

MARCH 2017

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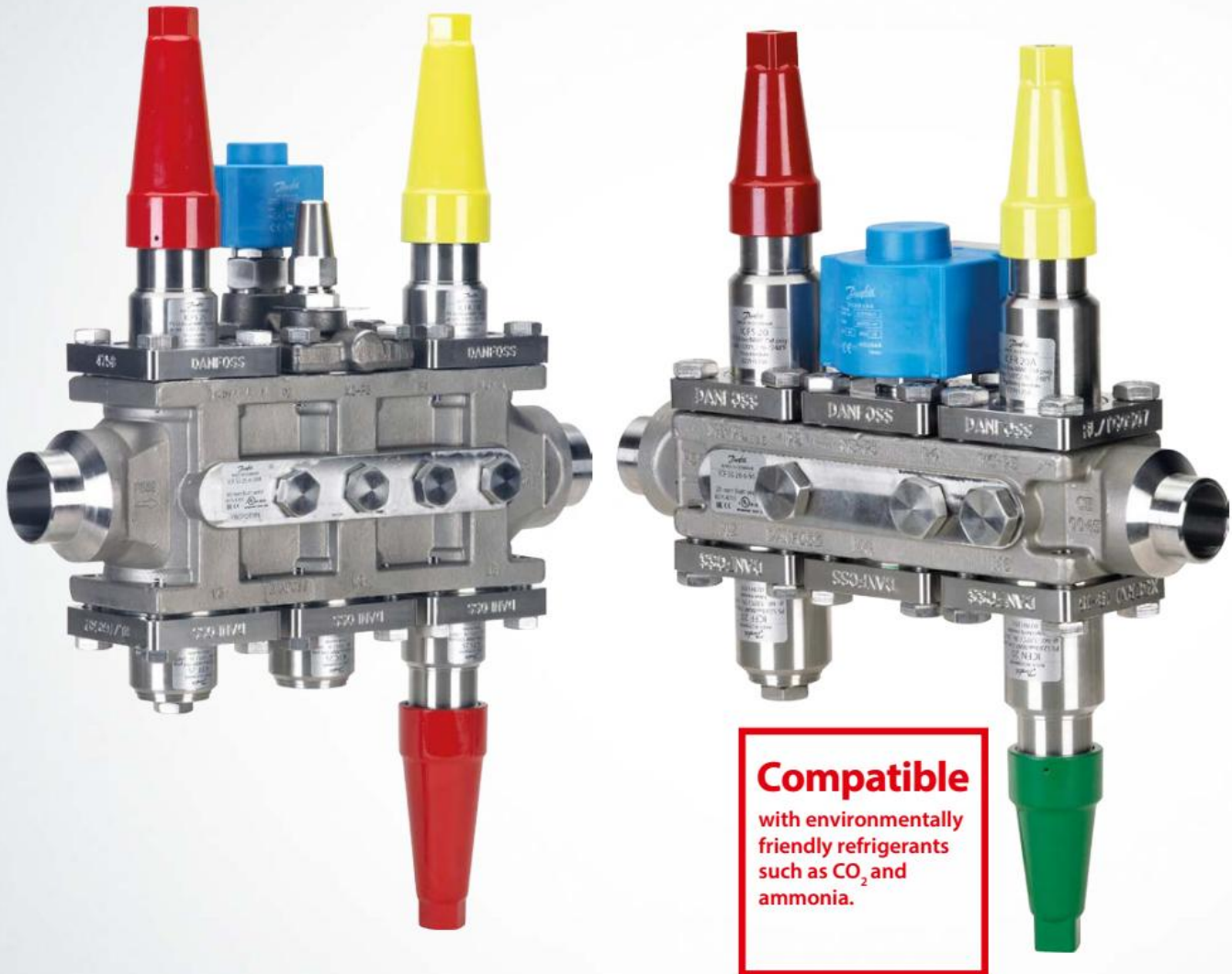
ON MARCH 27, 2017,

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Efficiency Standards: A Great Bipartisan Idea

By Michael Garry

One of the most effective U.S. government programs ever devised to save consumers and businesses money was the Energy Policy and Conservation Act (EPCA), signed into law in 1975 by President Gerald Ford, a Republican. Among other things, it authorized the development of minimum energy efficiency standards for appliances and equipment.

Several subsequent bipartisan legislative amendments called for regular updates to these standards and expanded the list of products to which the standards applied. The Department of Energy (DOE) is now required to periodically review standards for more than 60 products, representing about 90% of home energy use, 60% of commercial energy use and 30% of industrial energy use.

In this issue, we cover in some depth the impact of the DOE's latest efficiency standards for commercial refrigeration equipment on the HVAC&R industry. These new standards, which took effect March 27, raise the efficiency levels that display cases and freezers need to meet by about 30% on average.

The good news for end users like supermarkets and convenience stores is that over the next 30 years (not counting future updates), these standards will save businesses up to \$11.7 billion on their energy bills. The environment will also benefit, with the elimination of 142 million metric tons of carbon pollution.

Of course, the OEMs that manufacture commercial refrigeration equipment are the ones that need to adhere to these efficiency standards in order to legally sell their products. And, as delineated in our cover story on [page 36](#), many of them have found that, by converting their equipment to propane or isobutane refrigeration, they are able to meet not only the DOE requirements, but in many cases the even stricter ENERGY STAR 4.0 guidelines. A number of U.S. food retailers and consumer brands have begun installing the hydrocarbon equipment.

It's worth noting that OEMs themselves benefit from federal energy standards, which eliminate the possibility of a patchwork of state rules and help ensure that non-compliant products stay out of the marketplace.

Setting standards that save money while helping the environment is a concept that has been supported for decades by both sides of the political spectrum – until now.

The Trump administration's recently released 2018 budget proposal would refocus funding for the DOE's Office of Energy Efficiency and Renewable Energy – which oversees efficiency standards – on “limited, early-stage applied energy research and development”; this would represent a funding cut of more than 50%, according to the National Resource Defense Council (NRDC).

The budget would also eliminate more than 50 Environmental Protection Agency (EPA) programs, including ENERGY STAR, a 25-year-old program that, with a \$50 million annual budget, helped save \$34 billion in energy costs for businesses and consumers in 2015 alone, said the NRDC.

Of course, it's not clear how much support these particular proposals will receive in Congress, which ultimately sets the federal budget. Moreover, the standard-setting function of the DOE was established by statute and would not be easily overturned.

Still, it's troubling that the White House would put forth these counterproductive budget directives – to say nothing of its myriad other plans to undermine the environment. Given the degree to which the HVAC&R industry has gained from efficiency standards, it should do everything it can to make sure they remain in place ■ MG

VOLUME 3, ISSUE #23, MARCH 2017

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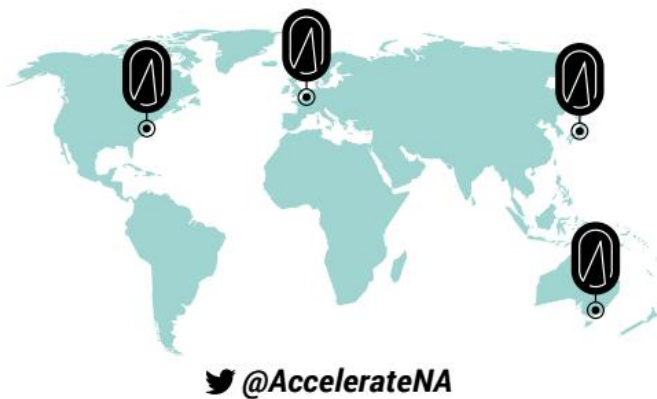
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AMERICA

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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://acceleratenas.com>



14

03 EDITOR'S NOTE

by Michael Garry

INFOGRAPHIC

06 CHANGE IN ENERGY CONSUMPTION LIMITS

08 EVENTS GUIDE

12 IN BRIEF

OPINIONS

14 PROPANE'S COMEBACK

- by André Patenaude

18 SMART REFRIGERATOR FANS JOIN THE INTERNET OF THINGS

- by Lou Moffa



24



36

TRENDS
COVER STORY

OEMS FLOCK TO HYDROCARBONS



32

END USERS
FOOD RETAIL:

ALBERT HEIJN'S
CARBON-NEUTRAL
STORE

TRENDS

22 WILL CO₂ CONTINUE
TO SURGE IN JAPAN?

24 CONSUMER GOODS
FORUM MEMBERS
CONTINUE NATREF
LEADERSHIP

POLICY

28 IS THE A3 CHARGE
LIMIT GOING UP?

EVENTS

44 IIR'S NATURAL
REFRIGERANT SHOW

TECHNOLOGY

50 GCAP'S UNUSUAL
TRADE SHOW

52 SECOP SEIZES
THE MOMENT

52



ABOUT ACCELERATE AMERICA

55 EDITORIAL CALENDAR



CHANGE IN ENERGY CONSUMPTION LIMITS

The U.S. Department of Energy's maximum allowable energy consumption in selected equipment for 2010 and 2017, compared with best achievable level

40ft³ vertical case, closed transparent doors

Low temperature, self-contained condensing unit



40ft³ vertical cabinet, closed solid doors

Low temperature, self-contained condensing unit



40ft² vertical open case

Medium temperature, remote condensing unit



40ft² semi-vertical open case

Medium temperature, remote condensing unit



40ft³ pull-down beverage case

Medium temperature, self-contained condensing unit



*DOE calculation of the lowest energy consumption achievable using best available technology.

Source: Carel white paper, "USA: Commercial refrigeration equipment. New energy conservation standards." Published 2017

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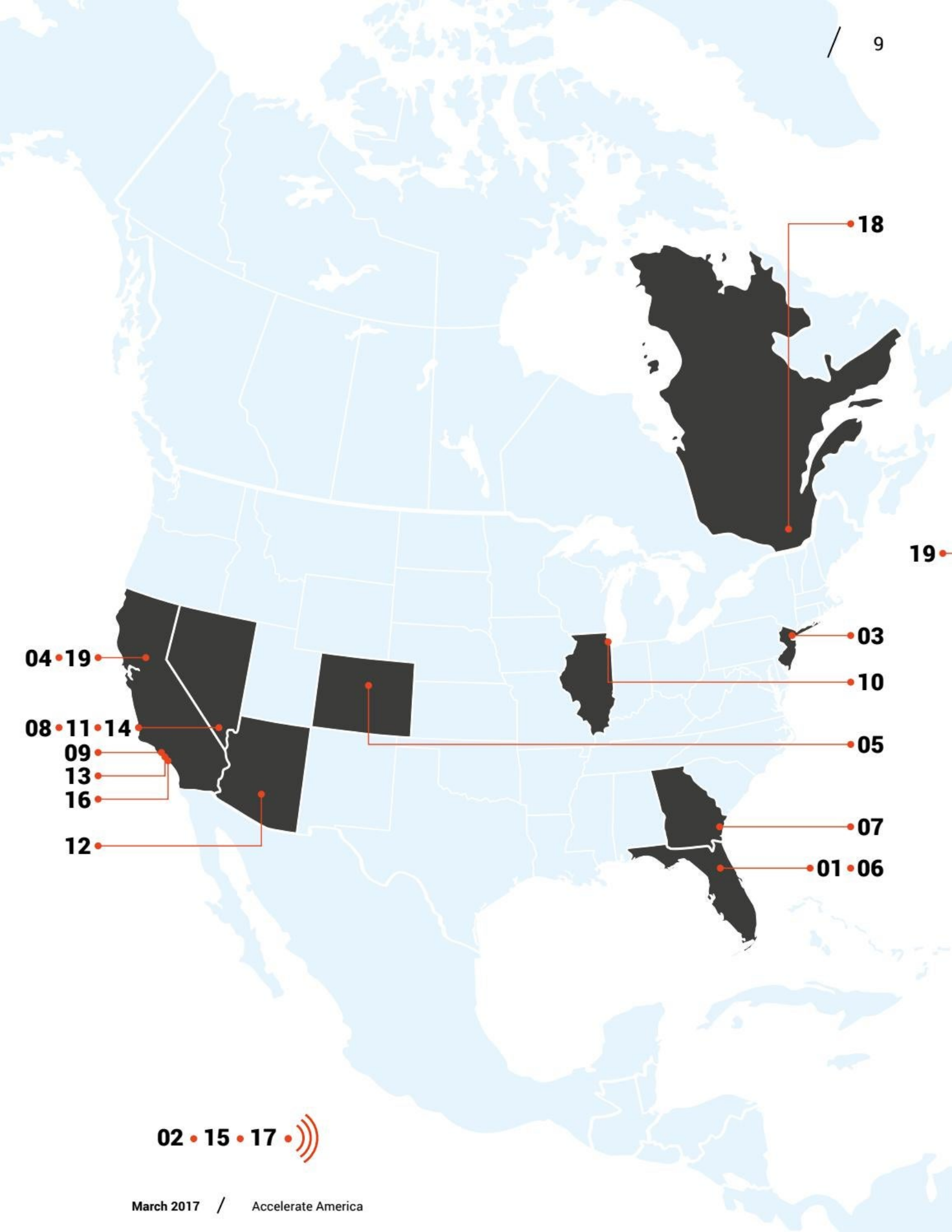
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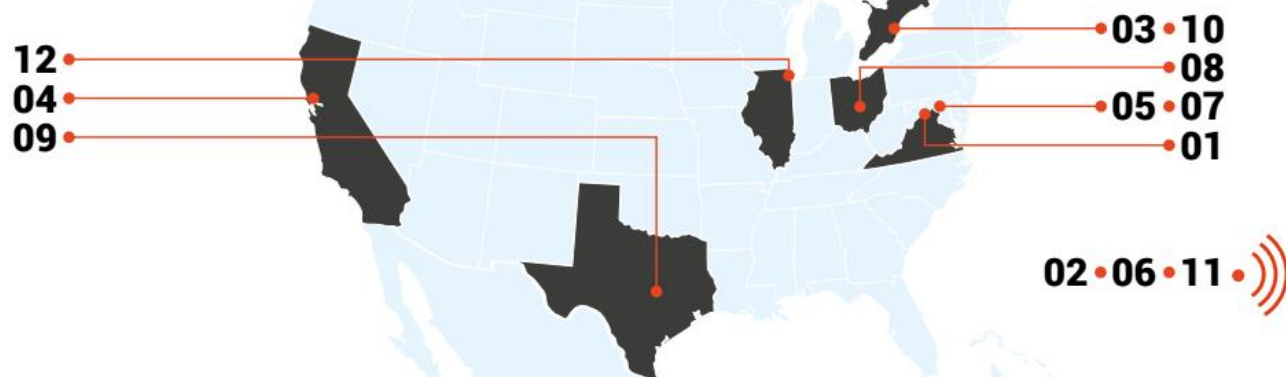
EVENTS GUIDE

March 2017 April 2017

- **01** March 26-28, Orlando, Florida
2017 National HVACR Educators and Trainers Conference
www: www.escogroup.org/hvac/nhetc/
- **02** March 29, Online at 2 pm EST
UL Webinar: An Overview of Codes and Standards Activities
www: <http://industries.ul.com/events/webinar-an-overview-of-codes-and-standards-activities>
- **03** March 30, Tarrytown, New York
AAA Refrigeration / Hillphoenix 8th Annual Symposium
www: www.aaarefrig.com/symposium
- **04** March 30, Sacramento, California
Natural Refrigerants Workshop
www: <http://nasrc.org/nat-ref-workshop>
- **05** March 29-31, Denver, Colorado
IEEE Green Technologies Conference
www: www.ieeegreentech.org
- **06** March 30 - April 1, Orlando, Florida
NEBB Annual Conference
www: <http://nebb.cvent.com/events/2017-nebb-annual-conference/event-summary-3698e4d8f03d4b26b5a1da2f4c5073cc.aspx>
- **07** April 1-4, Savannah, Georgia
SNAXPO 2017
www: <http://snaxpo.com/#SNAXPO>
- **08** April 2-5, Las Vegas, Nevada
2017 American Society of Thermal and Fluid Engineers (ASTFE) Conference and 4th International Workshop on Heat Transfer
www: <http://www.astfe.org/tfec2017/>
- **09** April 3-6, Los Angeles, California
Data Center World
www: [@DataCenterWorld #DCWLA17](http://global.datacenterworld.com)
- **10** April 4-6, Chicago, IL
ProFood Tech
www: [@packexpshow #ProFoodTech](http://www.profoodtech.com/?utm_source=IDFA&utm_medium=website-banner&utm_campaign=IDFA)
- **11** April 4-6, Las Vegas, Nevada
IFMA Facility Fusion Conference & Expo - International Facility Management Association
www: <http://facilityfusion.ifma.org/las-vegas/@IFMA #FFUS17>
- **12** April 10-12, Tempe, Arizona
National Frozen & Refrigerated Foods Association (NFRA) Executive Conference
www: <https://nfraexecutiveconference.org/>
- **13** April 19-20, Anaheim, California
Southern California Facilities Expo
www: www.fesc.facilitiesexpo.com/@Facilities_Expo
- **14** April 19-21, Las Vegas, Nevada
National Automatic Merchandising Association (NAMA) OneShow
www: www.namaoneshow.org/@NAMAvening #NAMAOneShow
- **15** April 20, Online at 1 pm EST
ASHRAE Webcast: Take Control: Using Analytics to Drive Building Performance
www: <https://www.ashrae.org/membership-conferences/webcasts>
- **16** April 22-25, Dana Point, California
IARW-WFLO Annual Convention and Expo
www: www.gcca.org/126th-iarw-wflo-convention/
- **17** April 25, Online at 2 pm EST
GreenChill Webinar: Using Refrigeration Batteries to Manage Energy Use
www: www.epa.gov/greenchill/events-and-webinars
- **18** April 26-27, Montréal, Quebec
MCEE
www: www.mcee.ca/@MCEE2017
- **19** April 26-27, Sacramento, California
Green California Summit
www: <http://www.green-technology.org/gcsummit17/index.html>



EVENTS GUIDE *May* 2017



- **01** May 1-3, Reston, Virginia
AHRI Spring Meeting
www: <http://www.ahrinet.org/News-Events/Meetings-and-Events/AHRI-2017-Spring-Meeting.aspx>
#AHRIspring
- **02** May 2, Online at 2 pm EST
GreenChill Webinar: International Institute of Ammonia Refrigeration's Resources for Using NH₃ and CO₂
www: <http://epawebconferencing.acms.com/nh3co2refrigerants/>
- **03** May 2-4, Toronto, Ontario
SIAL Canada
www: www.sialcanada.com
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- **04** May 3-5, Santa Rosa, California
37th Utility Energy Forum
www: <http://utilityforum.org/>
@UtilityForum #2017UEF
- **05** May 8-9, Washington, D.C.
Energy Efficiency Global Forum (EE Global 2017)
www: <http://eeglobalforum.org/>
@ToSaveEnergy #EEGlobal
- **06** May 9, Online at 2 pm EST
GreenChill Webinar: Strategies for Reducing Refrigeration System Charge Size
www: <http://epawebconferencing.acms.com/reducing-charge-size/>
- **07** May 15-17, Washington, D.C.
Better Buildings Summit
<https://betterbuildingsolutioncenter.energy.gov/beat-blog/register-now-2017-better-buildings-summit>
@BetterBldgsDOE #BBSummit17
- **08** May 16-19, Columbus, Ohio
15th NARCE - North American Rink Conference and Expo
<http://www.narce.com>
- **09** May 17-18, Arlington, Texas
NFMT High-Performance Buildings & Workplaces
www: <http://www.nfmt.com/highperformance/default.aspx>
@HPBWConference #HPBW17
- **10** May 17-18, Toronto, Ontario
IFMA Facility Fusion Conference & Expo - International Facility Management Association
www: <http://facilityfusion.ifma.org/toronto/>
@IFMA #facilitiesmanagement
- **11** May 23, Online at 2 pm EST
GreenChill Webinar: ASHRAE 1615 RP: Fault Detection and Diagnostic Methods for Supermarkets
www: <http://epawebconferencing.acms.com/ashrae1615rp/>
- **12** May 20-23, Chicago, Illinois
NRA Show
www: <https://show.restaurant.org/Home>
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IN BRIEF

POLICY

CARB APPROVES SLCP REDUCTION PLAN

SACRAMENTO, Calif.

The California Air Resources Board (CARB) has approved a plan to curb short-lived climate pollutants (SLCPs), including HFCs. The aim is to achieve a reduction in HFCs of 25% below business-as-usual emissions by 2020, and a 40% reduction below 2013 levels by 2030. "It's bans in conjunction with incentives that present the most effective mechanism to [reduce HFCs]," said Derek Hamilton, vice president, business development for shecco America, while testifying at CARB's board meeting in Los Angeles.

More information at:

<http://bit.ly/2mKkgzt>

EVENTS

EIA ASKS FOR LEVEL PLAYING FIELD

DUSSELDORF, Germany

Outdated safety standards that impose restrictive charge limits on hydrocarbons, and a lack of trained contractors in some parts of the world, still represent barriers to wider uptake of natural refrigerant technologies, Clare Perry, climate campaign leader at the Environmental Investigation Agency (EIA), told an ATMOSphere Network event at EuroShop 2017 in Düsseldorf, Germany earlier this month. "After CFCs, HCFCs and HFCs, many countries around the world want to finally get off the chemical treadmill," said Perry. Natural refrigerants offer sustainable, energy-efficient and future-proof cooling solutions, but the playing field still isn't level."

More information at:

<http://bit.ly/2nutB7J>

HYDROCARBONS

LAB FRIDGES EARN ENERGY STAR RATING

WALTHAM, Mass.

Thermo Fisher Scientific has announced that its Thermo Scientific TSX Series High-Performance Blood Bank Refrigerators, which use propane refrigerant, have been recognized by the U.S. Environmental Protection Agency as the first ENERGY STAR-certified laboratory-grade refrigerators. Introduced in December 2016, the ENERGY STAR specification for laboratory-grade refrigerators and freezers sets standards for energy-efficient laboratory equipment used specifically for the cold storage of non-volatile reagents and biological specimens. "We are delighted to be recognized for our commitment to sustainability," said Eric Roman, president of laboratory products, Thermo Fisher Scientific.

More information at:

<http://bit.ly/2nb1V17>

CO₂

DELIVERY SERVICE CUTS ENERGY WITH TRANSCRITICAL

BRUSSELS, Belgium

Dutch grocery delivery service Verscentrum Nederland (VCN) has derived significant energy savings by using a transcritical CO₂ system from Carrier at a retrofitted installation. VCN's director of e-commerce operations, Maarten van Dijk, told the 20th Annual European Cold Chain Conference that the energy-efficiency benefits of adopting CO₂ transcritical systems compared to their HFC-based counterparts were his main reason for choosing to convert the facility from refrigerants R134a and R507. "We have an energy saving average during the year of 32%," he added. "During the winter – up to 50%."

More information at:

<http://bit.ly/2o4m2q1>

RESEARCH

DANFOSS REPORT SAYS NATREFS 'PREFERRED'

BALTIMORE, Maryland

Natural refrigerants will take center stage in the greener refrigeration of the future, according to a recent report by HVAC&R component manufacturer Danfoss entitled "Refrigerant options now and in the future." A global move towards climate-friendly technology to deliver the objectives of the Kigali and Paris Agreements will lead many manufacturers to see natural refrigerants as "the preferred choice whenever possible, though safety will still be an important factor in regulating the usage of certain refrigerants," the report predicted.

More information at:

<http://bit.ly/2osEmVA>

HYDROCARBONS

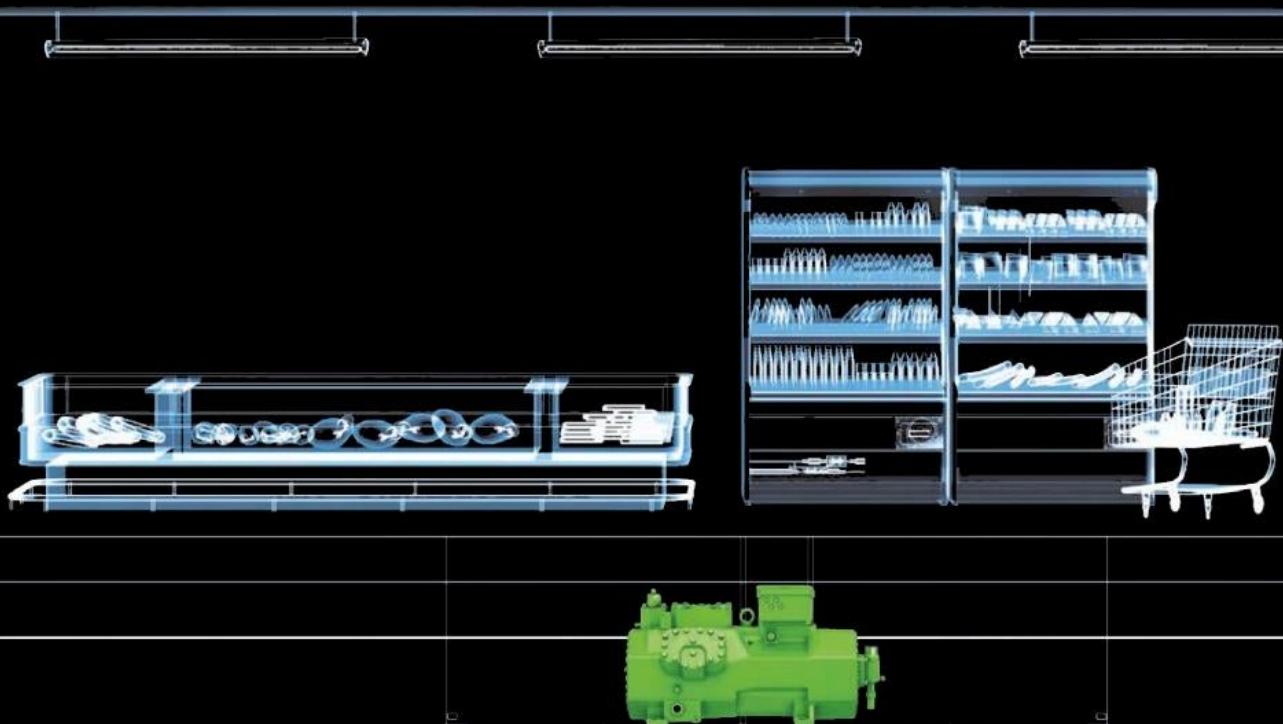
AHT BULLISH ON PROPANE FOR GROCERY

ROTTENMANN, Austria

Having opted for propane in the 1990s, AHT Cooling Systems GmbH remains committed to this natural refrigerant as a means of reducing the energy consumption and environmental impact of its cabinets, said Reinhold Resch, vice-president (research and development) at the Austrian firm. AHT, with U.S. headquarters in Charleston, S.C., already has over one million propane-based cabinets operating in the market worldwide. "We think propane is the best solution in the market for supermarket units," Resch said.

More information at:

<http://bit.ly/2o4pUY4>



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Bitzer

Propane's Comeback

Its high efficiency and low environmental impact have triggered a widespread resurgence for R290

— Part Two of a Series

By André Patenaude



At a time when refrigerants are being closely evaluated for their environmental impact, propane (R290) is emerging as an increasingly viable alternative to synthetic refrigerants.

With a global warming potential (GWP) of three and an ozone depletion potential (ODP) of zero, R290 poses virtually no threat to the environment. In fact, the Environmental Protection Agency (EPA) has listed R290 as an acceptable refrigerant substitute under its Significant New Alternatives Policy (SNAP), and recently exempted it from the venting prohibition in Section 608 of the Clean Air Act.

For some perspective on what's behind all the concern about refrigerants and the environment, the EPA estimates that an average supermarket using the hydrofluorocarbon (HFC) refrigerant R404A leaks about 25% of its refrigerant charge annually, resulting in approximately 1,556 metric tons of CO₂-equivalent emissions — or the annual energy from 165 homes. If you extrapolate that data across the number of grocery stores and other refrigeration applications in service globally, the magnitude of this impact quickly becomes apparent.

It's no surprise then that an international wave of regulatory actions aimed at phasing down high-GWP HFC refrigerants is underway, including the European Union's F-Gas regulations, the EPA's SNAP process and the recent Kigali Amendment to the Montreal Protocol. One result of this regulatory activity is an increased interest in the potential of natural refrigerants, including R290.

Among its advantages, R290 has excellent thermodynamic properties — such as low back pressure, high volumetric capacity and high coefficient of performance — that are very similar to those of R22. In Emerson's test labs, R290 consistently outperforms R404A in energy efficiencies, showing that it can help manufacturers meet the Department of Energy's new efficiency requirements for commercial refrigeration equipment. (See chart, [page 15.](#))

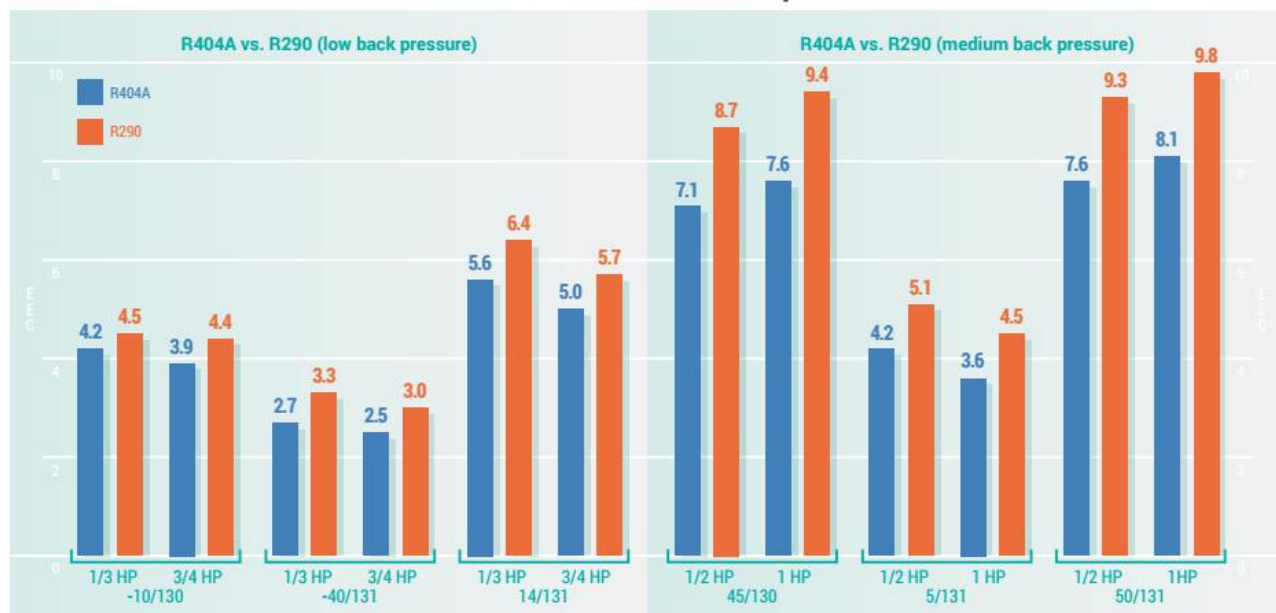
According to Howell Feig, national sales manager of AHT Cooling Systems USA, 2016 was a turning point for propane adoption.

"More and more of our customers are moving toward propane," said Feig. "From a business perspective it just makes sense. Our self-contained R290-based units are eco-friendly, energy-efficient and reliable."

Rejection and redemption

Propane was a true "green" refrigerant long before science had conceived of environmental problems such as ozone depletion and global warming. Its use dates back to the early 1900s when refrigeration systems relied solely on naturally occurring compounds like hydrocarbons in the compression cycle. From the beginning, R290 was characterized by its pros and cons — excellent thermodynamic properties on the one hand, potential flammability on the other. The fact that these early systems were prone to leaking didn't help alleviate concerns about the latter.

R290 and R404A EER Comparison



In Emerson's lab test comparing the Energy Efficiency Ratio (EER) of R290 and R404A in medium- and low-back-pressure applications, R290 consistently outperformed R404A.

In the 1930s, the invention of synthetic, nonflammable chlorofluorocarbon (CFC) refrigerants all but eliminated the use of propane in refrigeration applications. But in the 1980s, when CFCs were found to deplete the earth's ozone layer, the refrigeration industry once again started taking a closer look at natural refrigerants. Then, in the 1990s, as HFCs were identified as sources of global warming, the stage was set for propane's wider resurgence.

European food retailers were among the first to deploy R290-based systems in the early part of the 21st century. Ten years later, a handful of early adopters in the U.S. started using R290 in commercial refrigeration. Today, the commercial refrigeration industry is witnessing a proliferation of R290 systems, and some OEMs are making R290 the basis for their entire product portfolios. (See story, [page 36](#).)

For the most part, R290 has been limited to smaller, self-contained applications due to a longstanding charge limit of 150 g. Codes and standards groups such as the International Electrotechnical Commission (IEC) and Underwriters Laboratories (UL) are currently evaluating charge limit increases for R290 applications; updates to these standards are expected within the next few years.

Changing perceptions lead to broader adoption

In many ways, R290's reintroduction to refrigeration was born out of necessity. With many operators setting corporate sustainability goals and seeking to avoid regulatory entanglements, R290 is one of the few options capable of meeting both strategic objectives. And, as modern refrigeration technology has evolved to ensure component and equipment safety, the stigma that R290 is unsafe is quickly evaporating.

"It hasn't been overnight, but perceptions about propane are definitely changing," Feig said, recalling that AHT's focus on propane started with its European customers almost 20 years ago.

"We started down the path of manufacturing bunker-style cases for our European customers in the late 1990s, and had deployed them by 2002," Feig said. "These customers looked to propane primarily because of its negligible impacts to the environment and higher efficiency."

By 2010, Feig said that some of AHT's environmentally driven U.S. customers started asking for self-contained R290-based equipment. These early adopters served as proof-of-concept for those who followed, including many of today's retailers placing propane refrigeration applications in select stores.

In 2016, Target stated that all of its new stand-alone coolers with a compressor capacity below 2,200 BTU/h would use propane. When a major retailer like Target announces its plans to move toward R290-based refrigeration systems, it's an indication that viability and/or safety concerns are quickly becoming a thing of the past. Feig said that AHT is seeing a similar trend throughout its customer base, especially among retailers who have a strong commitment to sustainability across their entire food supply chain. Whole Foods Market is one such example.

"At this point, we've installed AHT propane cases in more than 100 Whole Foods stores across the country," Feig said. He added that the retailer is known for evaluating every possible option to reduce its carbon footprint; AHT's variety of propane-based equipment — from spot cases and islands to frozen doors and multi-deck units — could comprise a whole-store solution in many scenarios.

Another big concern in regard to R290 systems is serviceability. But Feig said that this is yet another lingering misperception.

"Our customers don't have to deal with the complexity of remote refrigeration systems," he noted. "Not only can technicians quickly be trained to work on these units, any problem they might have is isolated, meaning they don't have to worry about food loss across a whole department."

AHT's customers appreciate the simplicity of the installation process, he added. "Our cases are factory-sealed and extremely easy to deploy. Many of the models are plug and play, and while others may require connection to a water loop, those are still relatively easy and quick to install." AHT's current propane product line adheres to the R290 charge limit of 150g.

R290's potential

Although OEMs and operators alike are working within the 150 g charge limit, Feig feels that even incremental increases in the limit would make a significant difference.

"Increasing the charge limit would have a huge impact on case designs and further improve propane's performance efficiencies," he said. He explained that an increase to 500g, for example, would allow one compressor to service larger cases. But even with the current 150 g charge limit in place, AHT will transition its entire product line to R290 by the end of 2017 ■ **AP**

André Patenaude is director - CO₂ business development, Emerson Commercial and Residential Solutions (which now incorporates Emerson Climate Technologies). He was selected as one of Accelerate America's 25 Movers & Shakers driving adoption of natural refrigerant technology in North America.

R290: Pros and Cons

Pros:

- » Naturally occurring hydrocarbon
- » GWP = 3, OPD = 0
- » Readily available and affordable
- » Listed by the EPA as an acceptable refrigerant substitute in commercial refrigeration applications
- » Exempt from EPA's Section 608 venting prohibition
- » Excellent thermodynamic properties
- » High-efficiency, high-performance, reliable
- » Safe to use when proper protocols are followed

Cons:

- » Classified as an A3 flammable refrigerant
- » Not a "drop-in" refrigerant; equipment and components must be designed for R290
- » Globally mandated low-charge limits of 150 g restrict application range
- » Subject to local authorities having jurisdiction (fire and building codes)

Nature Outside



Nature Inside



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Smart Refrigerator Fans Join the Internet of Things

BUS communication for evaporator and condenser fans in display cases and bottle coolers give end users unprecedented control of fan operation, saving energy and limiting down-time

By Lou Moffa

Refrigerated coolers and freezers in retail stores are achieving new levels of efficiency in order to meet the U.S. Department of Energy's strict 2017 energy standards, which went into effect March 27.

Part of what makes this equipment more efficient is the inclusion of hydrocarbon refrigerants and associated components such as more efficient motors, LED lighting and other technologies. But the icing on the cake is the advent of "smart" controllers, software, sensors and network connectivity that allow end users to program and monitor components remotely via BUS data communication in order to maximize efficiency and provide the opportunity for proactive maintenance. Each component is now expected to be able to communicate and provide feedback to the smart controller.

Refrigeration equipment has thus joined the "Internet of Things," a growing cluster of devices or appliances that can be sensed or controlled remotely – and make possible such high-tech scenarios as smart homes and businesses, and smart grids.

A critical part of the refrigeration system that can be empowered by this smart BUS data communication technology is the fan that propels cool air in evaporators and warm air in condensers. BUS communication has been successfully used in larger rooftop condenser fans in supermarket applications for many years; and now, this new option can be used to enhance smaller refrigeration systems like display cases and bottle coolers.

Open protocols that are available from manufacturers allow these smart controllers to "talk" to fans, which actually have a lot to say about how they are being used, such as the speed at which they are operating and the amount of energy they are using.

For example, if the fan is sent a command to rotate at 900 RPM, is it actually rotating at only 500 RPM? That would indicate a problem. Is the fan approaching end-of-life? Is there something blocking the fan? This information – all available through BUS communication – needs to be discovered before a failure occurs that can sideline the entire refrigeration unit. The service technician called out to investigate the problem can also be alerted as to the exact replacement components to bring to the store for repair work, keeping equipment downtime to a minimum and streamlining the repair process.

The evolution of fans

A separate motor, impeller and basket assembly – the first generation of fans – operate at a "worst-case" single speed with no adjustments for changing conditions. Of course, many refrigeration systems only require worst-case conditions for a short period in their operating life; the net result is wasted energy and excessive noise. Not surprisingly, motors used in these applications have not been equipped with BUS communication.

The next generation of fans offered to OEMs was the complete fan assembly, using energy-efficient, electronically commutated (EC) external rotor motors. Delivered as a pre-assembled fan unit that is optimized for best performance, it allows OEMs to install fan assemblies directly into refrigeration systems during construction, eliminating the need for sub-assembly operations. A shallow mounting depth enables these units to fit into tight spots, providing low-profile refrigeration designs that often result in more internal room in the refrigerated area.

Pre-assembled fans come in several diameters and programmable speeds. The most suitable fan diameter is chosen by the refrigeration designer, who then fine-tunes the air movement by programming the motor to a specific speed setting. Programming the EC motor speed at the OEM level, based on the needs of the installation, allows a speed resolution setting as small as 10 RPM, delivering the optimum air flow without wasted energy or excessive noise.

These EC fans are commonly available with standard two-speed operation. The designer can easily “toggle” between programmed speeds one and two for operation under varying conditions, but is still limited by these two set speeds. As with the older style assemblies, designers have to consider the worst-case operating conditions; but, in this instance, the two programmed speeds could be used in average and worst case conditions, or in other operating conditions such as door openings and after defrost cycles. The two-speed system provides design flexibility, reduced parts inventory for OEMs and lower fan energy consumption during “typical” operating conditions. Currently, these EC fan assemblies are available with the two-speed option and programmable RPM motor – but without BUS communication.

Riding the BUS

The latest offering is the same pre-assembled fan assembly optimized for best overall efficiency, but now equipped with BUS communication. BUS-controlled evaporator and condenser fans are managed by master controllers, which are successfully being incorporated into the latest case designs. These controllers are also being used to communicate with a supervisory system as well as to control components such as expansion valves, lighting, compressors and other mechanical features in the refrigerated display case or bottle cooler.

BUS communication from a master controller replaces two programmed speeds by allowing end users to continuously vary motor RPM fan speed and provide additional motor feedback in a refrigeration application.

Independently regulating the speed of each fan in a loaded display case provides a more uniform temperature throughout the case. The ability to speed-control each fan independently could allow thermal sensors to be placed in specific areas within the case and maintain a specific temperature using closed-loop feedback.



BUS-enabled fan assembly for display cases or bottle coolers

The optimum RPM for even cooling can best be mapped out by the OEM at the design level. The designer can divide the case into sections, with each fan and sensor operating independently, while being regulated by the master controller. A command from the master controller can be used to set the RPM of a specific fan, any combination of fans, or all of the fans in the system. The master controller determines the RPM by analyzing collected data.

For example, faster recovery time to the temperature set point following a defrost cycle can be achieved by increasing the fan speed for a short period until the set point is reached. In general, a fan speed can be easily changed as needed to suit changing conditions. Events that can trigger changes include: day/night operation, occupancy feedback, door opening/closing, the use of night curtains, or any other monitored variable. In addition, fan airflow direction can be reversed as needed. For example, running the fan at short intervals in the reverse direction helps “blow out” debris and keeps a condenser clear.

These new EC fans are currently available with a 24 VDC input through a DC power supply, which may already be powering the LED case lighting. Low voltage DC-input fans eliminate high-voltage safety issues, and provide global manufacturers with a “single fan” part number for inventory and repair. Single-phase 115 or 230 VAC, 50/60 Hz input units are also planned.

Maintenance control

BUS communication affords the end user unprecedented maintenance control. The master controller is continually monitoring fan status, sending a notification to the end user if a specific fan is not operating as expected. The master controller can pass this information along by initiating an alarm light; in a more sophisticated configuration, the alarm can be tied to a building automation system. External monitoring using web-based or cellular networks can provide email or text notifications.

Error codes can be created for particular fan-status alarms, including locked rotor, low input voltage, confirmation of commanded RPM, over current, and loss of communication. A technician not familiar with a specific refrigeration system can easily use these codes to assist with the troubleshooting process. Additionally, a technician can access the error codes remotely if the master controller is equipped for this capability. The technician arrives at the customer site prepared with the correct replacement parts.

Moreover, each fan has a specific address in a refrigeration system; alerts are specific to a unique fan in a specific location. This enables quick and efficient troubleshooting and eliminates the need to empty a loaded display case to identify a problem. With an exact fan address, only the specific area of the display case requires unloading. Access to the specific fan is easy and no time is wasted during a repair.

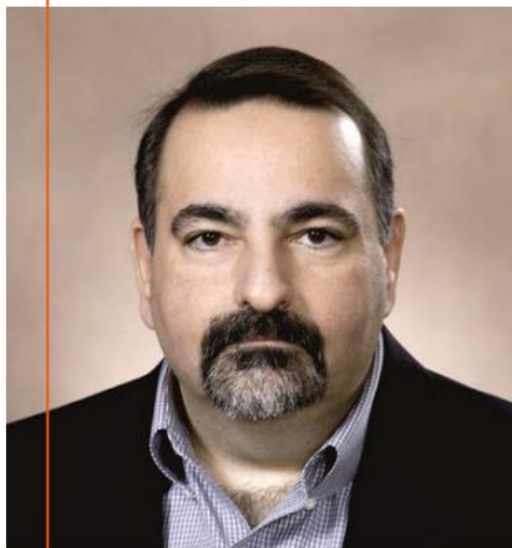
Another key feature of the BUS-enabled fan is that the controller monitors the total run hours that the fan has logged. This is extremely valuable for maintaining a preventative maintenance schedule, which prevents equipment downtime – a significant benefit to end users.

Default settings are also configurable by the end user. If BUS communication is interrupted, the fan speed can default to a user-defined preset speed until communication is restored, allowing for fail-safe operation.

Conclusion

Fans with BUS communication for display case and bottle coolers are currently available to OEMs. The addition of BUS communication to fans offers numerous benefits to OEMs, end users and their customers, and the maintenance personnel responsible for keeping these refrigeration units running daily and reliably.

By providing valuable feedback, BUS-enabled fans help meet demands for reliable, energy-efficient systems without changing the existing design footprint of display cases. These advantages would be both cost prohibitive and technologically challenging using alternative methods, such as a variety of complex mechanical controls or an array of “add-on” sensors. With BUS communication, all the feedback capability is built into the fan itself, which is now part of the Internet of Things ■ LM



Lou Moffa is market manager – commercial refrigeration for Farmington, Conn.-based ebm-papst Inc., where he has been employed for more than 12 years. He recommends air-moving solutions that help refrigeration system engineers, warehouse owners and supermarket managers keep food fresh across a variety of storage and display environments.

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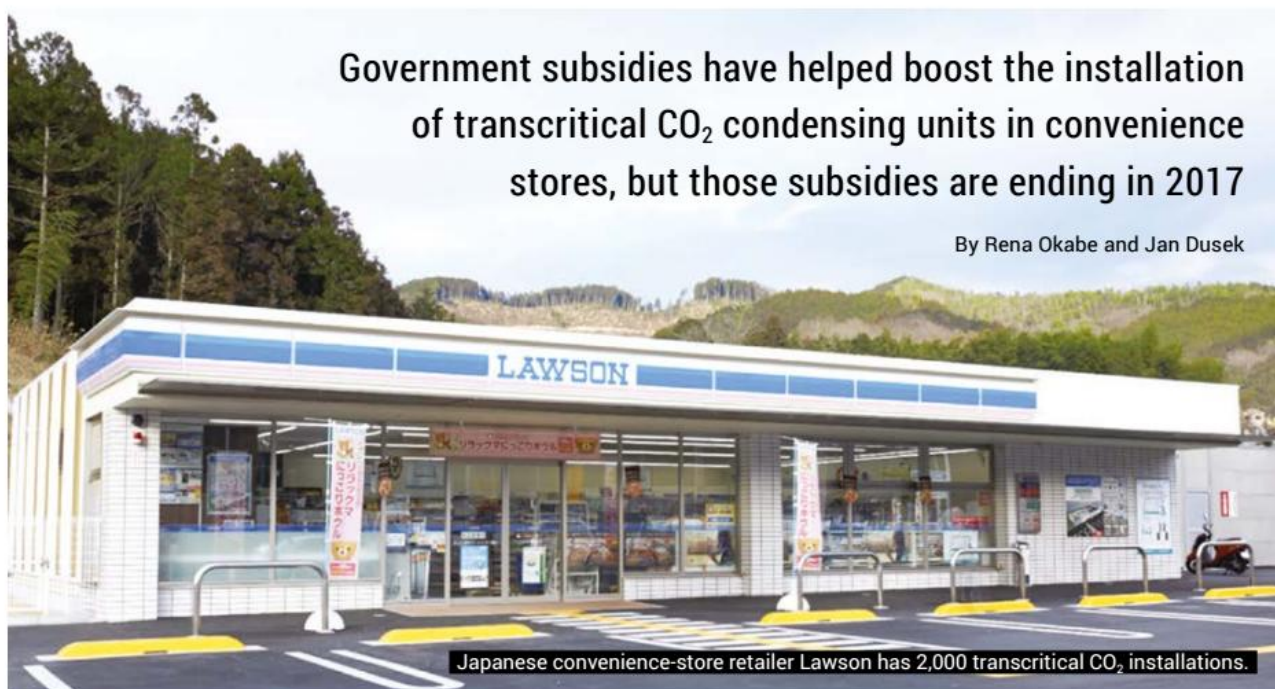


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Will CO₂ Continue to Surge in Japan?

Government subsidies have helped boost the installation of transcritical CO₂ condensing units in convenience stores, but those subsidies are ending in 2017

By Rena Okabe and Jan Dusek



The use of transcritical CO₂ systems in commercial refrigeration has escalated greatly in the past three years in many parts of the world, with Europe having over 9,000 stores using the technology at the end of 2016.

However, the biggest acceleration has taken place in Japan. From only 190 stores in March 2014, the market counted over 2,400 stores using transcritical CO₂ systems at the end of February 2017. This leap was achieved thanks to a combination of end-user interest, technological advancements and subsidies from the Japanese government.

However, while Japan has raced ahead in its use of CO₂ refrigeration systems, the vast majority are employed in small convenience store formats with only minor participation from larger supermarkets. The main reason for this disparity is the presence of regulations impacting larger high-pressure systems in Japan.

Moreover, the government subsidies that helped pay for these installations will no longer be offered this year. Will this put a stop to the growth of natural refrigerant systems in the Land of the Rising Sun?

Ubiquitous c-stores

Convenience stores are a regular sight in Japan, with over 55,000 spread throughout the country. The three largest convenience store chains – 7-Eleven, Lawson and Family Mart (now including Circle K Sunkus stores), with a combination of 50,326 convenience stores in January – together had 2,214 outlets running transcritical CO₂ systems at the end of February, or 4.4% of the total.

The commercial refrigeration market, supported financially by the Japanese Ministry of Environment from 2014 to 2016, will not in 2017 be able to rely on the subsidies that have covered one-third of the total installation cost of a natural refrigerant-based system. Some retailers

have expressed concern about the future of CO₂ systems without the subsidies. However, the commitment of market leader Lawson is encouraging.

Lawson, which made transcritical CO₂ refrigeration a standard for the majority of its new stores in September 2014, has continued its impressive rollout. According to the company, by the end of February 2017, Lawson had 2,000 transcritical CO₂ installations, and it aims to operate 2,700 CO₂ stores by the end of February 2018.

The other leading c-store retailers in Japan have also committed to converting their convenience stores to CO₂ refrigeration. For example, 7-Eleven, which has nearly 19,220 stores in Japan and opens around 1,500 outlets annually (including remodeled stores), has also spoken of the possibility of installing CO₂ refrigeration in all of its model stores. At present 7-Eleven operates 155 transcritical CO₂ stores. Family Mart has 59.

Japanese convenience stores usually utilize transcritical CO₂ condensing units between 2 and 20 HP supplied by Panasonic, which is responsible for over 90% of CO₂ installations in Japan. The typical convenience store operates Panasonic's 10 HP CO₂ outdoor condensing unit for medium-temperature displays, and a 2 HP outdoor unit for low-temperature cases.

Lawson noted that its "next-generation" convenience store now runs Panasonic's 15 HP outdoor CO₂ unit and two 2-HP units for freezers. By replacing previous HFC units with CO₂, Lawson was able save 27% in energy consumption.

Other Japanese providers of outdoor CO₂ condensing units include Sanden, which specializes in plug-in CO₂ displays, vending machines and heat pumps, and most recently, Mitsubishi Heavy Industries (MHI). In addition, MHI Thermal Systems surprised the market by announcing a new CO₂ 10-HP condensing unit, available in April 2017. Mayekawa, a supplier to the industrial sector, has developed new NH₃/CO₂ systems serving the needs of smaller facilities such as supermarkets.

The popularity of outdoor CO₂ condensing units in Japan has sparked interest among European and North American retailers as the trend toward ever smaller stores in the West continues.

Supermarkets lagging

While the use of CO₂ is growing in Japanese convenience stores, similar progress is notably absent from supermarkets. Of the 20,000 supermarkets in Japan, only about 140 use transcritical CO₂ refrigeration systems, and most of these only installed the technology in 2014 and 2015. (The first was installed in 2009 by AEON.)

One reason for this is that the transcritical CO₂ condensing units used by Lawson and other convenience stores are not powerful enough to accommodate the capacities of supermarkets; these larger stores would need an impractically large number of such units.

Smaller units are employed because the "High Pressure Gas Safety Act" makes the use of larger CO₂ systems that operate upwards of 200 kW – and are popular in U.S. and Europe supermarkets – difficult in Japan. The safety concerns related to CO₂'s high-pressure properties are seen as outdated, especially given that the technology has advanced greatly since the Act was passed. But it remains in effect, reducing the uptake of CO₂ in supermarkets.

AEON is the exception, with 99 supermarkets using CO₂ as of February 2017 (as well as 20 CO₂ convenience stores under the Ministop brand).

AEON's 231,000-sq.-ft. general merchandising store in Chiba City operates 20 transcritical CO₂ condensing units to provide cooling to 144 display cases. The store has posted energy savings of 23% (186,971 kWh per year) alongside a reduction of 857 metric tons of CO₂ – equivalent emissions per year.

Other Japanese supermarket chains using CO₂ include Co-op Sapporo with nine, Seiyu with five, and Co-op Miyagi with four

■ RO&JD

Hydrocarbons in Japan

The Japanese market for hydrocarbon-based self-contained display units for commercial applications has traditionally been non-existent due to concerns over flammability. This has occurred despite the standard use of isobutane (R600a) for domestic refrigeration, and the common use of hydrocarbons in beverage vending machines.

However, with self-contained hydrocarbon freezers and displays popular in Europe for over ten years, and starting to take off in the U.S. (see page 36), Chinese and European hydrocarbon manufacturers are starting to enter the Japanese market. The availability of Ministry of Environment (MOE) funding for hydrocarbon-based cooling equipment in supermarkets has allowed the market to grow in the last year, with at least 150 units in operation.

One example of this is Union, a small supermarket chain that has been receiving subsidies to implement R290 plug-in units in 14 of its stores in 2015 and 2016. Save-On, a prominent convenience store chain, is planning to install R290 plug-in units in 20-30 stores annually.

Convenience Store Chain	N° of CO ₂ Stores*
Lawson	2,000
7-Eleven	155
Family Mart	59
Supermarket Chain	
AEON	99
Co-op Sapporo	9
Seiyu	5
Co-op Miyagi	4

*Number of stores using transcritical CO₂ condensing units

Consumer Goods Forum Members Continue NatRef Leadership

Sainsbury's has over 200 CO₂ stores, while Ahold Delhaize uses a variety of natural refrigerants

By Eda Isaksson

Sainsbury's, a major U.K.-based grocer that operates 629 supermarkets and 770 convenience stores, has more than 200 stores fully running on CO₂ refrigeration. That makes it one of the leaders globally in retail implementation of CO₂.

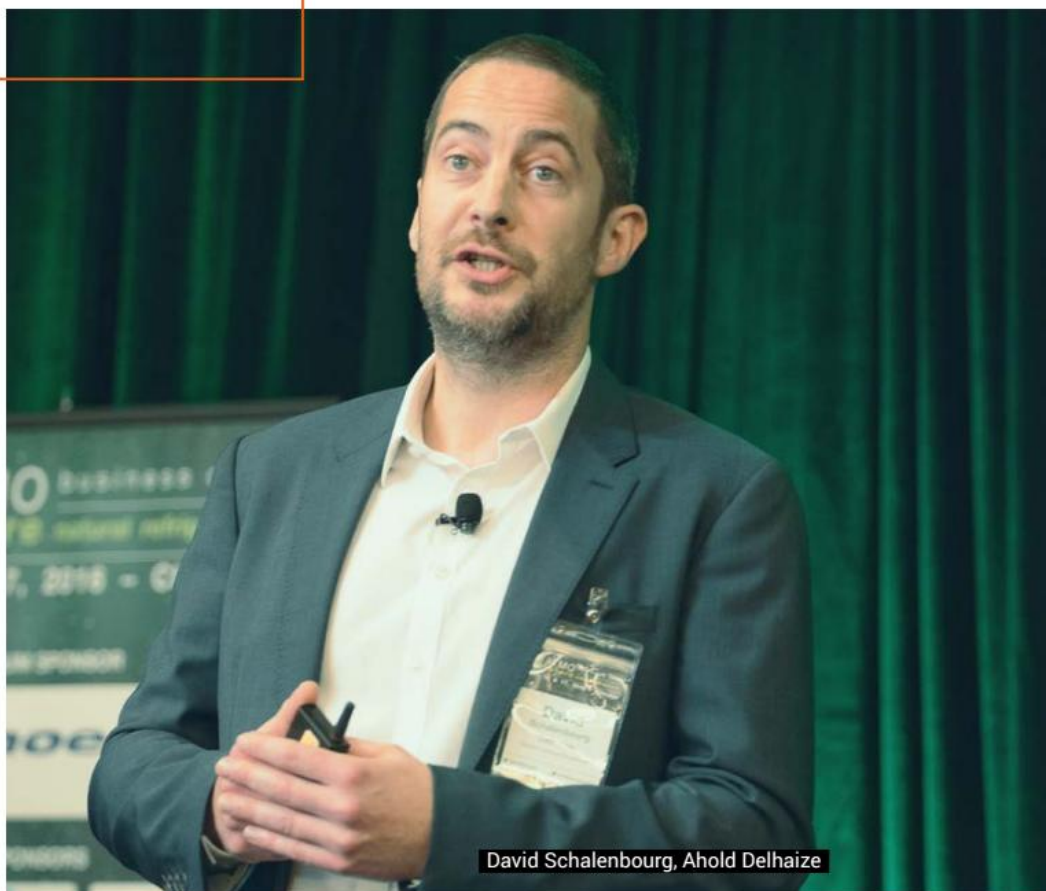
"In 2009, we took a bold decision to go with natural refrigerants to ensure that future installations were protected from the potential impact of using synthetics," said Paul Crewe, head of sustainability, energy, engineering and environment at Sainsbury's, during a webinar last month sponsored by the Environmental Protection Agency's GreenChill Partnership.

The webinar was titled, "Efforts to reduce refrigerant emissions through the Consumer Goods Forum (CGF)," of which Sainsbury's is a member and co-chair of its refrigeration working group.

Sainsbury's opted early on for CO₂ as its natural refrigerant of choice, and has deployed pump, cascade and transcritical booster systems. "They are all efficient, all operating and all doing extremely well," said Crewe. The chain considered ammonia, but chose to employ it only on the industrial side; hydrocarbons remain a possibility.

Crewe clarified Sainsbury's motivations for using natural refrigerants. "Please don't think that I am talking about refrigeration specifically from the 'doing-the-right-thing-for-the-planet' perspective," he said. "Of course, that is important, but my role is to make sure that commercial sustainability is at the forefront.

"This means is that while trying to do the right thing, we also need to make this a very important part of running our business by reducing costs and spending our capital investments in the right places."



David Schalenbourg, Ahold Delhaize

CO₂ has, in fact, proven its worth as an investment. "We have got to a position where the refrigeration installation is cost neutral," said Crewe. "This means that we have the equivalent of an HFC system in value for a CO₂ system."

On top of that, the CO₂ system is saving Sainsbury's energy. "We've experienced about a 50% energy reduction," Crewe said. "These systems are the highest performing solution we have in supermarkets." This translates to 330,000 metric tons of CO₂-equivalent emissions, enough to light 1.7 million domestic houses per year. Another big cost-saving advantage of CO₂ systems, added Crewe, is heat reclaim.



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Crewe said that initial concerns Sainsbury's had about CO₂ – such as lack of knowledge about the gas, high pressures, the availability of skilled technicians, and moisture control – have been overcome very quickly.

"Our experience has been that our concerns and the myths around CO₂ have been dispelled," he said. "Technology has grown immensely. And we ensured that the supply chain was ready to support our transition. It was very easy to train the technicians, as the system is essentially the same [as HFC models]."

"This has become a natural choice for us. It is now a part of our DNA."

Sainsbury's employs CO₂ refrigeration in different climates as well. "CO₂ absolutely does work in warmer climates," Crewe said. "We've seen systems with enhanced booster solutions, parallel compression, and ejectors work safely, comfortably and easily."

According to Crewe, more companies have entered the market with natural refrigerant solutions, and there are more unique system designs. "Ultimately, if you have an appetite for it, you can absolutely transition successfully to natural refrigerants – we've proved it."

Strong focus on naturals

Another big member of CGF is the recently merged Ahold Delhaize, with 6,500 stores and a presence in 11 countries; 60% of Ahold Delhaize's operations are based in the U.S. (at chains like Food Lion, Hannaford, Stop & Shop and Giant Food), the rest in Europe.

"Our focus is being more energy efficient in all our facilities, continue the transition to natural refrigerants and lower GWP alternatives, control leakage, and [improve] transport," said David Schalenbourg, Brussels, Belgium-based director of building projects, format and maintenance for Ahold Delhaize, during the GreenChill webinar.

The company is focusing on natural refrigerants in its new installations "more strongly in the coming years," said Schalenbourg, adding that "the operations in Europe and United States are largely influenced by policy and environmental politics."

Ahold Delhaize is using natural refrigerants in its stores as well as warehouses, he noted. In stores, the company has installed transcritical CO₂ racks, hybrid systems and self-contained plug-in propane coolers. (Its Dutch Albert Heijn division runs 110 transcritical CO₂ stores; see [page 32](#).) The company's warehouses employ ammonia and glycol, as well as ammonia/CO₂ systems.

"Our aim is to lead the way, help transform the marketplace, and show others what is possible," said Schalenbourg. "Because this is an important task and we want to take our part in this. Through ATMosphere conferences, CGF and other collaborations, we want to share this knowledge."

■ EI

CGF Pushes Natural Refrigerants

As a trade organization, the Paris-based Consumer Goods Forum (CGF) has been a leader in promoting the adoption of natural refrigerants.

Established in 2009, CGF consists of 400 retail and consumer brand organizations, including such major North American retailers as Target, Walmart, Kroger, Wegmans, and Sobeys, as well as such brands as Kellogg, Coca-Cola, PepsiCo and Campbell Soup.

In 2010, CGF pledged as an organization to start phasing out HFC refrigerants by 2015. Last October, it issued a second resolution committing to install where viable new equipment that utilizes only natural refrigerants or alternative ultra-low GWP refrigerants.

In Europe, CGF members employ natural refrigerants in more than 4,000 stores. In North and Central America, there are over 300 stores operated by CGF members with natural refrigerants.

On the manufacturers' side, more than 4 million refrigerated units with natural refrigerants have been installed, mainly by Coca-Cola, PepsiCo, Kellogg, McCain Foods, Heineken and AB InBev.

Last year, CGF published its first Refrigeration booklet, with case studies showing how CGF members have reduced HFCs and deployed natural refrigerants.

"Overall, as pointed out by the UNFCCC, phase-down of HFCs is the most cost-effective climate mitigation strategy available today," said Ignacio Gavilan, Environmental Sustainability Director of the CGF, in a webinar hosted last month by the Environmental Protection Agency's GreenChill Partnership.



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Is the A3 Charge Limit Going Up?

The IEC is considering raising the 150 g limit for flammable A3 refrigerants to 500 g, as research projects on hydrocarbons and A2Ls move forward

By Michael Garry

One of the often-cited limitations of hydrocarbons as refrigerants in the U.S. is the small charge that is allowed – 150 g for commercial applications (60 g for water coolers) and 57 g for domestic uses – per the Environmental Protection Agency (EPA).

While this small quantity works effectively in fractional horsepower refrigeration systems, it is insufficient for larger systems; this means that multiple units must be employed to accommodate larger loads, driving up costs considerably.

In February of 2016, U.K. OEM Carter Retail Equipment submitted an application to the EPA's SNAP (Significant New Alternatives Policy) program to increase to 1 kg from 150 g the maximum charge of propane permitted in stand-alone commercial refrigeration equipment. That application is still pending.

On a global level, the International Electrotechnical Commission (IEC), through its SC61C subcommittee Working Group 4 (WG4), is working on raising the charge limit for flammable (A3) refrigerants. The new maximum charge under consideration for propane is 500 g, said Marek Zgliczynski, chairman of the SC61C subcommittee, and manager of commercial refrigeration product engineering for Brazilian compressor manufacturer Embraco.

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

In April, Working Group 4 will hold a meeting in Turin, Italy, to review the latest comments made about the charge-standard proposal and “come out with the next draft proposal,” Zgliczynski said. Subsequent meetings will be held this year; during a plenary meeting in Vladivostok, Russia, in October, the SC61C subcommittee will decide whether a final draft is ready to be submitted for a yes-or-no vote. “The chances are we’ll finalize this by the end of 2017 and publish the standard in 2018,” he said.

A new IEC standard for the maximum allowable flammable refrigerant charge would influence the adoption of the same standard in the U.S. by the EPA and Underwriters Laboratories (UL), noted Zgliczynski. “This would be a reference, the global standard.”

Zgliczynski would like to see the U.S. “adopt exactly the same standard so that it is a universal standard.” The majority of the 26 experts in Working Group 4 represent U.S. manufacturers like True Manufacturing, Emerson, Hussmann and United Technologies. Working Group 4 also comprises representatives of 12 other countries, including Germany, New Zealand, and Japan.

Zgliczynski noted that most plug-in cases don't require a propane charge as high as 500 g. “For our products and main customers in America, 250 to 350 grams is enough to cover most of the applications,” he said. “Five hundred grams would be necessary just for some specific applications.”



KYSOR/WARREN

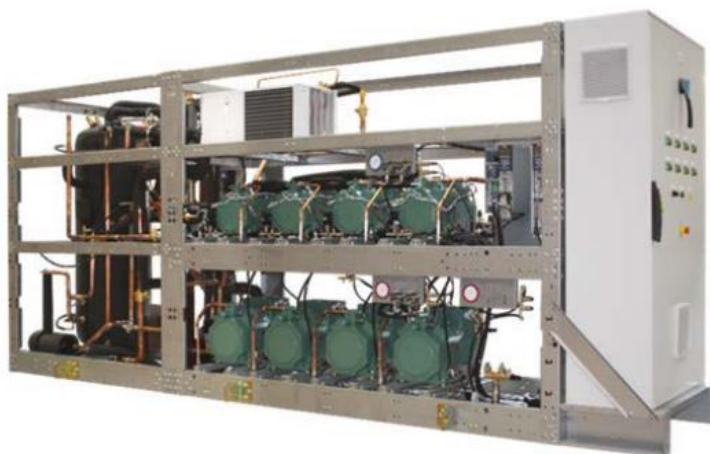
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“This would be a reference,
the global standard.”

— Marek Zgliczynski, Embraco.

Flammable refrigerant research projects

Meanwhile, major research efforts addressing flammable refrigerants – which would potentially support an update in safety standards and an increase in charge limits – are underway.

The largest is a \$5.8 million program started last year that is focused on the risks associated with flammable refrigerants, both A3 and A2L (slightly flammable). It has support from the U.S. Department of Energy (DOE), the Air Conditioning, Heating and Refrigeration Institute (AHRI), the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), the state of California and Johnson Controls. The research initially considered A2L refrigerants, and was expanded to include A3 refrigerants.

In late January, Omar Abdelaziz, group leader, building equipment research, energy & transportation science division for the DOE's Oak Ridge National Laboratory, said that the research on A3 refrigerants would start “in the next couple of months,” with a final report issued by September 30 of this year. He said this in answer to a question at the Sustainable Technologies for Stationary Air Conditioning Workshop, held at the AHR Expo in Las Vegas.

Ultimately, the research will be used to update ASHRAE standards 15-2013 (Safety Standard for Refrigeration Systems) and 34-2013 (Designation and Safety Classification of Refrigerants). In addition, by the end of 2017, findings will be provided to safety code committees in North America and globally, said Stephen Yurek, president and CEO of AHRI, at the workshop. That will, in turn, lead 2018 to changes in building and fire codes used by municipalities, which would take effect in 2021 and ultimately be adopted by state and local model codes.

“There are a lot of efforts going on to incorporate flammable refrigerants,” said Xudong Wang, director of research for AHRI, at the workshop. “The question is how to safely use them.”



From left: John Prall and Marek Zgliczynski, Embraco

AHRI's efforts, through its Air-Conditioning, Heating and Refrigeration Technology Institute (AHRTI) research arm and UL, are focused on “identifying the main knowledge gaps in the safe use of flammable refrigerants,” including leak and ignition testing, Wang added. “We want to understand the relative risks compared to A1 refrigerants with oil currently in the field.”

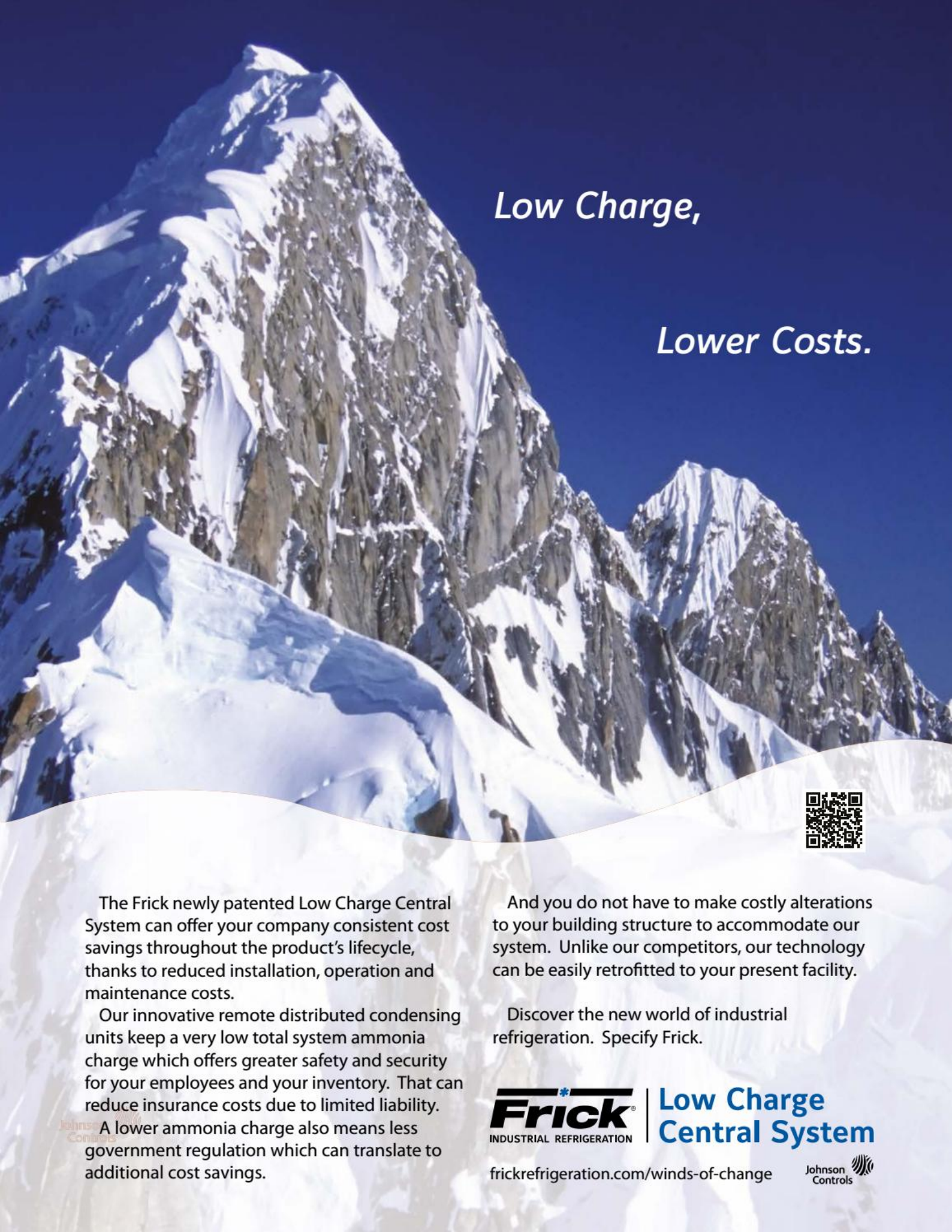
In another research project, launched this year, the U.S. Fire Protection Research Foundation is evaluating the fire hazard posed by flammable refrigerants to lay the groundwork for raising the 150 g charge limit on hydrocarbons. Co-leaders of the \$170,000 project include Target, a user of self-contained propane display cases, and the North American Sustainable Refrigeration Council.

“There is a need to assess the fire hazard of Class A3 refrigerants, and specifically propane,” said Amanda Kimball, project manager for the Fire Protection Research Foundation, an affiliate of the National Fire Protection Association, based in Quincy, Mass.

The overall goal of the project, said Kimball, is to evaluate the fire hazard of up to 1,000 g of propane in refrigeration appliances used in a commercial retail setting.

The project is expected to be completed this June

■ MG



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Albert Heijn's Carbon-Neutral Store

The Dutch retailer's new hypermarket employs solar energy and a CHP plant, as well as a transcritical CO₂ refrigeration system – one of 110 in the chain – to achieve a net-zero carbon footprint

By Andrew Williams

From left: Vincent van Dijk and Alfard Clerc, Albert Heijn

In the small town of Purmerend, the Netherlands, north of Amsterdam, a new Albert Heijn XL hypermarket has achieved the rare distinction of carbon neutrality.

And so, Albert Heijn, a chain of 950 supermarkets across the Netherlands and Belgium, has dubbed it "Europe's most sustainable supermarket."

"It's our own assessment based on the technology we've put inside the store," said Vincent van Dijk, a store-engineering consultant for Albert Heijn. "We've looked around Europe to see if there are comparable supermarkets – we don't think there are any."

The Purmerend store, which opened last November, is the first but certainly not the last Albert Heijn store to reach this goal. The retailer – a division of Ahold Delhaize, based near Purmerend in Zaandam – wants all of its stores to be carbon neutral by 2025. "That's a big aim for the future," said Alfard Clerc, the senior manager, store engineering in Albert Heijn's real estate & construction department.

At the Purmerend store, 50% of the energy used on site is provided by a combination of 700 solar panels (on the roof and sides of the building) and a combined-heat-and-power (CHP) plant in the parking lot. The CHP is fired by biogas and provides in-store heating and electricity.

Part of the motivation for placing solar panels on the side of the building was to make sure that customers see them. "We've done a lot of things, from small to large," van Dijk said.

The store's transcritical CO₂ booster refrigeration rack – Purmerend is one of 110 Albert Heijn stores with a transcritical CO₂ system – handles not only cooling but air conditioning in concert with absorption machines. (Albert Heijn is now remodeling its stores to include transcritical CO₂ refrigeration at the remarkable rate of 60-80 per year.)

The Purmerend store is also fitted with phase-change equipment for heat storage. "When we have too much heat, we store it," said van Dijk. "When we need heat, we take it out and put it back into the CO₂ transcritical



system. Underground, we store the cold. This is all managed remotely from the center of the Netherlands.”

Albert Heijn’s use of fully closable refrigerator doors cuts electricity use by 25%. Display cases use “6K” evaporators that deliver energy savings of 10% compared to the previous cabinets.

The new Albert Heijn XL is 30% more energy efficient than the previous store on the Purmerend site, and 10% more efficient than the company’s previous standard-bearer. “If we improve like that every year, that’ll be very nice,” van Dijk said.

Customers cannot miss the row of charging stations for electric vehicles in front of the store. “Of course, we’re in the Netherlands – so you can [also] pump up your bicycle tires!” Clerc said.

In sum, the carbon neutrality comes from “a combination of producing energy, buffering the storage, and the energy savings that we’re making with the refrigeration installation,” said van Dijk. “Nobody else in Europe is making installations in this combination.”

Excitedly hopping from one feature to another at the Purmerend store, Clerc stressed that this hypermarket is very much a pilot for new ideas. “This is really a playground. It’s the best spot to do it, because we

“ If we improve like that every year, that’ll be very nice. ”

can try everything here. It’s about learning what’s happening with our innovations.”

Going HFC-free

At the heart of Albert Heijn’s strategy to go carbon-neutral are plans to become HFC-free. “We’re looking at an HFC phase-down,” said van Dijk. “That’s the main route we’re following – and making our installations a little bit better every day.”

Since 2015, Albert Heijn’s policy has been to fit all new and remodelled stores with CO₂ transcritical installations. As an intermediate step, the company installed 350 hybrid CO₂-HFC systems between 2010 and 2015.

Fast forward to 2017, and Albert Heijn’s 110 transcritical CO₂ stores (including franchises) represent about 10% of its total store portfolio. “We have the ambition to work faster, but it’s also about cost,” van Dijk said. “The remodelling sequence is about 10 years, so that’s a very important consideration in speeding up towards going completely [carbon] neutral.”

Albert Heijn’s standard stores are fitted with the same CO₂ system regardless of location, keeping investment costs down. The capacity can differ but “we try to put the same installation and the same components in every store,” said van Dijk.

At the Purmerend store, though, the transcritical CO₂ booster system features parallel compression and is one of only a handful in Europe to use ejectors. An adiabatic gas cooler and a dry-cooler on the roof complement the rack.

Albert Heijn builds its refrigeration racks itself, in close cooperation with a team of advisors and the installers. “That’s a different way of doing it than most other companies, because we want to know all about it ourselves,” Clerc said.

“We make a document listing all the components,” explained van Dijk. “We make the calculation up front and know exactly what has to go in. Then the installers know exactly what to build.” This is important for future maintenance of the systems. “Sometimes the maintenance people are maintaining stores they didn’t build. So you have to have the same type of installation.”

Albert Heijn has contracted four companies – Retail Technics, Frimex, Carrier and Veld – to install and maintain the transcritical CO₂ systems in its stores. The firms monitor and adjust the systems remotely.

“These companies are very much part of our innovation and the improvements that we’re making to our installations,” van Dijk said.

For flexibility, Albert Heijn also uses stand-alone plug-in propane units to display certain products. Its distribution centers are cooled by a combination of ammonia and brine. “Always natural refrigerants,” noted van Dijk.

Regulatory impact

In Europe, regulation plays a critical part in driving natural refrigerant adoption. In particular, the European Union’s F-Gas Regulation, which entered into force in 2015, aims to reduce HFCs by 79% by 2030, as compared to average levels in 2011-2013.

To help deliver this target, the EU is progressively banning the use of certain HFCs in different types of new equipment. In 2022, for example, bans on using certain HFCs with GWPs above 150 in new centralized and plug-in commercial refrigeration equipment will come into effect.

“The HFC phase-down was an alarm bell that we have to start innovating,” said Clerc. Yet switching to natural refrigerants is a no-brainer for him regardless of the evolving policy landscape. “It’s about doing the right thing. It’s also about saving energy, and saving money.”

The global adoption last October in Kigali, Rwanda, of a Montreal Protocol amendment limiting the production and use of HFCs has only strengthened Albert Heijn’s resolve in this regard.

“Kigali confirmed that we’re going in the right direction,” Clerc said. “It’s also helping us to raise awareness that we need to remodel our stores,”

What challenges has the company encountered in remodelling stores with CO₂? Availability of components and training have proved to be crucially important, Clerc said. “Educating people plays an important role in determining how fast you can go.”



CHP plant supplying Albert Heijn XL store, Purmerend, the Netherlands

The biggest lesson Clerc has learned is the importance of forward planning, gathering data and getting calculations right. “All this is really important to finally going for that shift [to natural refrigerants].”

In Purmerend, owning the real estate made it easier to make the business case for investing in environmentally friendly innovations. “We had a unique opportunity [in Purmerend] to do this,” Clerc said. “Now we’re learning, and looking at which of the technologies at Purmerend we can develop and put into the normal remodelling of our other stores.” ■ AW

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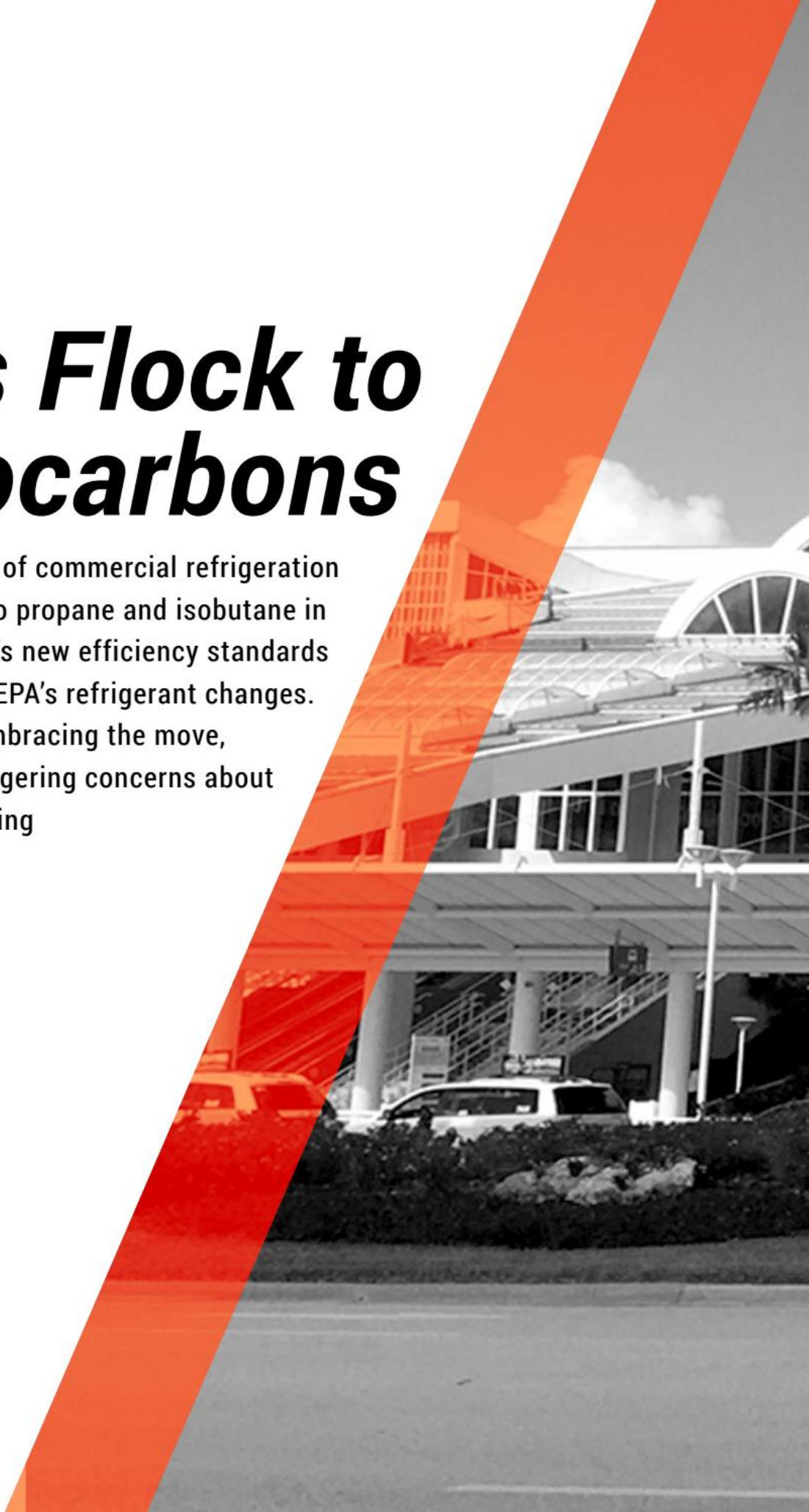
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OEMs Flock to Hydrocarbons

Myriad manufacturers of commercial refrigeration have made the move to propane and isobutane in order to meet the DOE's new efficiency standards – and prepare for the EPA's refrigerant changes. Many end users are embracing the move, though others have lingering concerns about flammability and training

By Michael Garry





Orange County Convention Center, Orlando, Fla. site of the NAFEM Show 2017
Photo credit: North American Association of Food Equipment Manufacturers

On February 28, 2014, the U.S. Department of Energy (DOE) announced new efficiency standards for commercial refrigeration equipment – an update to the last round of standards implemented in 2012.

After a period of extensive review incorporating industry feedback – and despite some legal challenges by industry groups – the new standards went into effect on March 27, 2017. They cover a wide array of equipment, including vertical, semi-vertical and horizontal cases, with and without doors, at medium and low temperatures, and using remote and self-contained condensing units. And they make the average commercial refrigeration unit about 30% more efficient compared to the previous standards.

Setting minimum energy conservation requirements for commercial refrigeration equipment – along with more than 60 other categories of appliances and equipment – is something the DOE is required to do periodically under federal laws passed in 1975 and 1987 and updated since then. Despite the Trump administration's plans to roll back regulations and cut funding for DOE and Environmental Protection Agency (EPA) programs, the 2017 standards are set, and would take years to undo.

While this routine puts pressure on manufacturers to invest in regular equipment upgrades, the impact on cost savings and environmental protection is profound. According to the DOE, over the next 30 years the 2017 standards will save end users like supermarkets up to \$11.7 billion on electricity bills, while cutting carbon pollution by about 142 million metric tons – equivalent to the annual electricity use of 14.3 million U.S. homes.

"In our supermarkets and grocery stores, refrigeration can use almost 40% of total energy use – contributing a large portion of these businesses' utility bills," said former Energy Secretary Ernest Moniz. "By improving the energy efficiency of commercial refrigeration equipment – like restaurant-size fridges or the deli case at your local grocery store – we can make our businesses more competitive, reduce greenhouse gas emissions and save money."

As part of releasing new efficiency standards, the DOE provided estimates of the minimum energy consumption that can be achieved for each piece of equipment using the best available technology. (See infographic on [page 6](#).) Often these ideal energy consumption levels are not much beyond what the DOE is actually requiring.



Warning sign from True Manufacturing at its NAFEM Show booth

Also on March 27, the Environmental Protection Agency announced the ENERGY STAR 4.0 efficiency standard, which applies to a range of commercial and home appliances. This optional standard is typically at least 15% more stringent than federal requirements.

For OEMs, the challenge imposed by new energy efficiency standards is how to go about meeting them. What combination of components will do cost effectively do the trick? This is where natural refrigerants, specifically hydrocarbons like propane (R290) and isobutane (R600a), come in.

The DOE lists numerous technologies that can increase the efficiency of equipment, such as variable-speed compressors, fan motors and LED lighting. A more fundamental decision, though, is what type of refrigerant to use. And what many OEMs interviewed last month at the NAFEM show in Orlando, Fla., said is that switching from HFCs to hydrocarbons – and using the compressors and other equipment that support hydrocarbons – can provide a critical boost to the efficiency of a commercial refrigeration system, particularly those that use solid or glass doors, for which the mandated jump in efficiency is greatest.

"Major light commercial equipment suppliers, if not all, have developed or are developing hydrocarbon solutions for the majority of their models," said Antoine Azar, former global program director for Coca-Cola and head of his own sustainability consulting practice, Sustainable Solutions.



Sara Sunderman-Kirby, Welbilt, in front of R290 units.

Indeed, in some cases, only by using hydrocarbons can equipment meet the DOE's demanding 2017 standards. That was true for Guatemalan OEM Fogel, said Federico Barquero Tefel, the company's vice president of commercialization.

Fogel's 7-cu.-ft. countertop cooler was able to meet the DOE's 2012 efficiency standard using R134a. "But if we want to use that now, the unit would not pass [the 2017 standard]," he said. "So we went with [propane] and lowered its energy consumption. And that's just one example."

Outside the U.S., OEMs have long taken advantage of the efficiency of hydrocarbons in refrigeration. For example, on the domestic side, there are more than two billion hydrocarbon refrigerators and freezers in homes worldwide, according to True Manufacturing. Commercial refrigerators using hydrocarbons have been used for more than 20 years, with more than four million units installed today.

But in the U.S., concerns about hydrocarbons' flammability – despite the small charge (150 g) allowed in commercial refrigeration equipment – have slowed adoption. Still many major end users are embracing hydrocarbon equipment ([see page 43.](#)) And some OEMs would like to raise the charge limit to at least 500 g in order to more economically support larger applications. ([See page 28.](#))

The DOE's efficiency rules represent the most immediate regulatory pressure on commercial refrigeration. But another regulation is on the horizon; the EPA's SNAP (Significant New Alternative Policy) program plans to delist HFCs like R404A, R507A and R134a in stand-alone commercial equipment in 2019 and 2020, forcing manufacturers to switch to lower-GWP refrigerants. Hydrocarbons, with their

near-zero GWPs, fit that need as well, and many OEMs are using them with an eye to preparing for the delisting of HFCs.

An early start

One of the leaders in the development of propane-based commercial refrigeration, True Manufacturing, has been prepared for March 27, 2017, for some time.

The O'Fallon, Mo.-based OEM has, over the past two years, converted about 80% of its foodservice and food retail coolers and freezers from HFCs to propane refrigerant, said Todd Washburn, director of sales & marketing, retail division for True. "The fact that we started with hydrocarbons much earlier than others puts us in a good position to meet the 2017 requirements."

According to Charles Hon, True's engineering manager, the company offers 327 hydrocarbon base models that meet the DOE's 2017 standards. From 35% to 45% of True's hydrocarbon equipment meet the ENERGY STAR 4.0 standard, added Washburn.

By dint of the propane equipment alone, True's units are on average 15% to 25% more efficient than their HFC predecessors, said Washburn. Other enhancements, like LED lighting and high-efficiency motors, boost the average efficiency advantage to between 25% and 30%.

For example, True model T-23-HC hydrocarbon single-door commercial refrigerator, which can use no more than 2.27 kWh of energy daily under the DOE's new requirements, consumes just 1.27 kWh daily; by contrast, True's R134a version uses 2.14 kWh daily. Over the course of a year, the propane unit would save an end user \$31.76 in energy costs (at 10 cents/kWh).

At last month's NAFEM Show, True featured many of its hydrocarbon display cases, refrigerators and freezers, pointing out to foodservice customers that these products use propane and "will be on the DOE 2017 list" of commercial equipment that meets the new efficiency standard, said Washburn. The DOE maintains this list on its online compliance certification database.

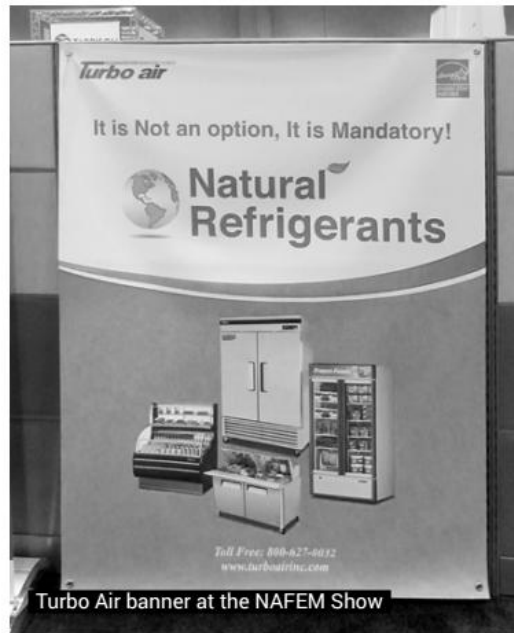
End users need to be aware of the new energy standards and ask their suppliers whether their equipment is compliant, advised Washburn. New equipment that does not meet the efficiency standards cannot be legally sold in the U.S. as of March 27. "If suppliers don't meet the standard, and you need [new equipment], you could have a supply issue. Customers don't want to be in that position."

Washburn does not believe the Trump administration, despite taking an anti-regulation posture, would try to roll back the new standards. "The DOE regs are law. To rescind them would take two years."

But how strictly the standards will be enforced is not as clear. "The big issue is: will there be any teeth to it?" said Washburn. "The standards are only as good as the enforcement. If there's no policing of this, it's really not fair to the people who are compliant and are doing the hard work."

The DOE's enforcement of its previous efficiency standards, set in 2010, was spotty. The agency only began auditing compliance in earnest over the past year, in an effort to take stock prior to the onset of the new requirements, explained Washburn, adding that a number of fines were issued.

For True, propane also satisfies the EPA's upcoming regulations delisting high-GWP HFCs. Moreover, the company does not plan to use HFO blends as a lower-GWP alternative to HFCs in its equipment. "We can do our product line with propane so there's no need to use a refrigerant with a higher GWP than propane," said Washburn. And, he noted, if California adopts plans to ban refrigerants with a GWP over 150 from commercial refrigeration, then many HFO blends would not be a viable alternative, while propane would.



Large chain rollout

Another major OEM, Welbilt (formerly Manitowoc Foodservice) has completed conversion of its reach-in and under-counter refrigerator and freezer units for chain restaurants to propane from R404A.

The full conversion of those units to propane, completed late last year, followed a rollout of R290 units by a large chain customer, said Sara Sunderman-Kirby, product manager for Welbilt's Delfield brand, who declined to name the retailer without its permission.

Welbilt's propane units are 15% to 17% more efficient than their HFC predecessors and meet the new DOE efficiency requirements, she said, adding that the cost of both equipment types is comparable.

Minus Forty Technologies Corp., a Georgetown, Ontario-based manufacturer of freezer and refrigerated cabinets, has converted all but one of the 36 products in its portfolio to propane.

"We've been working towards converting our entire product line to R290 for two years now," said Chris Strong, the company's vice president of sales and marketing. "What we discovered in our research and speaking to our component suppliers is that we had a better chance of achieving the DOE initiatives by converting to R290, because it operates as a more efficient refrigerant."

"We have a small quantity of R404A systems remaining. In the interest of not scrapping parts, basically we're just getting through our remaining inventory. Pretty much everything else is R290 now."

In addition to regulatory pressures, the company's decision to opt for propane was partly driven by its corporate social responsibility policy. "That's our mandate for environmental sustainability," Strong said.

Strong reported growing demand for its propane equipment in the United States, partly driven by strong sales in the pet food industry, which needs freezers to store frozen raw pet food.

OEM Beverage Air plans to convert all of its myriad foodservice refrigeration equipment to propane refrigerant from HFCs by the end of the year, according to Bill Siskar, vice president of manufacturing and engineering.

Though it still offers HFC versions of its equipment, Beverage Air ultimately prefers to use one refrigerant "for ease of manufacturing," Siskar said.

So far, all undercounter, worktop and sandwich prep units have been converted to propane. "Only hydrocarbons let us meet the DOE 2017 requirements for undercounter and worktop units," he said. The conversion to propane will also help the company deal with the EPA's delisting of HFCs in a few years. "It kills two birds with one stone."

Beverage Air began producing hydrocarbon equipment after "certain customers asked for it," said Siskar. He acknowledged that hydrocarbon units are "slightly more expensive" because of additional components.

Swiss OEM Liebherr has introduced a line of hydrocarbon refrigerators and freezers for the U.S. foodservice sector that not only exceed new Department of Energy (DOE) efficiency standards but meet the even more stringent ENERGY STAR 4.0 efficiency standard.

The single- and double-door freezers and refrigerators use propane in larger units and isobutane in smaller units, which include Eco-Cooler appliances supplied to Red Bull, said René Waldner, central product management for Liebherr's Austria office.

The propane appliances being launched in the U.S. have existed in Europe since 2007, said Waldner, adding that "We have been producing hydrocarbon refrigerators for over 20 years."

The maximum charge of propane used in the units is 100 g, he noted, well under the 150-g maximum.

Hydrocarbons for Coke

Imbera, a division of Mexico-based Femsa, the largest Coca-Cola bottler in the world, is migrating its Coke beverage coolers to hydrocarbons as part of an overall transition to propane and isobutane refrigerants designed to meet higher efficiency standards.

Coke has long designated CO₂ as its standard refrigerant for new beverage coolers, vending machines and fountain equipment. But last year, at the ATMOSphere America conference in Chicago, Antoine Azar, then the company's global program director, announced that Coke would be open to hydrocarbons for smaller equipment.

"Our portfolio for Coke will be available in CO₂ and hydrocarbons," said Andres Martinez-Negrete, technology and product development director for Imbera, which displayed its latest models at the NAFEM Show. Imbera has heretofore been a major supplier of CO₂ coolers for Coke. 

Another Way to Boost Efficiency

Variable-speed compressors are making hydrocarbon compressors even more efficient.

"You gain a minimum of 10% efficiency with hydrocarbons," said Marek Zgliczynski, manager of commercial refrigeration product engineering for Brazilian compressor manufacturer Embraco. "With variable-speed, you get another 20%-40% improvement in efficiency."

Other benefits of variable-speed include a reduction in the size of the compressor and noise reduction, he noted.

Embraco has grown its variable-speed compressor portfolio to help OEMs meet the Department of Energy's 2017 efficiency requirements for commercial refrigerators, and moving forward, to meet ENERGY STAR 4.0's even more stringent efficiency standard, said John Prall, Embraco's technical support, North American Region.

Embraco's latest variable-speed propane compressor, the 13-cu.-cm. Full Motion (FM) T413U, will be available mid-2017 for commercial freezers and refrigerators. It includes a bivoltage inverter that can operate at 115 V or 220 V.

While variable-speed compressors come with a premium, end users can recoup that cost in less than a year, said Zgliczynski. But since Embraco's customer is the OEM, not the end user, "the end user has to drive demand for the product," added Prall.

Martinez-Negrete noted that Coke is focusing on coolers with hydrocarbon charges smaller than 150 g. "Coke has limits for each specific size and capacity," he said.

For its general foodservice equipment line, Imbera has migrated to hydrocarbons in the past year, using propane and, for smaller equipment, isobutane, said Martinez-Negrete. The migration will enable Imbera's units to meet the Department of Energy's new efficiency requirements, and the company has started tweaking its cooler design to enable the units to meet the ENERGY STAR 4.0 standard.

"You need hydrocarbons to reach 4.0," he added.

In 2017, the Coke coolers will be absorbed into the foodservice business, and all equipment "is going to meet DOE 2017 and ENERGY STAR 4.0," said Martinez-Negrete. ENERGY STAR 4.0 "will be optional but preferred in the market. Without it, it will be harder to place equipment." He acknowledged that some customers still prefer HFC equipment.

The U.S. market, where Imbera has sold about 20,000 hydrocarbon coolers, "is just beginning" to use that equipment; Mexico is much further along, with more than 350,000 installed hydrocarbon units. The cost premium for its hydrocarbon equipment is about 5%.

Besides Coke, Imbera's customers include other beverage makers, as well as unattended "micromarkets" that set up beverage and food coolers in offices and rely on self-checkout; the coolers are temperature-monitored and self-lock when temperatures rise above a certain level.

Imbera is interested in integrating variable-speed compressors in its units, though currently there's a "cost hurdle to overcome," Martinez-Negrete said.

Another Coke equipment vendor, Dallas-based SandenVendo America, which has provided the beverage giant with CO₂ vending machines in the U.S., is preparing for field trials of R290 vending machines in North America, said Larry Hieb, the company's vice president of engineering. He declined to name the beverage companies for which the trials are being done. "The energy efficiency of R290 is superior to HFCs and CO₂," he added.

Low demand so far

Turbo Air, a refrigeration manufacturer based in Long Beach, Calif., is almost finished developing propane versions of its foodservice equipment, though it sees low demand for hydrocarbon units so far in the U.S.

The company operates one manufacturing plant in Grand Prairie, Texas, one in China and two in South Korea. "We have about 200 R290 units, but a few under-counter [hydrocarbon] units don't meet the [Department of Energy's] 2017 standards, so we are still working on those," said Nelson Lee, director of operations, Texaking, Turbo Air's Texas division.

The propane models are 15% to 35% more efficient than their HFC counterparts, said Lee.

But Turbo Air still offers HFC units that meet DOE's new standards because "at this point 95% of customers still prefer current specs [HFCs]," said Lee. "Only a few chain customers want R290 units as a sample to try it out and see what happens."

Still, he added, given the EPA's future delisting plans, "eventually [customers] will need to go for R290, so it's better to switch as soon as possible." To make that point at its booth at the NAFEM Show last month, Turbo Air displayed banners and handed out fliers stating, "It is not an option, it is mandatory! Natural Refrigerants."

Traulsen, a Fort Worth, Texas-based division of the ITW Food Equipment Group, is offering a "dealer's choice" to foodservice operators – the same equipment using either R290 or HFCs (R404A/R134a).



The development of Traulsen's hydrocarbon offerings has taken place over the past 18 months in preparation for the DOE's 2017 efficiency requirements. Units that didn't meet the standards have been eliminated. "Those were low volume – nobody's crying," said Scott Mallernee, Traulsen's sales development manager.

Sales of HFC units still outpace those of hydrocarbon equipment, he said. "People are slow to adopt new stuff. Some chains don't want R290 because of the flammability."

To address concerns about flammability, Welbilt "trained the public and our customers on the safety and good benefits of R290, because instantly when people think of R290 there's a lot of hesitation because it's flammable," said Sunderman-Kirby. With the charge limit of 150 g for hydrocarbons in commercial refrigeration, Welbilt's smallest unit "only has as much charge as a Bic lighter," Sunderman-Kirby said. "When we let them know that they feel a lot better."

True's Washburn does not see propane's flammability – especially at the 150-g charge limit in refrigeration cases and freezers – as a roadblock in the marketplace. "Once customers understand the charge size, [flammability] becomes a non-issue."

True has also met another concern about hydrocarbon equipment – the availability of trained service technicians – head on. "We train third-party service technicians all the time," Washburn said. "We go to them, and sometimes they come to [our headquarters in O'Fallon, Mo.], and we do online training." With the growing number of hydrocarbon units in the marketplace, technicians are more apt to seek out training, he noted.

Turbo Air, however, is still dealing with the training issue. Turbo Air has trained its 22 in-house technicians spread across 14 branches in the U.S., but it has not yet started training third-party independent technicians, which it plans to do. "Most of the guys in the trade are not aware of R290 equipment," Lee said.

Moreover, many equipment dealers are continuing to promote HFC equipment until the delisting of HFCs begins, noted Lee. "We have 720 dealers nationwide, but they are not ready to explain to restaurant owners what propane is."

But the changeover to hydrocarbon equipment in food service and retail in the U.S. is still in its early stages, noted Washburn, adding that Canada, Mexico, Latin America and South America are also just getting started. "When you look at the total amount of cabinets in the marketplace, it's going to take years for all of the HFC units to flush through." ■ MG

Hydrocarbons in the Field

The following end-user companies have installed hydrocarbon cases:

- » U.S. discounter **Target**, which has made a commitment to installing self-contained cases using propane as the refrigerant, as of January had them in 580 of its more than 1,800 stores throughout the United States, according to Paul Anderson, Target's director of engineering. In 2017, Target plans to operate some stores that use nothing but propane cases for refrigeration, Anderson said.
- » **Whole Foods Market**, which is testing a propane/CO₂ cascade system in a store in Santa Clara, Calif., has installed self-contained propane display cases – mostly horizontal bunker units – from AHT Cooling Systems in more than 100 stores. (Including Whole Foods, more than 1,000 U.S. stores have AHT's propane cases.)
- » Last year, **Red Bull** reported deploying more than 200,000 isobutane ECO-Coolers in the U.S., with expectations that this number would double within two years.
- » **Dr Pepper Snapple Group's** acquisition of propane coolers "is getting underway," said spokesperson Chris Barnes. "We're working with several different suppliers for this equipment, and they're at different stages of deployment with their systems, so implementation of new R290 cooling equipment in our system will begin soon."
- » In the U.S., **PepsiCo** is phasing out HFCs from new vending machines and coolers in 2019, using propane instead "where regulations allow," said Emad Jafa, director, R&D equipment development, PepsiCo. Currently PepsiCo is halfway through its conversion plans.
- » **Hannaford Supermarkets** has installed AHT's dual-temperature spot propane cooler in the seafood department at 30 stores, said Harrison Horning, director of equipment purchasing, maintenance and energy for Hannaford. The chain is also running about 120 of True's propane beverage coolers in about 15 stores, with plans to install about 100 more per quarter "until we have them in all Hannaford stores," he said.

In addition, Hannaford has two stores using eight to 10 low-temperature, self-contained propane island cases from Novum Refrigeration Technology. "We are considering Novum dual-temperature coffin cases for another store, and may continue to install them in more stores in the future where it makes sense to replace old coffins with new coffins" said Horning.

Hannaford is also developing plans to install water-cooled, self-contained R290 display cases in a proposed new store. This would include all low-temperature cases, about 16 in all. Horning is considering using either an air-cooled chiller or a fluid cooler to cool the water.

"It appears the R290 market may be gaining momentum," he said.

IIAR's Natural Refrigerant Show

The industrial trade group, traditionally focused on ammonia, is increasingly addressing CO₂ applications, which were featured in its renamed conference and exhibition

By Michael Garry

This year, the International Institute of Industrial Refrigeration (IIAR) renamed its annual conference from the Industrial Refrigeration Conference & Exhibition to the Natural Refrigeration Conference & Heavy Equipment Expo, reflecting a new emphasis on, not just ammonia, but another natural refrigerant, CO₂.

The 2017 event, which took place February 26-March 1 in San Antonio, Texas, did indeed feature many exhibits and sessions that addressed systems using ammonia, ammonia/CO₂, or CO₂ by itself.

The following overview highlights some of the major announcements at the show.

Evapco's packaged chiller

Evapco displayed its new Evapcold low-charge packaged ammonia chiller at its IIAR show booth. The chillers are designed to produce temperatures ranging from 10°F to 60°F, with a "sweet spot" between 10°F and 35°F, said Kurt Liebendorfer, vice president, Evapco.

Dairy operator Prairie Farms has purchased two of the chillers to process milk at one of its dairies, becoming the first end user to employ the new system. Prairie Farms chose the chillers "because they are expanding an existing facility and getting rid of a very old ammonia system," said Liebendorfer. Each chiller uses a small ammonia charge (less than 1 lb./TR) to cool glycol at 22°F, which is pumped into the milk processing area to generate a 35°F temperature.

Prairie Farms also purchased two of Evapco's low-charge packaged penthouse refrigeration units, which are rooftop-mounted, Liebendorfer said. These produce a 35°F temperature for a cooler area that



stores processed milk. The penthouse unit and the chiller "complement one another," he added.

Evapco offers more than 50 models of the chiller with capacities ranging from 20 TR to 150 TR. The units include variable-speed screw compressors and water-cooled condensing.

The chiller also includes a heat reclaim loop that recovers heat from the compressor and warms glycol, which can be used for defrosting, humidity control and under-floor warming.

Other applications of the chiller include docks, produce rooms and HVAC.

Liebendorfer sees more adoption of low-charge ammonia units. "What I'm sensing at the [IIAR] show is that change is happening. There's less skepticism of low-charge and packaged configurations."

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MRBRAZ's AC chiller

MRBRAZ & ASSOCIATES, an engineering design firm based in Azle, Texas, has designed and installed low-charge DX ammonia chillers that provide air conditioning in office space at about 10 warehouse locations run by a major U.S. retailer, including four in the past year.

"We have installed critically charged chillers for [the retailer] for six years," said Claude Wilkinson, director of engineering for MRBRAZ. He said the retailer – which he declined to name for publication without its approval – was one of the first in the U.S. to install a low-charge ammonia chiller.

The rooftop chiller is designed with only 1 lb./TR of ammonia, which is confined to the unit; chilled water is pumped to an air handling unit, which delivers cool air to office space. The typical chiller contains about 100 lbs. of ammonia and employs a VFD screw compressor and ECM motors.

"The chiller is not only more energy efficient than an R404A unit but more maintenance-friendly," said Wilkinson.

Hillphoenix to distribute NXCOLD

OEM Hillphoenix has announced that it will be the sole distributor of NXCOLD's ultra-low-charge packaged ammonia units for industrial applications in Canada, Mexico and Latin America, handling manufacturing, marketing and installation.

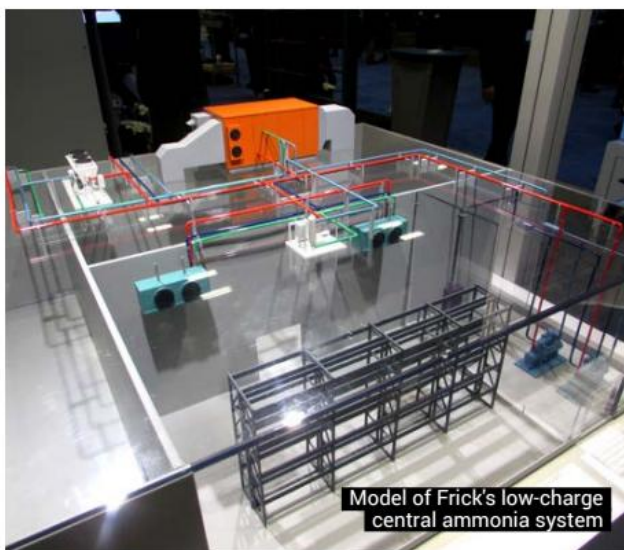
"The NXCOLD product is a good fit for us because it taps into our core competency as a manufacturer," said David Neu, vice president, industrial refrigeration for Hillphoenix. "With the innovation of the ultra-low-charge system and our manufacturing and marketing capability, we believe there will be a rapid growth curve for the product in Mexico, Latin America and Canada. There's a tremendous amount of untapped opportunity."

In the industrial arena, Hillphoenix has installed transcritical CO₂ systems in ice rinks, including three in Anchorage, Alaska, with a fourth starting up in September. The NXCOLD agreement "gives us an immediate entry into the ammonia side of the market," said Tim Henderson, industrial program manager for Conyers, Ga.-based Hillphoenix.

NXCOLD, based in Los Angeles, designed the system to be capable of ammonia charges that are under 1 lb./TR. Over the past few years the company has installed



From left: David Neu and Tim Henderson, Hillphoenix



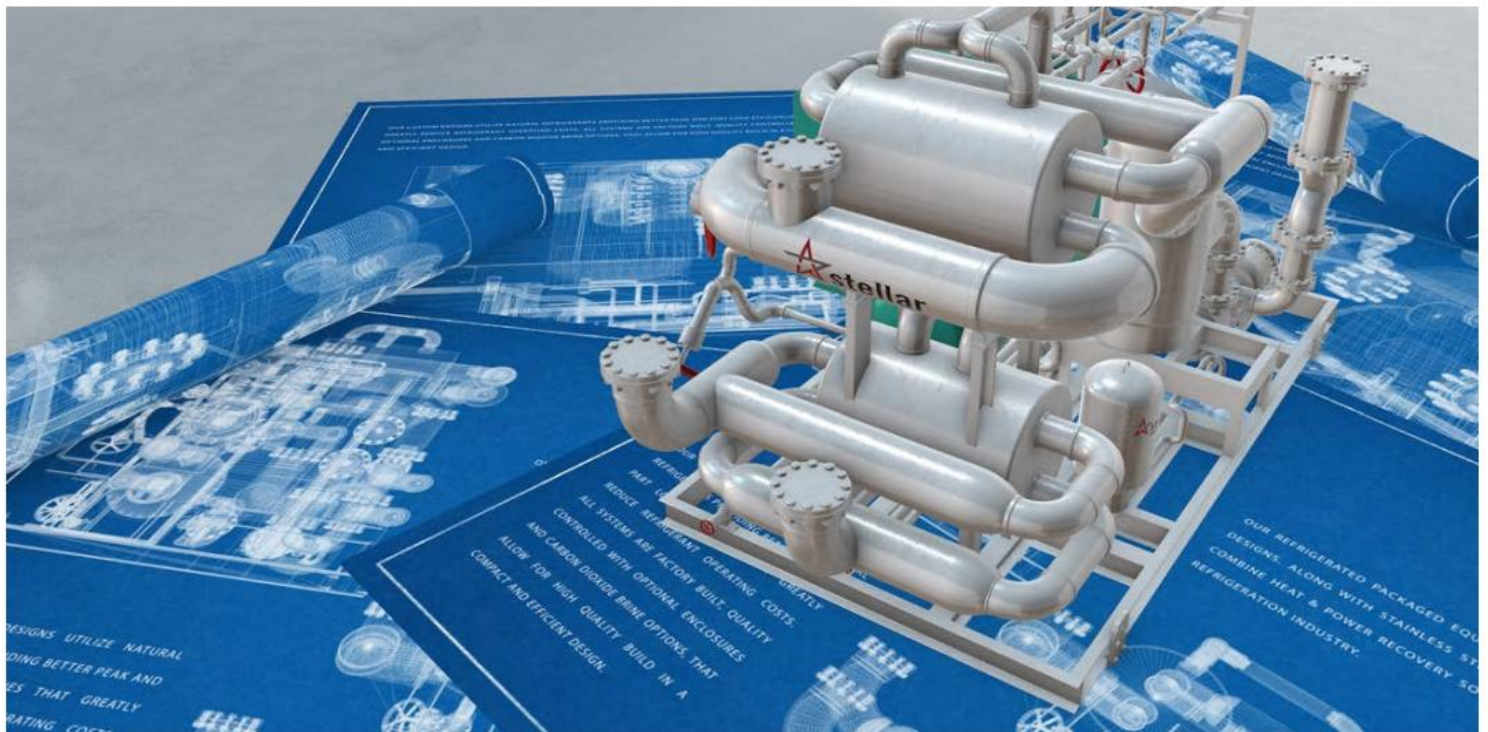
Model of Frick's low-charge central ammonia system

units in cold-storage facilities in California, including a Lineage Logistics plant in Oxnard, Calif., a Baker Cold Storage Facility in Long Beach, Calif. (managed by Lineage Logistics), a Los Angeles Cold Storage facility, and a Neptune Foods seafood storage warehouse in San Pedro, Calif. Hillphoenix has also manufactured NXCOLD units for the U.S. market.

Frick's low-charge central system

Frick Industrial Refrigeration, a division of Johnson Controls, introduced a low-charge ammonia central system that uses "remote distributed condensing" (RDC) units to substantially reduce the amount of ammonia required in industrial applications.

The RDC units, which include a condenser (such as plate-and-frame or adiabatic) and a small liquid supply vessel, are placed near two to three DX evaporators – "the point of liquid use," said Joseph Pillis, director, global industrial refrigeration



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technology, Johnson Controls, Waynesboro, Pa., adding, "The concept of distributed condensing is really what makes this different."

Apart from the liquid ammonia transfer between the RDC and the evaporators, "only [ammonia] vapor is distributed through the plant," he added. This eliminates long liquid lines and reduces the amount of liquid ammonia that needs to be stored. The use of DX evaporators also cuts down on the charge.

Frick's low-charge central system is capable of limiting the ammonia charge "in the range of 1.5 to 3 lbs. per ton [of refrigeration]," said Pillis.

Unlike rooftop-based low-charge ammonia packaged systems, Frick's design maintains use of a traditional engine room, though it only contains compressors and a control panel. As a result, "compressors can be much larger machines [than in packaged systems], running at much higher efficiency than little machines – on the order of 5% to 25%," Pillis said. "We can run two-stage compressors and do economizers off both stages. It's a very flexible design."

Controls are key to managing the ammonia charge in the liquid supply vessels. "They monitor the liquid levels to make sure we don't run out of liquid in places where we need it," said Pillis.

The low-charge central system is installed at a food processing facility, providing 660 TR of capacity with only 2 lbs./TR of ammonia charge. The range of capacities for which the system is typically designed range from 250-1,000 TR, said Michael Colley, Eastern regional sales manager for Frick.

“If you've got one CO₂ compressor that can do almost 200 tons for medium temperature, that changes the face of industrial refrigeration.”



Emerson's 160 CFM single-screw CO₂ compressor

Emerson's new CO₂ industrial compressors

At the IIAR show, Emerson, through its Vilter company, promoted transcritical and subcritical CO₂ compressors for industrial end users. Its new 550 series of open-drive reciprocating compressors, to be released in the next two months, will accommodate capacities ranging 50 TR to 223 TR for low-temperature applications (-20°F evaporating and 23°F condensing). The compressors will come in two, four- and eight-cylinder models. The eight-cylinder model was on display at Vilter's IIAR show booth.

The 550 series compressors have been running for the past year at Emerson's Helix Innovation Center in Dayton, Ohio. "It's pretty exciting stuff," said André Patenaude, director – CO₂ business development, Emerson Commercial and Residential Solutions.

Emerson is also developing single-screw compressors for medium- or low-temperature transcritical CO₂ applications, ranging from 188 TR to 357 TR of capacity at 23°F evaporating and 95°F gas cooler out. The compressors will be offered in several displacements ranging from 128 CFM to 243 CFM. At the IIAR show, the 160 CFM model was on display. The compressors can also be used in low-charge ammonia applications.

The smallest, 188-TR screw compressor provides almost eight times as much capacity as Emerson's 25 TR unit, previously its largest offering. "If you've got one CO₂ compressor that can do almost 200 tons for medium temperature, that changes the face of industrial refrigeration," he said. Emerson will be seeking a field test site for the industrial screw compressor this year. ■ MG

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GCAP's Unusual Trade Show

The ammonia training facility is offering continuous, unattended booth space to vendors and contractors for marketing and training

By Eda Isaksson

Since opening its doors in 2003, the Garden City Ammonia Program (GCAP) has gained a reputation for hands-on training in the art and science of industrial refrigeration, with five engine rooms housing 20 ammonia compression systems at its facility in Garden City, Kansas.

In these training "labs," as they are known, students have the chance to experience real-life situations in what are miniature versions of actual large-scale facilities. Recent equipment additions to the labs include Alfa Laval's U-Turn heat exchanger and Parker Hannifin's Rapid Purge.

This year, GCAP is extending this approach with what it calls a continuous year-round "trade show," where industrial equipment manufacturers and contractors can display their products and services in unattended, 10-ft by 10-ft. booths within a 30,000-sq.-ft. area. In some cases, "cutaways" of products will be displayed. The annual cost for exhibiting is \$3,800.

GCAP, which trains 3,500 students annually, including employees at over 850 companies, is using the trade show as a weekly training vehicle. Most students are operators, technicians, supervisors or engineers who work in an industrial refrigeration facility.

Trade show exhibitors also receive complimentary booth space (normally \$400) at GCAP's Ammonia Safety Day, an annual regulatory awareness event in Kansas City, Kan.; this year it will take place on June 1.

So far 25 companies have signed onto exhibiting at GCAP's trade show, said Jeremy Williams, GCAP's directing manager and lead instructor. The exhibitors include Temprite, Danfoss, Parker Hannifin, Calibration Technologies, Schambaugh & Sons, Farley's Refrigeration, Cyrus Shank Company, and

Bluvas and Associates. The trade show comprises 45 booths, with the possibility of adding 40 more.

Dual purpose

Williams sees a dual marketing and training purpose to the trade show. "I think it's a great avenue to take the [student] end user directly to the manufacturer, but they will have direct contact with the people working in and around the equipment, as compared to speaking to an engineer or person from corporate."

Although the trade show is focused on ammonia refrigeration, companies offering systems using CO₂ are also welcome to join. In addition, one of the largest training focuses of GCAP, steam boilers, will be on site.

The products on display tie in to GCAP's training program, which encompasses ammonia refrigeration, CO₂ refrigeration, steam boiler systems and process safety management/risk management programs. The CO₂ courses deal mainly with cascade NH₃/CO₂ systems; Mayekawa's NewTon NH₃/CO₂ system, one of the first installed in North America, is in an engine room.

GCAP plans to create a small-scale division for training students on commercial refrigeration units using ammonia, propane and CO₂. "Although GCAP's focus has been industrial refrigeration, we do currently have some training on commercial refrigeration," Williams explained.

"In the next couple of years," he added, "I think there will be a significant transition into natural refrigerants compared to what we've seen in the past. As the industry makes that transition, there is going to be a lot of people that will need training in this area. We will help fulfill that demand."

■ E1



Jeremy Williams, GCAP

Training in Spanish

GCAP recently began offering ammonia refrigeration training in Spanish, led by two bilingual instructors.

The increasingly popular program has so far included over 100 students, more than 20% from outside the U.S. "It has been a humbling experience having people come from overseas to join our classes offered in Spanish" said Jeremy Williams, GCAP's directing manager and lead instructor. "There is a need for this not only in the U.S. but globally."

GCAP is in the process of translating its ammonia refrigeration manual, "Seeing Industrial Refrigeration from the Inside Out," into Spanish – a process expected to finish in April – and plans to launch classes in Mexico and Venezuela in 2017-2018.

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Secop's booth at Chillventa

Secop Seizes the Moment

The German compressor maker is taking advantage of the new efficiency requirements in the U.S. to market its propane units

By Charlotte McLaughlin and Michael Garry

As OEMs serving the light commercial and household sectors in the U.S. have transitioned to hydrocarbon commercial refrigeration equipment ([see page 36](#)), Secop sees opportunities for its growing line of propane (R290) and isobutane (R600a) compressors.

Like most changes in the HVAC&R market, the move to hydrocarbons is being shaped by legislation, particularly the U.S. Department of Energy's new efficiency requirements for commercial display cases, which took effect March 27. Looming HFC delistings in 2019 and 2020 under the U.S. Environmental Protection Agency's directives is another factor.

Secop, a German maker of hermetic compressors for households, the light commercial sector and mobile refrigeration, has already been able to benefit from these changes — especially the new DOE standards, said Pieter Boink, its head of business development & marketing, in an interview with *Accelerate America* at the NAFEM Show in Orlando, Fla., last month.

"In the U.S., there was this duty to change that was a huge window of opportunity for us," he said.

"We didn't want to miss it, and in 2016 was very successful for us compared to a few years ago." And Secop is still "taking advantage of this," focusing on 150 V/60 Hz models for the U.S. market."

The shift towards hydrocarbons by U.S. OEMs has been further influenced by Coca-Cola's decision to open the door to hydrocarbons for smaller equipment and not just focus on CO₂.

Secop planted roots in the U.S. in 2013 when it opened its U.S. headquarters in Roswell, Ga., near Atlanta. That was three years after its creation in 2010, when German holding company AURELIUS AG bought Danfoss Household Compressors from Danfoss, and its name was changed to Secop GmbH.

"In the U.S. in the beginning we were grouped closely with the Danfoss sales organization, and they have continued to sell our products," explained Boink. "But we have seen the need from the big OEMs that wanted to deal directly with us, and that is why we started the operation in [Roswell]."

“ We have gone through so many [refrigerant] changes and we should go to the right one now. ”



Pieter Boink, Secop

Unique thermodynamic properties

In meeting the DOE regulations and the even stricter ENERGY STAR 4.0 standard that also launched on March 27, OEMs realized that they “need propane” because of its unique thermodynamic properties, said Boink.

According to a recent paper on hydrocarbons by Eurammon, a European natural refrigerant association, propane “is considered to be one of the most efficient refrigerants.”

Boink agreed. “With the conversion to R290 from HFCs you gain 20% to 25% [in energy savings].”

Typically, SECOP compressors use R290 for commercial applications and R600a for the household sector.

All of Secop’s R&D is now focused on hydrocarbons. “We don’t see an alternative; for us it’s R600a and R290,” said Boink. “Of course, we keep an eye on what the chemical industry is developing with new [HFO] refrigerants, but at the moment we do not see the thermodynamic benefit.” He pointed to the temperature glide posed by HFO blends, which can negatively impact efficiency.

“We have gone through so many [refrigerant] changes and we should go to the right one now,” he said.

However, the switch to hydrocarbons in the U.S. is not as simple as it would seem. OEMs cannot just switch out an HFC compressor for a hydrocarbon one.

“We have customers who took R134a equipment and just put an R290 [compressor] in and they got the worst results,” said Boink.

Secop is providing this technical know-how at its Roswell facility. “It’s for [customers who] lack the capacity, so we do the conversions for them,” he said.

The OEMs being supported are from across the Americas. “We had quite a lot of units both from the U.S. and from Mexico and other countries,” Boink said.

At the facility, Secop tests the whole refrigeration system – not just the compressor, but the condenser, the fan, and more – to see what needs changing in order to accommodate a propane compressor.

The next step for SECOP in the U.S. is to get a foothold in the household market with R600a compressors. R600a is still fairly new for the U.S. compared to the rest of the world, where isobutane has long been used in household refrigeration due to its ability to work well in small-scale equipment.

“Household is around 35% to 40% [of our portfolio] and that is not really the case in the U.S.,” Boink said.

Secop is currently working on isobutane projects with some household manufacturers. “The big companies are preparing for it and [many] already have this in other parts of the world, so it really is just about moving it here,” said Boink. “I don’t see it as being an issue.”

A bigger boost

While hydrocarbons boost the efficiency of refrigeration systems, an even larger boost can come from variable-speed technology, which utilizes an inverter to control the cooling provided by the system.

"Adding variable-speed technology on top [of propane], the industry can realize more than a 40% system efficiency improvement compared to fixed-speed compressors with HFCs or HFOs as the refrigerant," Boink said.

Secop has been working with this technology for a long time, having introduced a hydrocarbon variable-speed hermetic compressor in 1998. Currently, 10% of the company's portfolio includes variable speed. "I estimate in the next two to three years that will move to 50%," Boink said.

For household R600a equipment, Secop offers a variable-speed compressor, the XV model, which is only 10-cm high and incorporates several new technology elements. In the commercial arena, AHT Cooling Systems is using a Secop propane variable-speed compressor in chest freezers.

At the moment, cost is still an issue for variable speed, especially the larger the equipment gets. "Basically, for the bigger compressors, you are doubling the investment, but when you [get smaller], the smaller the additional cost will become," he said.

Many OEMs do not yet support the greater investment, even though Boink estimated that it can be easily paid back to the end user in a year, even for bigger equipment.

"Our OEMs say they can't sell higher costs, but what they don't realize is they can sell the benefit," he said. "Larger organizations – [convenience] stores, supermarkets, etc. – get cautious about energy bills and they look to the efficiency savings they are getting."

The energy saving offered by variable-speed compressors, added Boink, is greater than that of expansion valves, at lower cost.

Another key benefit for OEMs is that, with one variable-speed compressor, they can cover a wide range of applications. Normally, "if you have 10 models you can end up having 10 different compressors, one for each model," he said. "But with variable speed, you can reduce it to one or two compressors."



Secop R600a compressor for household refrigerators

The charge hurdle

The U.S.-mandated charge limit of 150 g for propane in commercial equipment is "really the only roadblock blocking the move to hydrocarbons" in some larger display cases, Boink said. But there are efforts afoot to raise the limit.

The International Electrotechnical Commission's working group on household and similar electrical appliances has begun to prepare a draft to raise the limit on hydrocarbons from 150 g to 500 g. (See page 28.) Other research groups are also investigating the flammability of hydrocarbons as a pathway to raising their charge limit.

Boink believes this could really help the industry by "pointing out there is really no safety issue." AHT Cooling Systems, he noted, has safely deployed 70,000 to 80,000 units with a higher charge.

Concerns about safety is a function of unfamiliarity with the technology, Boink said. He recalled one story about a supermarket that called for a service technician to fix a failed fan. "The guys came and said it's the CO₂, [even though] the fan has nothing to do with the refrigeration cycle. But there is this perception that CO₂ is dangerous and with [hydrocarbon] cabinets it's the same." ■ CML&MG

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Issue #21

January 2017

Publication date: January 11

Focus: California: A Bridge to the Future

Issue #22

February 2017

Publication date: February 21

Focus: Focus: Industrial Refrigeration; the NewTon in food processing

Issue #23

March 2017

Publication date: March 21

Focus: Hydrocarbon refrigeration in foodservice applications

Issue #24

April 2017

Publication date: April 19

Focus: Industrial Refrigeration (low-charge ammonia and CO₂)

Distribution: IARW-WFLO Convention, April 22-2

Ad submission deadline: April 13

Issue #25

May 2017

Publication date: May 22

Focus: NatRefs vs. HFOs

Distribution at ATMOSphere America, June 5-7

Ad submission deadline: May 16

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June 2017

Publication date: June 20

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Ad submission deadline: June 14

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Publication date: July 25

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Publication date: Oct. 18

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Ad submission deadline: Oct. 12

Issue #30 (Vol. 4)

November-December 2017

Publication date: Nov. 28

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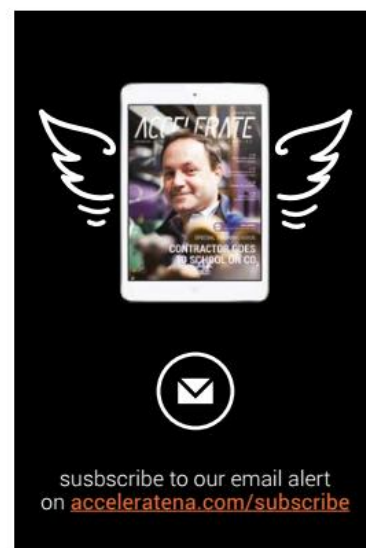
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VOLUME 3 ISSUE # 23

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Accelerate's network of offices stretches from New York and Brussels to Tokyo and Melbourne. Accelerate America is published monthly except for a mid-year and year-end double issue. The views expressed by the contributors are not necessarily those of the Publisher. Every care is taken to ensure the content of the magazine is accurate but we assume no responsibility for any effect from errors or omissions.

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