in a Better Buildings Alliance webinar on advanced refrigeration earlier this year with NREL colleague Grant Wheeler, commercial buildings HVAC research engineer. (The webinar also included the DOE's Emerging Technologies Group – see page 22.)

On a typical refrigeration system in a grocery store, compressors consume about 50% of the energy and "maybe 10% goes to the condenser fans, if you have a constant speed," Deru explained.

A basic way to significantly reduce the energy usage by condenser fans, he suggested, is installing a variable frequency drive (VFD) on their motors. But Deru went on to discuss a different type of high-efficiency, large-size motor – called a high-rotor pole-switched reluctance motor (HRSRM) – from Software Motor Corporation (SMC), ranging from the one to 10 hp.

While switched-reluctance motors have existed for a long time, "no one's been able to figure out how to really make them efficient and provide a smooth power curve," said Deru.

But the SMC unit has been designed to control speed, torque and vibration, and provides "a very smooth transition," he said.

TEST AT WALMART STORE

NREL has conducted a demonstration test at a Walmart store with two air-cooled condenser banks, one with 10 motors and the other with eight. In the test, half of the motors were high-efficiency induction units, and half were HRSRMs.

In phase one, the same control signal sent to the induction motors is applied to the HRSRMs, and the energy consumption is compared at the same speed.

The preliminary results of phase one show that, with both motors running at 850 rpm, the legacy condenser system consumed 1.04 kW per motor, said Wheeler. By contrast, the HRSRM condenser system used 0.73 kW per motor, a drop of 30%.

NREL planned to run the phase-one test with lower rpms from 30 minutes to an hour "so we can actually get a much more detailed power measurement," Wheeler noted.

In phase two of the test, NREL plans to optimize control with the HRSRM controller in order to garner more energy savings. "Each motor has its own controller and communications, and has a lot of intelligence built in," Deru said. This enables turning individual motors on or off.

"We can do a lot of cool things and we can optimize the control of the condenser bank, and we can think about how that is going to impact the whole refrigeration system, " Deru continued.

For example, one of the plans for phase two is variable head pressure control, adjusting a compressor's discharge pressure based on the outdoor air temperature.

"Creating some kind of different algorithm that would actually work better for variable head pressure control would save additional energy," said Wheeler.

The last idea for phase two is predictive control, "where we would actually give this controller the ability to predict what the system is going to be doing, and optimize for power." ■ MG

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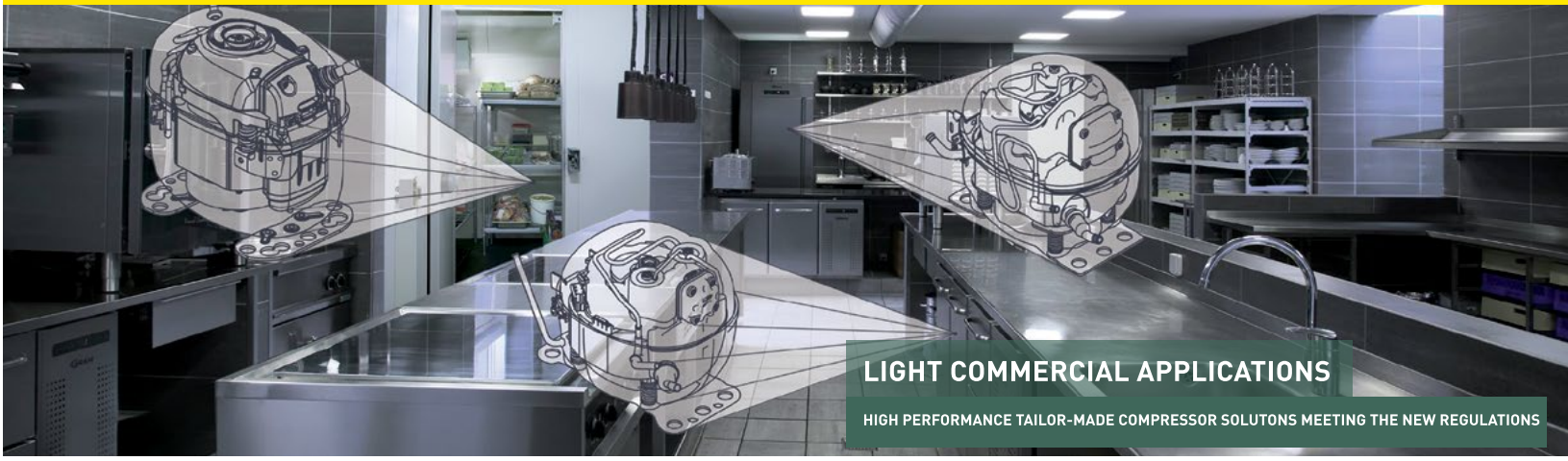

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EPA STARTS NEW RULE-MAKING ON HFCS

In the short term, the agency will follow court ruling barring it from replacing HFCs under SNAP

– By Michael Garry

The U.S. Environmental Protection Agency (EPA) last month issued a notice of guidance affirming that it would adhere to a U.S. Court of Appeals decision last August that limits its ability to regulate HFCs, while also stating its intention to commence a notice-and-comment rulemaking process to revisit how it can regulate HFCs.

The EPA's notice was issued "to dispel confusion and provide regulatory certainty" for end users of refrigeration, air conditioning and other applications affected by the EPA's Significant New Alternatives Policy (SNAP) program Final Rule 20, issued on July 20, 2015. That rule, which delists numerous HFCs for certain applications under the Clean Air Act, was, in effect, invalidated by the decision last August by the U.S. Court of Appeals for the District of Columbia Circuit.

"In the near term EPA will not apply the HFC listings in the 2015 rule, pending a rulemaking," the agency said in the notice of guidance, its first response to the court ruling.

At the same time the EPA said it "plans to begin a notice-and-comment rulemaking process to address the remand of the 2015 rule." The agency added that it "intends to consider the appropriate way to address HFC listings under the SNAP program in light of the court's opinion" and also consider "the larger implications of the court's opinion remanding the rule to the agency."

The court gave the EPA several options for regulating HFCs, including "retroactive disapproval" and the use of other laws such as the Toxic Substances Control Act.

The August 2017 ruling by the U.S. Court of Appeals for the District of Columbia Circuit was issued in the case *Mexichem Fluor, Inc. v. EPA*. The two plaintiffs in the case were foreign manufacturers of HFCs: Mexichem Fluor and Arkema SA.

In January the court refused to rehear the case. Honeywell, an intervenor, has appealed the decision to the U.S. Supreme Court. The other intervenors were Chemours and the Natural Resources Defense Council (NRDC)

NAMA's reaction

The National Automatic Merchandising Association (NAMA) reacted favorably to the EPA's guidance, which confirms the suspension of a January 1, 2019 deadline for phasing out HFCs in vending machines.

"This … action delivers the positive result NAMA was working toward, a result that benefits manufacturers and operators alike -- providing valuable, additional time to work through challenges related to a transition away from HFCs," said Eric Dell, NAMA's senior vice president.

"Moving ahead, the industry will continue to work together with the EPA on this issue and remains committed to a transition away from HFCs," he added. "In fact, NAMA is undertaking research to determine optimal next steps and address concerns related to alternative refrigerants."

Meanwhile, last month, the California Air Resources Board (CARB) adopted a regulation prohibiting the use high-GWP HFCs refrigerants, thereby maintaining in California many of the EPA's SNAP prohibitions.

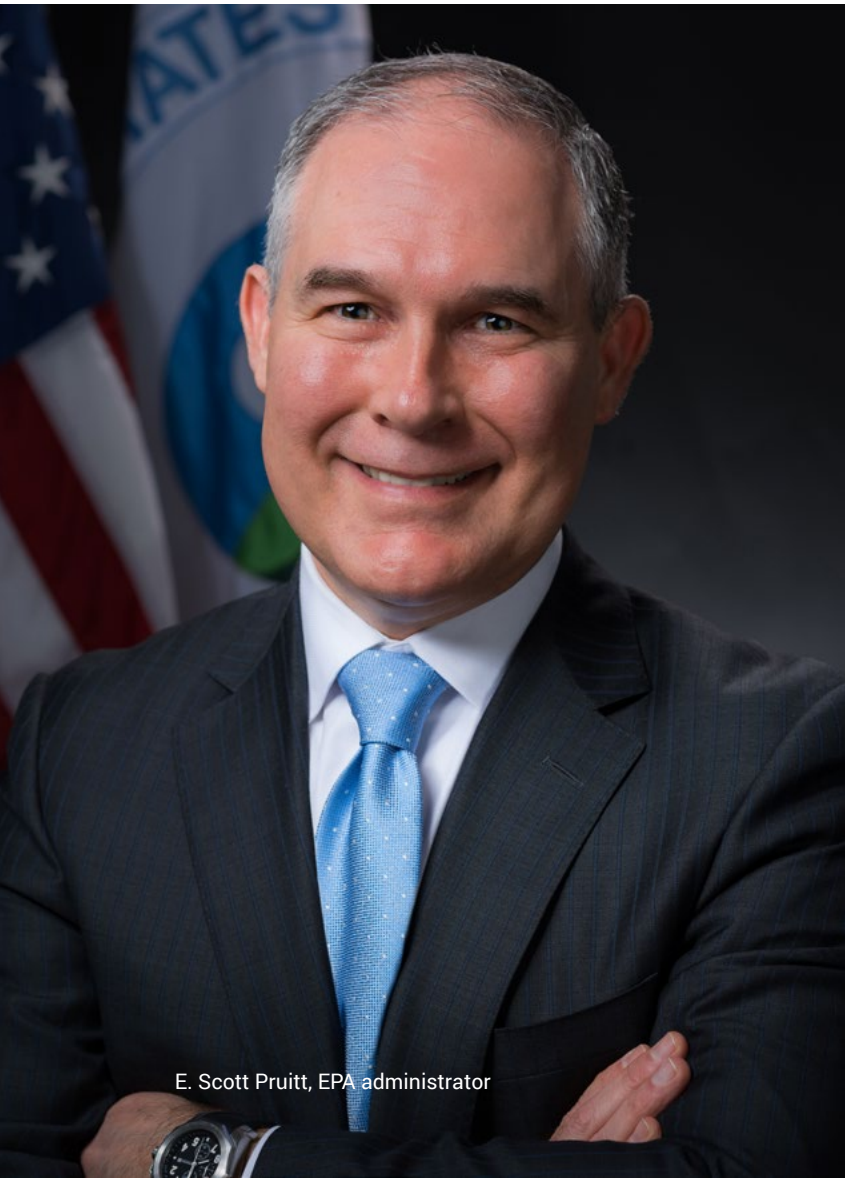
The U.S. Congress has also begun to address this issue. In February two U.S. senators – John Kennedy (R-La.) and Tom Carper (D-Del.) – introduced a bipartisan bill, the American Innovation and Manufacturing Act, that would empower the EPA to issue rules phasing down HFCs through a cap-and-trade program and the "advancement of environmentally friendly technologies."

The bill would also conform to the Kigali Amendment to the Montreal Protocol, which calls for a global phase-down of HFCs. The U.S. Senate has yet to ratify U.S. participation in the Kigali Amendment. ■ MG

EPA EYES REFRIGERANT-HANDLING RULE REVISIONS

Proposal would target 2016 extension of Section 608 restrictions to HFCs and HFOs

– By Mark Hamstra



E. Scott Pruitt, EPA administrator

In another effort by the Trump administration to roll back regulations, the Environmental Protection Agency is seeking to revise a 2016 extension to Section 608 of the Clean Air Act rule covering the venting, repair and replacement of refrigeration equipment.

Letters dated Aug. 10, 2017, from the EPA to manufacturing industry groups – and signed by EPA Administrator E. Scott Pruitt – said the EPA was revisiting a 2016 rule that extended certain restrictions on the handling of refrigerants to include so-called "non-exempt replacement" refrigerants such as HFCs, HFOs and HFO blends.

In the letters, which were addressed to law firms representing the National Environmental Development Association's Clean Air Project (NEDA/CAP) and the Air Permitting Forum, the EPA said that in addition to its plans to revisit the rule concerning the refrigeration handling requirements, it would also examine the deadlines imposed for certain requirements. The two associations represent corporations on issues related to the Clean Air Act.

The EPA is "aware of your concerns regarding the feasibility of meeting the Jan. 1, 2018, compliance dates and will consider options for relief if we receive adequate information from you to substantiate the basis for such relief," the letters state.

The EPA's timetable for introducing its proposed rule revisions was unclear. A regulatory agenda for the proposal indicated that a Notice of Proposed Rulemaking (NPRM) would be filed in April and that the new rule would be finalized by year-end, but no NPRM had been filed by early May.

While natural refrigerants, including ammonia, nitrogen and carbon dioxide, remain exempt from the new restrictions for many end uses, if the EPA eases restrictions on HFCs and HFOs it could enhance the appeal of those refrigerants.

Treating HFCs Like CFCs

In the 2016 rule, the EPA updated Section 608 of the Clean Air Act with restrictions on the use of refrigerants such as HFOs ad HFCs because of their high GWP, which measures their ability to trap heat in the atmosphere. The rule, some elements of which took effect at the beginning of 2017 and 2018, and some of which will take effect in 2019, brings these substitute refrigerants in line with ozone-depleting substances (ODS), such as CFCs and HCFCs.

Effective Jan. 1, 2018, the EPA requires anyone purchasing non-exempt substitute refrigerants such as HFCs, HFOs and HFO blends to be a certified Section 608 technician. Refrigerant distributors must also maintain records of those sales.

Also effective Jan. 1, 2018, technicians must be Section 608-certified in order to open any appliance that contains non-exempt substitutes such as HFCs. They also must use Section 608 certified recovery and recycling equipment when opening an appliance that uses non-exempt replacement refrigerants, such as HFCs.

> *“All of these requirements previously applied to ozone-depleting refrigerants, like CFCs and HCFCs, so it’s not new on that front.”*

“All of these requirements previously applied to ozone-depleting refrigerants, like CFCs and HCFCs, so it’s not new on that front,” said Sara Kemme, environmental protection specialist at the EPA, during a recent EPA GreenChill webinar in which she presented an overview of the changes to Section 608 requirements.

The rule does not require any new training for these technicians who are already Section 608 certified, but it did create a new test bank for future certification, she said.

Lower Leak Thresholds

The new rule also lowered some leak-rate percentage thresholds above which equipment must be repaired, effective Jan. 1 of next year. Natural refrigerants such as ammonia, nitrogen and CO_2 all remain exempt from the new duty-to-repair thresholds for many applications.

The new thresholds are as follows:

- 30% for industrial process refrigeration (IPR), down from 35%;
- 20% for commercial refrigeration, down from 35%;
- 10% for comfort cooling, down from 15%.

Beginning next year, the rule requires that the leak rate must be calculated every time refrigerant is added to equipment containing 50 pounds or more of refrigerant. Any repairs must bring the leak rate below the threshold, as validated through verification tests conducted before and after the repair.

“If it exceeds the thresholds, it must be repaired, or you need to develop a retrofit or retirement plan,” said Kemme.

Ongoing Inspections

Equipment that has exceeded the the leak threshold is also subject to ongoing periodic leak inspections after the repair is complete. These inspections must be conducted by a certified technician, but are not required on equipment — or portions thereof — that are continuously monitored by an automatic leak detection system.

The 2016 rule also extends repair verification requirements to commercial refrigeration and comfort cooling applications, effective Jan. 1, 2019. Previously the verification requirements had only been required for repairs conducted on industrial refrigeration equipment.

For commercial equipment with 500 lbs or more of refrigerant, leak testing must be conducted once every three months until the leak rate is shown not to exceed the threshold for four consecutive quarters. For commercial equipment with between 50 and 500 pounds, leak inspections must be conducted annually following the repair of a leak exceeding the threshold.

Repair deadlines

Most leaks must be repaired within 30 days — for industrial equipment that would require a shutdown of the equipment, the deadline is 120 days — but the rule provides extensions under certain circumstances.

One exemption extends the window for repair by 120 days if a necessary part is not available within the repair period.

“If you need to replace some big component of your system, you can do that and have that part installed rather than having to retrofit or retire the appliance,” said Luke Hall-Jordan, environmental protection specialist at the EPA, in response to a question during the webinar.

The extension is especially relevant for supermarkets, he said, because it affords them more opportunity to replace a single case, for example, rather than retire or retrofit an entire refrigeration system.

“Hopefully that will encourage folks to repair, rather than retire or retrofit their appliances,” said Hall-Jordan.

In addition, supermarkets have 18 months to retire leaking equipment if the replacement equipment uses exempt refrigerants such as ammonia, nitrogen or CO_2.

The 2016 rule also introduces changes to the reporting requirements for chronically leaking equipment. Effective in 2019, operators must report to the EPA any equipment that leaks 125% or more of its full refrigerant charge in a one-year period. The reports must describe efforts to identify and repair the leaks. ■ MH

SECTION 608 TIMELINE

The Environmental Protection Agency finalized new requirements for the handling of certain refrigerants in 2016 under Section 608 of the Clean Air Act, primarily extending restrictions to include HFCs and HFOs. Natural refrigerants remain exempt from the restrictions for many end uses. Here is a timeline showing when the requirements took or will take effect.

2017

EFFECTIVE JAN. 1, 2017

- New recovery and/or recycling equipment must be certified for use with HFCs.
- Reclamation standards and reports include HFCs.

2018

EFFECTIVE JAN. 1, 2018

- Certified recovery and/or recycling equipment must be used for appliances with HFCs.
- Existing safe disposal requirements extend to HFCs.
- Technicians must adhere to specified evacuation levels when opening HFC appliances.
- Recordkeeping is required for technicians disposing of appliances with between 5 and 50 lbs of refrigerant.
- Technician certification is required to work on appliances with HFCs.
- Only Section 608-certified technicians, and companies that employ them, can purchase HFCs; refrigerant distributors may only sell HFCs to certified technicians and must retain records for those sales.

2019

EFFECTIVE JAN. 1, 2019

- Leak-repair verification requirements extend to comfort cooling and commercial refrigeration.
- New, lower thresholds for leak rates require repair.
- Periodic leak inspections are required for appliances that have exceeded the leak-rate threshold.
- Reporting is required for chronically leaking appliances.

2020

EFFECTIVE MARCH 1, 2020

- First reports are due for appliances that leaked 125% or more of their full charge in calendar 2019.

LONGO'S PURSUES TRANSCRITICAL INSTALLATIONS

Working with Neelands Group, the 32-store Canadian chain is using CO_2 at all new stores, including a net-zero outlet opening this summer.

– By Michael Garry and Charlotte McLaughlin

In Canada, where the Sobeys supermarket chain has led the nation in transcritical CO_2 refrigeration installations, other Canadian food retailers are following suit.

For example, Longo's, based in Vaughan, Ont., has partnered with contractor Neelands Group to install transcritical systems in a number of stores. Last year, about 25% of Longo's stores used the system, with all future store openings planning to employ it, according to Neelands Group' website (www.neelands.com).

"Longo's cares about sustainable solutions and is comfortable taking a slightly longer term view," said Steve Horwood, VP of sales and operations for Neelands, which has installed CO_2 systems for five years.

As part of that approach, "Longo's has identified [CO_2 refrigeration] as a key trend for the future of the supermarket industry," he added. Longo's did not respond to a request for comment.

This year, Neelands and s2e Technologies are building a Longo's grocery store in Stouffville, Ont., that will use transcritical CO_2 refrigeration as part of an overall store goal to achieve a near net-zero rate of electrical energy consumption, Neelands reports on its website. The location is slated for completion in the summer of 2018.

> *Longo's has identified [CO_2 refrigeration] as a key trend for the future of the supermarket industry.*

One of the energy-saving technologies used by the store will be a combined cooling heat and power (CCHP) system. It will operate by using natural gas from the grid to provide 150 kW of electricity and approximately 700 million BTUs of heat reclaim. (See sidebar on this page for more energy-saving systems at the store.)

This heat reclaim will be used to drive an absorption chiller, which will in turn pre-cool the top side of the transcritical CO_2 system. By doing this, Neelands said, the system will be able to operate in a subcritical mode rather than transcritical when the ambient temperature rises above 88°F, resulting in higher operating efficiencies.

Last year, CO_2 installations were completed at two new Longo's locations in Ajax and Guelph, Ontario, that opened late August/early September 2017.

Low maintenance costs

According to Neelands, Longo's stores are achieving excellent, best-in-class energy, operations and sustainability results as a consequence of using systems like CO_2 refrigeration and high-performance HVAC, as well as refrigeration performance analytics, and a "unique" approach to maintenance operations.

These results include, for example, a refrigeration leakage rate that is six times better than the industry average; an OM (operations/maintenance) cost of less than 50% of the industry average; and a 74% reduction in unplanned repair work.

With traditional HFC refrigerants, emissions for a typical 40,000-sq-ft supermarket like Longo's can be 30 to 35 kg of emissions per sq ft per year. That is reduced to less than 5 kg per sq ft per year when using a CO_2-based refrigeration system, Neelands said.

Also in 2017 Neelands designed and installed CO_2-based refrigeration systems for a major global retailer at a new big-box location in Waterloo, west of Toronto.

The Waterloo project was preceded by a Neelands CO_2 refrigeration job for the same retailer in Ottawa. Two others were in the process of construction in southern Ontario for the company, with completion dates set for the end of 2017.

These were the first CO_2-based systems ever for the retailer, which is based in the U.S. and has a major global presence.

Neelands also worked with smaller retailers on CO_2 installations. For example, a Highland Farms supermarket in Vaughan, Ont., opened with a CO_2 refrigeration system design. And Coppa's Fresh Market debuted CO_2 refrigeration technology at its supermarket location in King City, Ont. ■ MG & CM

Net-Zero Longo's Store

An upcoming Longo's grocery store in Stouffville, Ont., is planning for a near net-zero rate of electrical energy consumption, through the use of energy-saving technologies, according to Neelands Group, contractor for the store, on its website (www.neelands.com).

For example, the store, slated to open this summer, will incorporate solar energy generation on the rooftop, facade and carports, plus combined cooling heat and power (CCHP) systems. The net-zero goal calls for the ability to generate as much electrical energy as is expended in the operation of the store in a year.

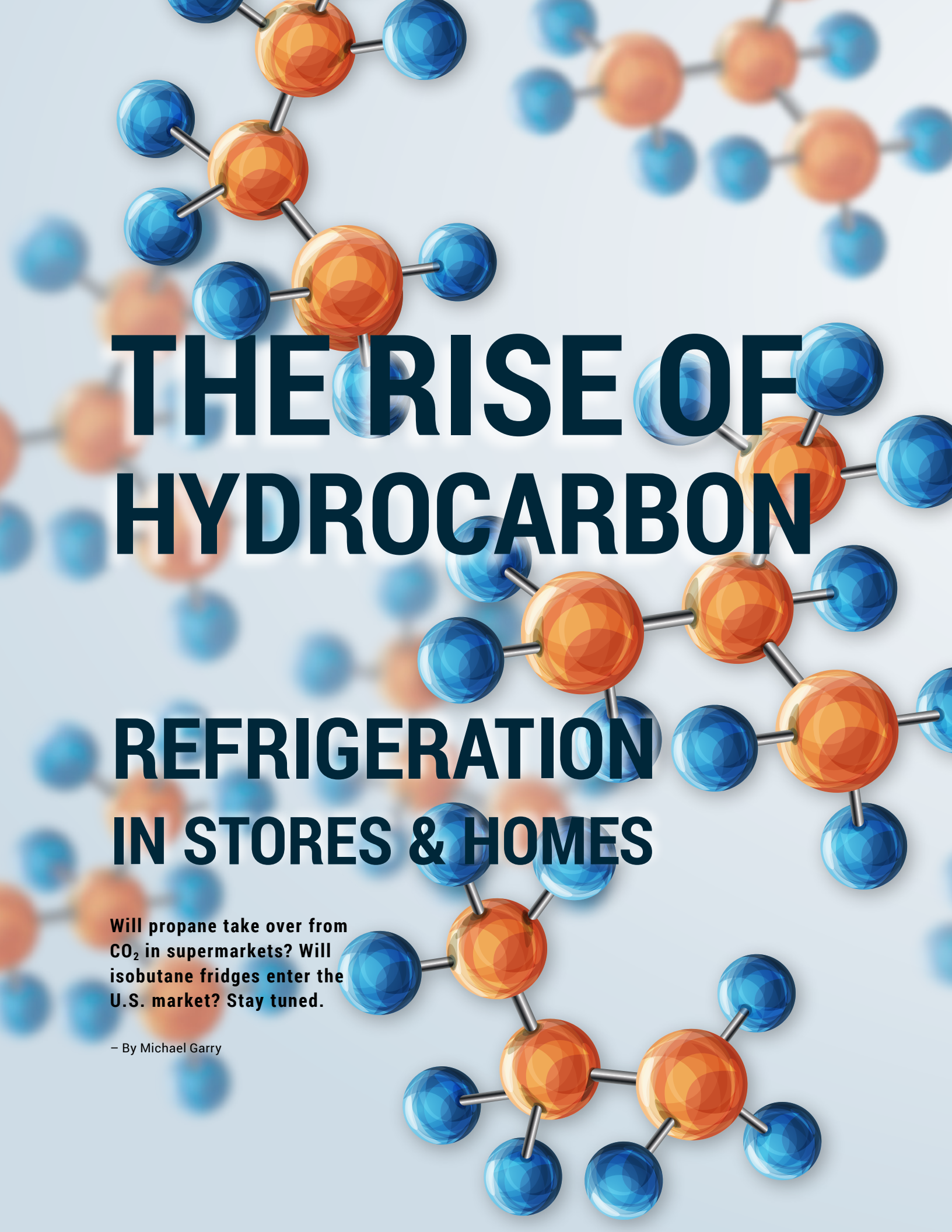
"All of these sustainable technologies have been used elsewhere in some fashion, but the Longo's Stouffville project is unique in its integration of the technologies," said Noel Neelands, president of Neelands Group. "Once executed, this project will be the first of its kind for a supermarket."

A pilot project demonstrated average electrical consumption savings of 52%, while measurably improving air quality and maintenance management functions. "They realized a tremendous reduction in electricity consumption," said Neelands.

Neelands has partnered with s2e Technologies on the project. "Grocery stores have some of the highest energy intensity footprints amongst commercial buildings, but we are striving to make a difference," said Ady Vyas, VP of projects and engineering for s2e Technologies. "With our partners, we have led the design of a net-zero energy supermarket that reduces operating costs and sets a new standard in the retail community for what can be achieved."

A key step toward achieving net-zero energy and emissions is the incorporation of solar PV panels in the building envelope, rooftop and car ports. For instance, a rooftop solar PV installation will generate, on average, about 285 MWh per annum, representing 13% of electricity consumption by a typical Longo's supermarket. Car ports and shopping-cart corrals have been designed to accommodate solar PV panels that will generate up to 350,000 kWh per year.

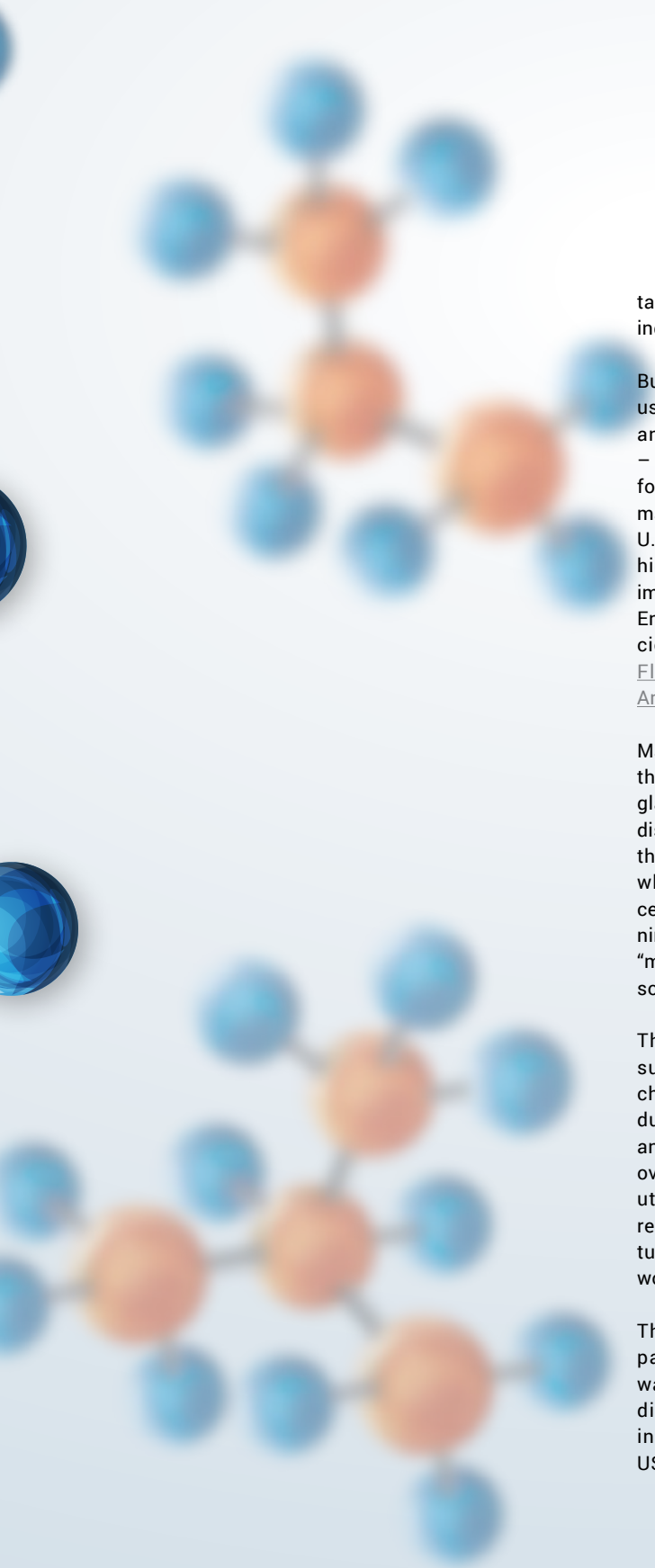
Customers will have access to charging stations for their electric vehicles at the new Longo's Stouffville. The design plan calls for the installation of two charging stations, each with two ports. This will allow four vehicles to be charged at any given time.



THE RISE OF HYDROCARBON REFRIGERATION IN STORES & HOMES

Will propane take over from CO_2 in supermarkets? Will isobutane fridges enter the U.S. market? Stay tuned.

– By Michael Garry



In the competition among natural refrigerants in the food retail sector, CO_2 was the first to gain widespread acceptance, starting in Europe and then moving around the world.

But lately, self-contained display cases using hydrocarbons – propane (R290) and isobutane (R600a), in particular – have been moving aggressively into food retail and foodservice outlets in major industrial countries, including the U.S., Canada and Mexico. In the U.S., higher energy-efficiency requirements imposed last year by the Department of Energy greatly increased interest in efficient hydrocarbon cases. (See "OEMs Flock to Hydrocarbons," Accelerate America, March 2017.)

Many supermarkets have started using these self-contained cases – such as glass-door beverage coolers or bunker displays – for spot assignments around the store, particularly at the front end, while continuing to rely primarily on central systems. Some stores are beginning to employ more and more of these "microdistributed" modular cases, with some even exploring full-store lineups.

The growth of hydrocarbon cabinets suggests the possibility that, if the charge limits applied to hydrocarbons due to their flammability are raised – and that is expected to begin happening over the next year – then microdistributed propane cases could challenge remote systems as the go-to architecture in supermarkets. This, of course, would be transformational.

The potential for self-contained propane cases in small supermarkets was recently highlighted by German discounter Lidl, which began opening stores in the U.S. last year. Lidl US confirmed that it recently received platinum certification from the U.S. Environmental Protection Agency's GreenChill Partnership for achieving certain refrigeration goals at a store in Kinston, N.C.

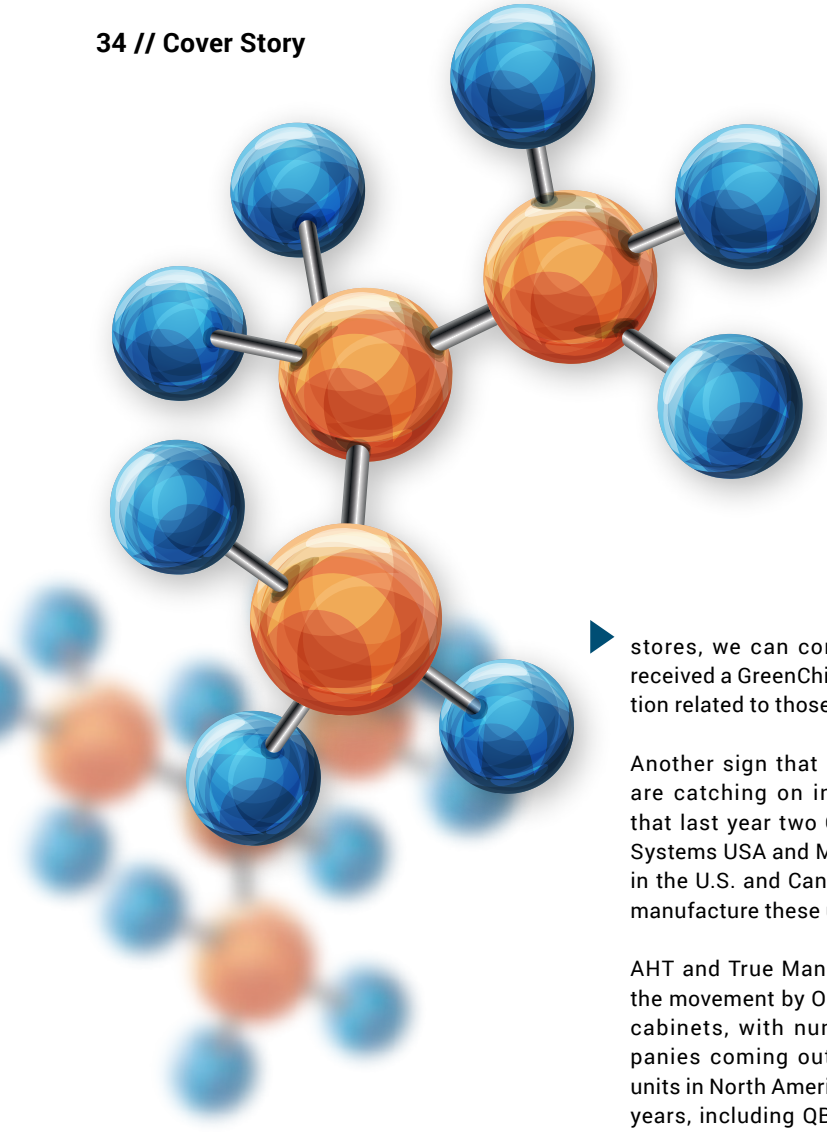
Platinum is the highest certification level that the GreenChill Partnership grants a supermarket. GreenChill has often awarded platinum certification to stores that use natural refrigerant systems like transcritical CO_2 that bring refrigerant GWP levels under 150.

Neither Lidl US nor the EPA would confirm what type of refrigeration system the chain is using at the Kinston store. However, public information points to Lidl US using self-contained cases with propane.

In the GreenChill Partnership Group on LindedIn, Gabrielle Jette, associate in Greenhouse Gas Mitigation & sustainability at consulting firm ICF, wrote last month that the store "is the first to achieve GreenChill certification using self-contained cases as a primary refrigeration system."

Lidl said in 2016 that it was committed to using propane for all new self-contained refrigerated units at its German stores, and planned to roll out R290 in all future installations across Europe.

In an email response to a query from *Accelerate America* about the GreenChill certification and the refrigeration system used at the Kinston store, Chandler Ebeier, public relations specialist for Lidl US replied, "Our teams work with a variety of technologies and processes that help us increase efficiency. This is an important part of our business that allows us to reduce waste and deliver our customers better prices. Although we do not comment on each individual process or technology we have in our



> *"The self-contained option presents a level of flexibility that I think is unmatched in many respects."*

stores, we can confirm that we have received a GreenChill platinum certification related to those."

Another sign that hydrocarbon cases are catching on in North America is that last year two OEMs, AHT Cooling Systems USA and MTL Cool built plants in the U.S. and Canada, respectively, to manufacture these units.

AHT and True Manufacturing have led the movement by OEMs to hydrocarbon cabinets, with numerous other companies coming out with hydrocarbon units in North America over the past few years, including QBD Cooling Systems (Quality By Design), Welbilt, Beverage-Air, Traulsen, Liebherr USA, Turbo Coil, Montague, Fogel, Minus-Forty Technologies, Imbera, SandenVendo and Turbo Air.

Compressor makers Embraco and Tecumseh have also stepped up to meet the growing demand for hydrocarbon components in North America while designing more energy efficient, variable-speed compression systems.

On the end user side, many retailers have been equipping their stores with multiple hydrocarbon display cases, notably national operators Whole Foods Market (100-plus stores), Target (more than 900 stores in 2017) and ALDI US (about 200 stores last year), as well as regional players like Hannaford Supermarkets and Lowe's Markets, and many others that are installing hydrocarbon coolers at the checkout. In addition, foodservice outlets like Starbucks and McDonald's, convenience store chains like Circle K and USA To Go, dollar discount stores, and specialty chains like Freshpet have begun installing hydrocarbon equipment, and brands like Red Bull, Coca-Cola, PepsiCo, Nestlé, General Mills, and Unilever have rolled out hydrocarbon equipment in retail locations.

PLUG-AND-PLAY FLEXIBILITY

Why are self-contained hydrocarbon cabinets causing such a buzz in the retail sector? For one, it's their simplified design, which typically includes hermetic, factory-charged condensing units, either air-cooled or water-cooled by means of an external loop.

Compared with traditional centrally cooled cases, this design offers lower installation and maintenance costs and very low leak rates, with no need for a machine room, large rooftop condensers or extensive piping to cases.

In addition, their plug-and-play flexibility allows self-contained cases to be moved at will around the store for whatever marketing purpose.

AHT's self-contained propane cases – including multidecks and deep freezers – are designed to offer a simpler alternative to remote systems, one that provides retailers in urban environments "with more flexible spaces," said Drew Tombs, president of AHT Cooling Systems USA, who spoke during a recent Emerson E360 webinar.

That flexibility also enables retailers to convert centralized R22 or HFC systems to a self-contained all-natural scenario in a stepwise fashion without disrupting store operations. "Self-contained is an easy add-on," said Tombs.

AHT R290 case

AHT began serial production of propane cases in Europe in 2002 in response to global ice cream customers "who were looking for ways to reduce energy consumption of their cases," said Tombs. Since then the company has supplied over one million propane cabinets globally, with both R290 and R600a, including more than 20,000 in North American supermarkets and convenience stores, said Tombs.

Last year, AHT opened its first production plant in the U.S., near Charleston, S.C., the company's fourth global plant. The new plant was built "on the assumption that this market was ready for our solutions, particularly multi-deck propane plug-in units," said Tombs.

The benefits of self-contained cases have captured the attention of Whole Foods Markets, one of the leading users of R290 units in the North American food retail market, with installations in more than 100 stores, mostly under-counter cases and bunker displays on the sales floor.

In general, Whole Foods has taken a "silver buckshot" approach to natural refrigerants, testing several different system types, said Tristam Coffin, director of sustainability and facilities for the chain's Northern California region in the Emerson E360 webinar. But he has grown increasingly impressed with the potential of self-contained cases. "In regard to serviceability as well as mobility, especially in urban environments, the self-contained option presents a level of flexibility that I think is unmatched in many respects," he said.

Whole Foods is also testing the first propane/CO_2 cascade centralized system at a store in Santa Clara, Calif.

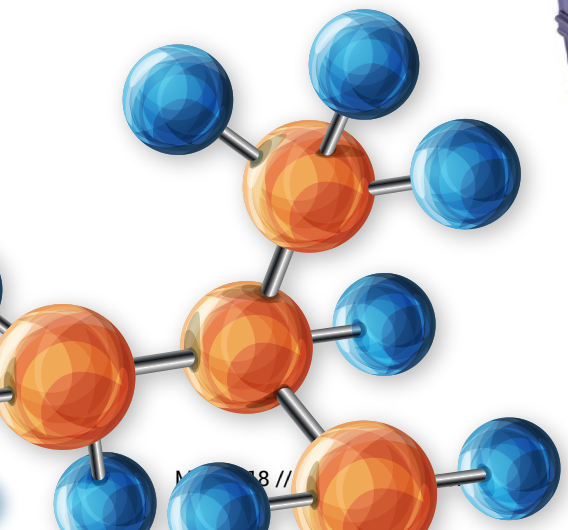
From an energy perspective, hydrocarbon cases have an exceptional track record. Target, for example, has found that an R290 cooler can consume 53% less power than a comparable R134a unit. According to Coffin, self-contained hydrocarbon systems offer energy savings of between 30% to 50% over traditional self-contained cases or DX racks. (In some instances, a portion of the efficiency gain may be due to ECM motors, LED lights or other improvements not used in baseline units.)

Moreover, hydrocarbons deliver cooling capacity with minimal charge sizes, and are compatible with copper, standard mineral oils and other common system components.

And, of course, hydrocarbons propane and isobutane feature a negligible GWP of about three, making it a "future-proof" refrigerant when it comes to environmental regulations. The low GWP combined with energy efficiency results in a very competitive total equivalent warming impact (TEWI).

In comparison to low-GWP HFOs like R1234YF, propane has an expected cost advantage, noted André Patenaude, director of food retail marketing and growth strategy, Cold Chain, Emerson, in the E360 webinar. The larger compressor displacement used by R1234YF requires bigger compressors, valves and heat exchangers, which can drive up cost. "R290 systems are much smaller and more cost efficient," he said.

AHT R290 case



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ACHILLES' HEEL

Hydrocarbons' Achilles' heel is its flammability. Because of this, hydrocarbons must adhere to strict charge limits imposed by regulators around the world. On the domestic level, isobutane-based refrigerators, with a maximum charge of 150 g (what's contained in a cigarette lighter) have been widespread in Europe and other countries outside of the U.S. for many years, thanks to the pioneering efforts of Greenpeace. However, in the U.S., manufacturers have not been able to market these fridges due to the charge restriction of 57 g.

But there is a growing movement to raise the charge limit for domestic fridges in North America to 150 g, and the U.S. home appliances market is preparing the take advantage of that increase when it occurs (see story, page 41).

The hydrocarbon charge limitation of 150 g, while acceptable for domestic fridges, is still considered insufficient for larger commercial units, prompting industry-wide interest in raising that charge limit to 500 g. (See page 40.) The current 150 g limit "creates challenges for end users, OEMs and engineers of record to design systems that are applicable for the grocery industry," said Coffin.

AHT's larger units, such as some of its multi-decks, are designed with multiple propane circuits (each still under 150 g) to accommodate the bigger loads, Tombs noted. With a higher charge limit, one circuit would be sufficient, reducing the cost of the cases.

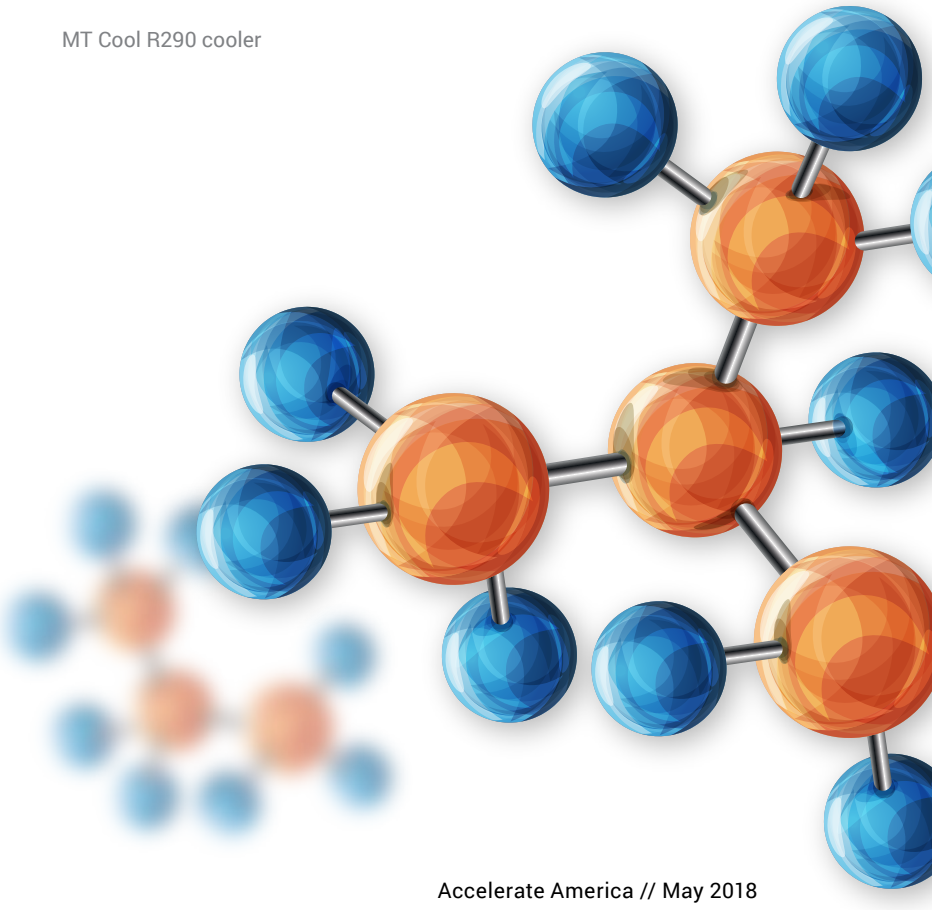
"We have invested in how to do microdistributed systems with multiple circuits that can still meet current regulations and bring propane into the market while legislation continues to look at [charge] increases," said Tombs.

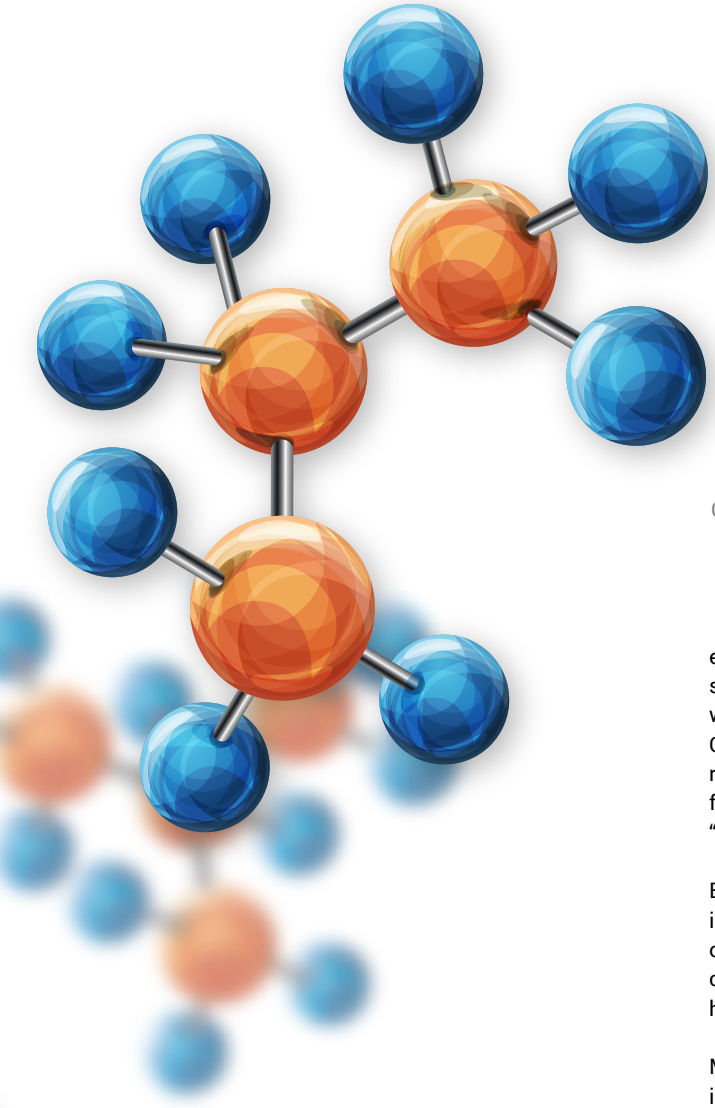
In 2015, AHT showed in Europe that, with bigger circuit charges, it was possible to use only propane self-contained cases in a store. The OEM gained special permission to use up to 700 g of propane in a single circuit. Today, more than 50 stores supplied by AHT use propane in more than half of their refrigeration and "we're starting to establish full-store systems," Tombs said.

Mark Bedard, president and CEO of MTL Cool, Chambly, Quebec said he is also "anxious to get the charge limit up to 500 g."

After opening a manufacturing plant last year for four lines of glass-door hydrocarbon beverage coolers (three with propane and one with isobutane) and an open freezer case, MTL Cool began selling them, mostly in the U.S. "In six months, we

MT Cool R290 cooler





QBD Cooling Deck 3.0 R290 cassette system

expect to have thousands installed," he said, adding that in a year these cases will account for 55% to 60% of MTL Cool's business,. Many of MTL Cool's retail and brand customers have asked for hydrocarbon technology because "they want to be green and fly that flag."

But until the charge limit goes up, MTL is unable to cost effectively make some open cases with hydrocarbons. With a charge of 500 g, "we could shift 100% to hydrocarbons," Bedard said.

MTL Cool is trying to differentiate itself in the marketplace with specially designed cabinet doors. For example, its Vista hydrocarbon unit features insulated glass doors with clear frames that have "no visual impairment," said Bedard.

Another difference in MTL Cool's hydrocarbon units is that they mostly use MicroGroove 5 mm tubes in heat exchangers. "That lets us put less refrigerant in the system and keeps us under 150 g," said Bedard. "We can also absorb more heat with less material," though the cost of MicroGroove tubes is higher than conventional tubes.

MTL Cool obtains its MicroGroove coils from Super Radiator Coils, one of the few providers of these coils.

Another Canadian OEM, which started shipping hydrocarbon glass-door merchandisers in 2016 as a result of changing regulations and requests from customers, is QBD Cooling Systems (Quality By Design), Toronto. R290 units now represent about 70% of its business and growing.

QBD's hydrocarbon cabinets were recognized in 2017 and 2018 by Natural Resources Canada with ENERGY STAR Manufacturer of the Year in Commercial Products awards.

"I see people waking up to the fact that this is something they need to get on board with and get a comfort level with," said Safder Jaffer, VP and general manager at QBD.

QBD's key customers include global beverage brands and global foodservice and retail chain stores. "Because our customer base is ahead and have their own sustainability mandates, they keep us ahead," said Jaffer. QBD has also started supplying hydrocarbon cases to food retailers, and provides units with advanced cooling controls to retail pharmacies for storing medication and vaccines.

About 70% of QBD's hydrocarbon coolers contain removable refrigeration decks (cassette systems) called Cooling Deck 3.0, according to QBD. "You can remove them in two minutes," said Jaffer, saving on maintenance and achieving lower total lifecycle costs. "It's a better system in the long run because of flexibility." Fogel is another OEM that offers removable cassettes.

The rest of QBD's units use traditional split systems. QBD has also started developing open-air hydrocarbon units.

> *"I see people waking up to the fact that this is something they need to get on board with and get a comfort level with."*

IEC MOVES TOWARD CHARGE INCREASE

On a global level, the International Electrotechnical Commission (IEC) is spearheading the effort to raise the charge limit for propane.

The IEC subcommittee SC61C decided last October to advance a draft amendment that would increase the propane charge limit for commercial units to 500 g. A vote by IEC committees on that amendment is expected in the first half of 2018; assuming it passes, a final vote would take place by the end of 2018, with a new charge limit ready by the start of 2019.

Once the IEC finalizes the charge increase, standards bodies in the U.S. – UL, ASHRAE, EPA and code organizations – are expected to follow suit, though the process may take two or more years.

Many observers are frustrated with the slow pace of change within code bodies. To address that, the North American Sustainable Refrigeration Council (NASRC) recently circulated an industry petition calling for faster code updates. "Our goal is really to harmonize with the [IEC] standard and do so in the most expedited way possible," said Danielle Wright, executive director for NASRC, in a recent webinar hosted by the Department of Energy's Better Buildings Alliance.

Supporting the efforts to raise the charge size of commercial units, several research studies have been assessing the flammability risk posed by hydrocarbons. Last September, Scott Davis, principal engineer for Gexcon US, presented the findings of a study sponsored by the Fire Protection Research Foundation that assessed the safety of various hydrocarbon charge limits. It found, for example, that a 1,000-g charge in an appliance in a big-box grocery store is comparable in safety to a 150 g charge in a small commercial kitchen. (See "Study Shows Propane Charge-Limit Scenarios," Accelerate America, October 2017.)

In addition, the Air Conditioning, Heating and Refrigeration Technology Institute (AHRTI) has begun working on a study of the risks posed by A3 (flammable) refrigerants, following a similar study of A2Ls.

QBD's Cooling Deck 3.0 uses "lint-tolerant" condensers designed with larger openings to allow debris to pass through and not clog up the coil. "It's easier to clean and tolerates more build-up," said Jaffer.

SAFETY FIRST

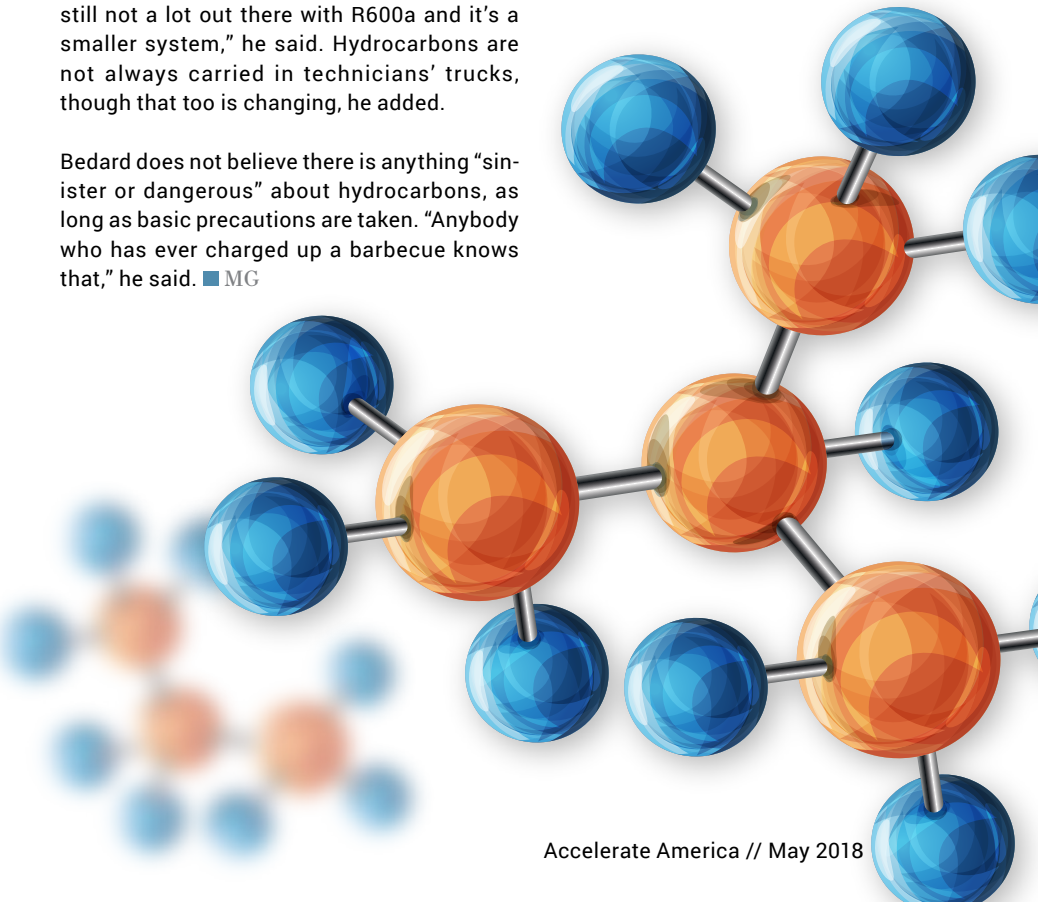
Given the flammable nature of hydrocarbons – and concerns about the knowledge base of technicians – OEMs and industry groups have taken pains to train technicians in the safe servicing of the equipment. Training expert Arthur Miller, principal at KAM Associates, has been delivering morning-long training sessions at the AHR Expo (See "Revisiting Hydrocarbon Safety," Accelerate America, February 2018.) RSES offers online hydrocarbon training at https://www.rses.org/hydrocarbons.aspx.

QBD is in the habit of listening to technicians "to understand what their challenges are," said Jaffer. "Many good ideas will come from the field."

As technicians get more experience with hydrocarbon equipment, "their fear will diminish," Jaffer added. "There is still some sense of, 'This is kind of new,' but that will improve with time and experience."

MTL Cool's Bedard see service improving for R290 but still problematic for R600a. "There's still not a lot out there with R600a and it's a smaller system," he said. Hydrocarbons are not always carried in technicians' trucks, though that too is changing, he added.

Bedard does not believe there is anything "sinister or dangerous" about hydrocarbons, as long as basic precautions are taken. "Anybody who has ever charged up a barbecue knows that," he said. ■ MG



Home Fridge Makers Still Pushing for Higher Charge for Isobutane

For the past decade, the Washington, D.C.-based Association of Home Appliance Manufacturers (AHAM) has been playing "whack-a-mole" when it comes to transitioning to isobutane (R600a) refrigerants for home refrigerators, said Kevin Messner, its senior vice president, policy & government relations.

That is, as soon as one issue is addressed, another one pops up.

"We're an industry that is willing and committed to transition to isobutane," he said. "We make these products for the rest of the world and it would be great from a manufacturing perspective to get them as harmonized as possible."

Domestic refrigerator manufacturers have already invested close to $100 million in gearing up to make conventional home refrigerators with isobutane, he said.

To enable the complete transition to happen, AHAM has been pushing for the charge limit for isobutane in home fridges set by the Environmental Protection Agency to increase from 57 g to 150 g. That is the standard outside of the U.S., and the amount of isobutane needed to cost effectively produce large home refrigerators. The 57 g limit – set by the EPA in 2011 when it permitted isobutane to be used as a replacement gas under its Significant New Alternatives Policy (SNAP) program – has allowed only compact refrigerators to be made in the U.S., Messner said.

Last December, it looked as if AHAM would get its wish as the EPA issued a "direct final rule" raising the hydrocarbon charge limit to 150 g for domestic fridges, based on a UL standard set last year that raised the charge limit to that amount. However, that was pending a comment period, and in February EPA reversed course in SNAP Rule 22 after receiving a small number of "adverse comments" on the change.

But the agency said it would address those comments as it continued to consider the charge increase. (See "EPA Pulls Charge Boost for Domestic Fridges," *Accelerate America*, March 2018.)

AHAM was also eager to see the charge limit rise to 150 g because the EPA SNAP program announced in 2016 that R134a, the primary HFC used in U.S. domestic refrigerators, would no longer be allowed beginning in 2021. Given its difficulties getting the charge limit raised for R134a's replacement, AHAM considered the 2021 deadline too soon, and requested that it be moved up to 2024. "Rushing it would not be good for anybody," said Messner. "And another few years would have a negligible impact on the environment."

However, that scenario has changed as a result of a U.S. Court of Appeals ruling last August invalidating the EPA's ability to strike HFCs from use as replacements for ozone-depleting gases. Though the rule only applied to EPA SNAP Rule 20, which didn't contain the impending prohibition against R134a in home fridges, the ruling is expected to apply equally to Rule 21, which does contain that prohibition. That would remove the 2021 deadline for replacing R134a, and it doesn't preclude manufacturers from using R600a – results favorable to AHAM.

On the other hand, last month, the EPA said it "plans to begin a notice-and-comment rulemaking process to address the remand of the 2015 rule." The agency added that it "intends to consider the appropriate way to address HFC listings under the SNAP program in light of the court's opinion" and also consider "the larger implications of the court's opinion remanding the rule to the agency."

In addition, a bill was introduced in February in the U.S. Senate that would provide the EPA with the power to regulate HFCs; the Senate may also take up for ratification the Kigali Amendment to the Montreal Protocol, which calls for a global phase-down of HFCs.

Further complicating matters, the California Air Resources Board announced in March that it was preserving the SNAP rules on HFCs in the Golden State.

The upshot for AHAM, explained Messner, is that AHAM still wants to see the EPA raise the charge limit for isobutane to 150 g as soon as possible; that would give manufacturers certainty about moving forward with their plans for using the refrigerant in larger U.S home fridges, even as the U.S. government figures out how it wants to regulate HFCs, which Messner thinks could take a while.

Even without the EPA increasing the charge limits, the court ruling allows manufacturers to use 150 g of isobutane under standards set by UL (and CSA in Canada). But AHAM is still seeking the EPA's endorsement of the charge limit change, which would be the quickest way to achieve it, said Messner.

"There's the final investment that can't happen till we know what the charge size is," said Messner.

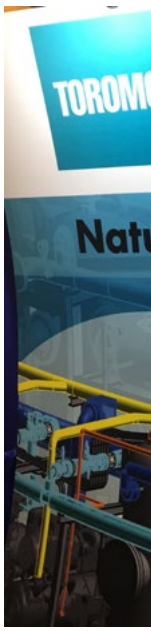
In preparation for the transition to isobutane, AHAM last year released guidelines for the safe servicing of residential appliances with flammable refrigerants. (See "Are Home Fridges in U.S. Turning Toward Hydrocarbons?" *Accelerate America*, November-December 2017.)

Messner noted that domestic fridge manufacturers are not able to use HFO refrigerants and are not interested in using HFO blends that have a GWP up to 700. "They'd rather just go for the natural refrigerant."

CO_2 Shares Spotlight with Ammonia at IIAR

The rise of transcritical CO_2 refrigeration in the industrial sector was manifested by numerous exhibitors at the traditionally ammonia-focused event

– By Michael Garry and Mark Hamstra



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1 / Benoit Rodier, CIMCO
2 / Hillphoenix booth at IIAR Conference
3 / GEA presentation at IIAR Conference

While low-charge ammonia packaged and central systems were prevalent on the exhibit floor at the International Institute of Ammonia Refrigeration (IIAR) 2018 Natural Refrigeration Conference & Expo, held in March, transcritical CO_2 technology for industrial applications was also showcased by numerous companies.

The following is a roundup of CO_2 products and perspectives at the event, followed by some ammonia-related products.

CIMCO EYES SMALLER PLANTS

Toronto-based contractor CIMCO sees smaller industrial refrigeration plants as a market that is potentially ripe for the deployment of transcritical CO_2 refrigeration systems.

In an interview with *Accelerate America* at the IIAR Conference, Benoit Rodier, director of business development at CIMCO, said the company is seeking to expand its installation of transcritical CO_2 systems to these smaller end-users, primarily as an alternative to synthetic refrigerants.

"In really big projects, an ammonia-central system still has its place," said Rodier.

Increasingly, industrial operators are taking a serious look at smaller rooftop installations for transcritical systems, rather than using machine rooms. Several equipment suppliers have begun offering transcritical systems designed for rooftop installations, he said.

For many installations, the goal would be to deploy a series of smaller transcritical CO_2 systems that each provide refrigeration for a specific room or temperature zone within a facility, Rodier explained.

"The idea is not to have one rooftop [system] to supply the entire plant," he said. "You are going to a smaller machine, which will be for a smaller zone. You are going with a multiple-rack system."

Meanwhile, Rodier said cost remains a significant barrier for the adoption of the NewTon ammonia-CO_2 cascade system, marketed in North America via a collaboration formed in 2015 between CIMCO and Japanese equipment manufacturer Mayekawa Manufacturing Co.

"It is a very high-end, quality product, but price-wise, it's difficult," said Rodier. "That is really the roadblock right now."

CIMCO also recently installed its first ammonia/CO_2 ice rink system in the U.S. The system features CO_2 that is piped directly under the ice,, running through a continuous loop, much like brine or glycol.

The system, which has been in place for about six months, is located in North Dakota and has been very well-received by the ice rink operator, according to Rodier. The direct-CO_2 floor provides strong ice quality and consistent temperatures throughout the ice, he said.

"He has the best ice in the area," said Rodier.

CARNOT: UNPRECEDENTED CO_2 INTEREST

Quebec OEM Carnot Refrigeration has seen an uptick in interest in its transcritical CO_2 systems for industrial applications, said Marc-André Lesmerises. "I have never seen that before [at the IIAR Conference]." He attributes it partly to the IIAR "talking about natural refrigerants more than just ammonia."

A Carnot transcritical system was recently installed in a cold storage area at an operating MaMa LaRosa Foods Italian-style dough plant in Taylor, Mich. "I believe strongly as an engineer that for most applications the best refrigerant is CO_2 only," said Lesmerises.

Carnot has developed its own "custom" ejector that it started using in transcritical systems; it can be employed to facilitate defrost. "I like the simplicity of our ejector," said Lesmerises. "You can use it all year – not just when it's hot – to gain benefits, even in Canada."

HEATCRAFT: SCALING TO INDUSTRIAL

Though Heatcraft Worldwide Refrigeration, Stone Mountain, Ga., showcased a commercial transcritical CO_2 system at the IIAR Conference, the company plans to "scale it up to industrial," said Grady McAdams, Heatcraft's director of cold storage sales.

The industrial model would have a capacity ranging from 100-300 TR, he said.

McAdams said the company is seeing about equal interest from the industrial sector in both transcritical CO_2 and ammonia/CO_2 cascade systems, "though most people feel it's a further leap to transcritical CO_2."

HILLPHOENIX: QUOTING CO_2

In addition to showing NXTCOLD low-charge ammonia packaged units, Hillphoenix, Conyers, Ga., was also marketing its industrial CO_2 transcritical system. Transcritical "is growing – we're quoting as much industrial transcritical CO_2 as we are NXTCOLD," said Tim Henderson, industrial program manager for Hillphoenix.

Most industrial transcritical CO_2 systems offer about 150 TR for low temperatures and 200 TR for medium, he said. "If it needs to be bigger, it can go in multiple pieces."

ZERO ZONE: PARALLEL COMPRESSION AND ADIABATIC CONDENSER

Zero Zone, North Prairie, Wis., featured several CO_2 industrial systems, including the ColdLoop transcritical chiller system, the ColdLoop subcritical system and the Edge XT condensing unit (water- or air-cooled).

"Customers who are using HFCs are feeling the pressure," said John Collins, Zero Zone's industrial sales manager. "With parallel compression and adiabatic condensers, we have much more viable [transcritical] options for them."

Parallel compression and adiabatic technology "gets most of the lower 48 U.S. states into the range where it's attractive to use CO_2," he added. "So we're seeing a lot growth in our business in those product lines."

GEA: CO_2 COMPRESSOR FOR U.S.

German manufacturer GEA discussed its Bock semi-hermetic transcritical CO_2 compressor, which has been marketed in Europe and will be available in the U.S. in mid-2019, said Lawrence Bradley, director of solution sales – refrigeration for GEA North America. "We're waiting for UL approval."

In Europe, GEA has "built a good number of rack systems using Bock compressors in cooling and freezing applications," he said.

Transcritical CO_2 systems are set to grow five-fold by 2020, said Bradley. The growth of CO_2 was evident at the IIAR Conference where in the past the emphasis would be just "ammonia, ammonia, ammonia," he said.

MG

DANFOSS UNVEILS DIGITAL GAS DETECTORS

Danfoss, a manufacturer of controls and components, is aiming its new digital gas detectors at industrial refrigeration facilities that use natural refrigerants, including ammonia and CO_2.

James Hower, industrial refrigeration sales director at Danfoss, led an information session at the IIAR Conference detailing how the company's latest digital gas detectors can reduce installation and maintenance costs while maximizing safety because of their high degree of accuracy. The detectors are ideally suited for users of ammonia in particular, he told *Accelerate America*.

"It's simpler to use because it is digital," said Hower. "You can calibrate it without tools."

The detectors have maintenance reminders with alarms built in — features that are lacking in other gas detection systems that have been on the market, he said.

"Not only are they more accurate and easier to use," said Hower, "they also have on-board diagnostics, keypads and digital displays that change color with ppm readings, and connectivity to central control systems."

The Danfoss gas detectors allow users to have two different sensors connected to a single controller, which could provide a more streamlined solution for facilities using ammonia/CO_2 cascade refrigeration systems, or for those using low-charge ammonia solutions.

Ammonia/CO_2 refrigeration users could have one sensor programmed for ammonia detection and another for CO_2 detection, both monitored from a single electrical box, while low-charge ammonia users could have two different sensors programmed for different levels of ammonia detection — one for 0-100 ppm, for example, and another for 1,000-plus ppm.

In order to assist in the deployment of gas detection systems of all types and in all settings, Danfoss has begun issuing application guides.

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BITZER US SHOWS COMPRESSOR MONITORING SYSTEM

Refrigeration equipment manufacturer Bitzer US, Inc., showcased its largest industrial compressor at the IIAR Conference, along with a new electronic monitoring system, the IQ Module.

The twin-screw compressor, which can be used with various refrigerants in applications of up to 300 tons of medium-temperature refrigeration, integrates the electronic monitoring system to facilitate operation protection and maintenance, according to Joe Sanchez, director of engineering for Bitzer US, Inc., based in Flowery Branch, Ga.

"It's a plug-and-play compressor," said Sanchez. "We are integrating electronics into the monitoring of the compressor, so it makes life really simple for end-users, contractors and technicians."

The monitoring system is currently available for compressors in the 150-TR to 300-TR range, but Bitzer plans to make the monitor available for smaller systems as well, said Sanchez. It's applicable to various refrigerants.

The IQ Module allows industrial users to monitor multiple compressors from a single controller without the extensive wiring that would traditionally be required to connect compressors to master controllers in multiple-compressor installations.

"All you need is Modbus communication, and you get all of the data for the compressor to a master controller," said Sanchez. "This is really not done at the industrial level like this."

The system includes a tool that allows technicians to access compressor data — such as alarms, trends, faults and other statistics — wirelessly via Bluetooth to facilitate service.

At the IIAR conference, Bitzer was showcasing a simulator that demonstrated how the controller could monitor various analog inputs in an ammonia system.

"It is going to be a great diagnostic tool," said Sanchez.

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1 / Danfoss digital gas detectors
2 / Joe Sanchez, Bitzer US, Inc., with twin-screw compressor and monitor

Gaining Natural Experience

Eastern Refrigeration has installed three different CO_2 refrigeration systems in supermarket across New England, including a transcritical system with heat reclaim

– By Michael Garry and Mark Hamstra

Many supermarket operators have hit the "pause" button on new-store development as they seek to digest the implications of last year's acquisition of Whole Foods Market by Amazon and the future of bricks-and-mortar retailing in a world of increasing ecommerce availability.

That slowdown in development may also be having a negative impact the installation of new refrigeration systems — although operators continue to test and deploy natural refrigeration technologies, according to Stan Shumbo, VP at Colchester, Conn.-based Eastern Refrigeration, a refrigeration contractor for the supermarket industry.

Shumbo recently spoke with *Accelerate America* about his company's experience with CO_2 refrigeration technologies at three varied projects across New England.

"People are talking about [CO_2 refrigeration], but right now the whole supermarket industry is kind of in flux, because of what's going on with Amazon-Whole Foods," said Shumbo. "Everyone is kind of taking a step back. I think a lot of us have seen that over the last year."

Shumbo also said natural refrigeration technologies are still seen as expensive by many supermarket operators, particularly smaller independents with limited resources.

"We obviously want to see them go to natural refrigerants, but a lot of the smaller guys cannot afford it," he said.

But Shumbo said it's difficult for him to recommend anything other than natural refrigerants, because of the uncertain future for synthetic refrigerants.

CAPTURING HEAT

One CO_2 installation that Eastern Refrigeration recently completed at an independent supermarket in New England featured a rooftop transcritical CO_2 booster system from Hillphoenix. The system — Eastern Refrigeration's first transcritical CO_2 installation — was added as part of a store remodel that was done while the store remained open.

One of the advantages of the system is that it reclaims the heat given off by the CO_2 after it is compressed, and uses it to provide ambient heating and dehumidification for the store. The hot gas is piped to a special heat reclaim coil, which Eastern Refrigeration had specially made for the installation and placed in the HVAC room. (The store features a Season 4 HVAC system.)

In addition, the refrigeration system uses a glycol heat exchanger to heat the store's water supply, using glycol that has been heated by the compressors.

Capturing this heat for reuse in the store for both the air and water helps boost the return on the investment in the new refrigeration equipment.

In order to install the new system while the store was operating, Eastern Refrigeration first placed the new condensers/gas coolers on the roof and installed and pressure-tested all of the new piping for the refrigerant loop in the ceiling while the previous refrigeration

Stan Shumbo, Eastern Refrigeration

system was running. Then it brought several of the new walk-in refrigerators online with CO_2, with a new evaporator in each walk-in.

The company then installed the new cases, which are cooled via the CO_2 system, in each department, one at a time — a row of produce cases, for example, followed by a row of meat cases, etc.

"We worked our way systematically across the store," said Shumbo.

The whole process took about seven months, he said.

"When you are working around an open store, you have to keep them in business," said Shumbo. "There were a lot of temporary moves of existing equipment just to make room for the new equipment."

The system includes adiabatic condensers/gas coolers from Baltimore Aircoil, which helps boost efficiency of the CO_2 system on days with high ambient temperatures, when CO_2 becomes less efficient. Adiabatic condensers are becoming increasingly common in supermarket refrigeration installations, according to Shumbo, even for non-CO_2 systems.

A second CO_2 system, which Eastern Refrigeration helped design with Hillphoenix and then installed at a regional supermarket chain, features a cascade CO_2 design with direct expansion (DX) for low temperatures, and glycol for the medium-temperature cooling needs.

"We actually did the condensing side off of the medium-temp DX," Shumbo explained. "It was kind of a strange system."

A third Hillphoenix CO_2 system that Eastern Refrigeration installed involved the conversion of a traditional Walmart in Massachusetts into a Walmart Supercenter featuring a full refrigerated and frozen grocery offering. In that instance, Eastern added a secondary medium-temperature glycol system and a secondary CO_2 low-temperature system.

Shumbo said Eastern does not have any additional CO_2 installations scheduled, but the experience of installing the systems to date has helped prepare the company for the future.

MEETING RECRUITMENT CHALLENGE

Shumbo acknowledged that recruiting technicians has become a challenge for the whole industry. Eastern has been able to recruit some workers from technical high schools in the area, he said.

"Some of our guys worked for us while they put themselves through college, got an engineering degree, then came back to work for us," said Shumbo. "They can make a good living. It's a good trade, and it's becoming more and more technical."

Recently Shumbo has begun having discussions with some local community colleges — Tunxis Community College in Farmington, Conn., and Asnuntuck Community College in Enfield, Conn. — about adding supermarket refrigeration training. Both colleges currently offer some education in energy management and in HVAC.

"We are going to talk with them about possibly tailoring their energy management towards the supermarket side, and maybe working with them to tailor some of their HVAC program more to the supermarket refrigeration side," he explained.

Energy management is particularly relevant with CO_2 systems, Shumbo said.

"Once you go to the CO_2 technology, it's no longer mechanical expansion," he said. "It's all electronic, so energy management becomes so much more of a factor." To provide training on CO_2 systems for its workers, Eastern Refrigeration has partnered with the Hillphoenix Learning Center.

He also cited the proliferation of programmable motors that can be set to operate at different speeds for different applications as an example of the increasing need for technical skills in the industry.

Recruiting qualified workers was also expected to be a topic of discussion at a recent meeting Shumbo attended with the Institutional & Supermarket Equipment (ISE) buying group, he said. ■ MG & MH

PureFreeze low-charge ammonia unit

M&M's Low-Charge Entry

The manufacturer of large industrial ammonia/CO_2 systems unveils its first standardized packaged units.

– By Michael Garry

M&M Refrigeration, a Federalsburg, Md.-based manufacturer of industrial refrigeration systems, in January introduced a line of low-charge ammonia configurable modular systems – another entry in the growing field of packaged low-charge systems.

The high-efficiency line, called Pure Refrigeration, consists of three models – PureChill, PureCold and PureFreeze – that range in capacity from 50 to 200 TR. All have an ammonia charge of 0.5 lb or less per TR while employing a secondary fluid or CO_2.

The systems are prefabricated and delivered assembled "so the time for installation is significantly reduced, along with labor costs," said M&M in a statement

Because of the units' low ammonia charge, "PSM costs are lower than standard systems, insurance rates are reduced, and there is a safer work environment for your employees and products," said M&M.

M&M is known for supplying ammonia/CO_2 industrial systems using traditional engine-room configurations with CO_2 evaporators in the load area. (See "Pioneer of Low Charge," *Accelerate America*, March 2016.")

To get more insights into the M&M's new packaged line, *Accelerate America* interviewed Chuck Toogood, vice president of business development for M&M.

> *They also use a food-grade coolant fluid or CO_2 to transfer the energy, so there is no direct contact between the ammonia and air in the cooler or freezer.*

// Tell us about your new Pure Refrigeration line.

Chuck Toogood: It consists of three product lines. Common for all of them is that they do not require an engine room and the related engine-room requirements. They can be installed on the roof or on the ground outside the building. They all have an ultra-low ammonia charge; they also use a food-grade coolant fluid or CO_2 to transfer the energy, so there is no direct contact between the ammonia and air in the cooler or freezer. This concept was developed because even a few pounds of ammonia in the cooler or freezer can still cause a lot of damage.

// Are these M&M's first "packaged" units?

CT: No. M&M have had packaged systems for similar applications for the last 20 years. However, the packages made so far have not been standardized and modularized as the Pure Refrigeration line has.

// How do the three lines differ?

CT: The PureChill product line is an ultra-low-charge ammonia chiller line for higher temperature applications (60°F to 15°F). The targeted applications include air conditioning, process cooling as well as room cooling for chill rooms, docks, etc. Room-cooling applications are made in combination with our PureAU line, which consists of light-weight air units in stand-alone penthouses. A food-grade, low-temperature coolant is used in the air unit, so no contamination of ammonia into the cold storage rooms is possible. The PureAU is not in direct contact with the PureChill unit; only piping and wiring connect these units.

The PureCold product line is basically the same as the PureChill line, but is designed for lower temperature applications (20°F to -30°F), such as cold storage and low-temperature process cooling. Again, for cold storage, the PureCold is used in combination with the PureAU line.

The PureFreeze product line is developed for low- to ultra-low-temperature applications (-25°F to -60°F), such as IQF freezers, blast freezers and plate freezers. Inside the box is an ammonia/CO_2 cascade unit, with extremely high efficiency and very low ammonia charge.

// What are the best applications for the Pure Refrigeration lines?

CT: The Pure Refrigeration line options offer a variety of applications for the end user. For example, they are an easy fix when additional capacity is needed, such as when an additional chill or freezer storage is added to an existing facility but there is little or no space for additional compression equipment; they are also an option for end users facing the CFC and HCFC refrigerant phase-out mandated by the Montreal Protocol.

// Would these be considered typically rooftop units located over the load?

CT: These units can be designed to mount on the roof directly above the load. However, they are also designed to be installed on the ground mounted near the load for retrofit applications where the existing roof structure cannot support the total load.

// What kind of condensing do the units use?

CT: All units have water-cooled condensers as standard. Other condenser types are available, but the ammonia charges would increase significantly.

// Would these units be an alternative to your traditional ammonia/CO_2 industrial system?

CT: Not necessarily. It's just an extension of our product range, mainly for customers that do not have an engine room, but still want a highly efficient and environmentally friendly refrigeration system, based on natural refrigerants. We strongly believe that the more than 65 cascade NH_3/CO_2 industrial systems we have designed and delivered to our customers since 2004 are the correct choice for the larger refrigerated warehouses and food processing facilities, where both refrigerated storage and ultra-low temperatures are needed for the storage of some products and blast- or quick-freezing of certain products. ■ MG

PureCold low-charge ammonia unit

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