

FEBRUARY 2016

ACCELERATE

ADVANCING HVAC&R NATURALLY

A M E R I C A



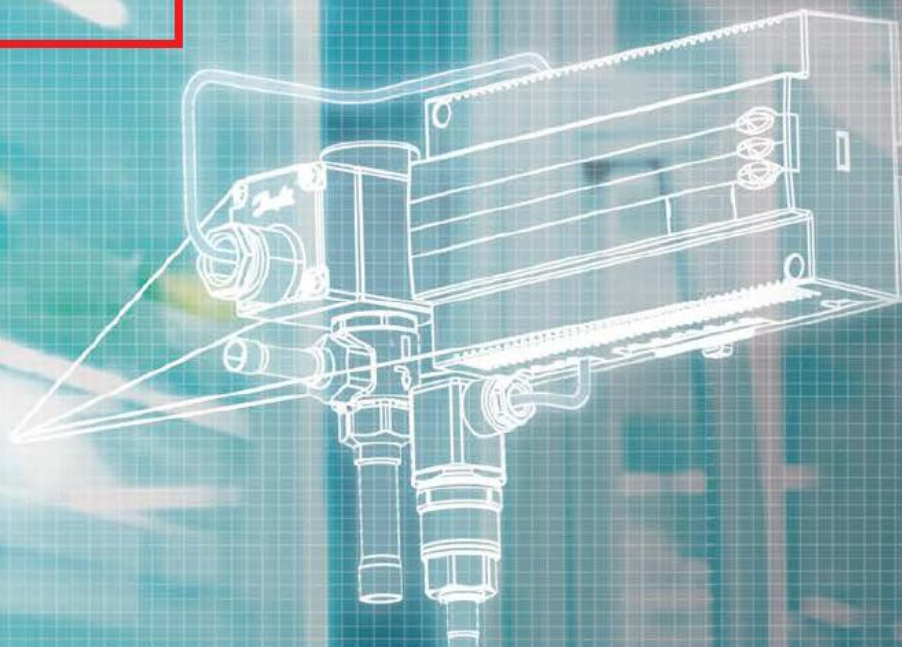
HERE COME HYDROCARBONS!

p.22

The foodservice industry turns to propane and other HC refrigerants to deal with looming DOE and EPA regs

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TOMORROW

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Editor's note by Michael Garry

SAVING THE DAY



The last time *Accelerate America* ran a cover story on the use of natural refrigerants in the foodservice industry, in the March 2015 issue, we featured Tomas Ambrosetti of Coca-Cola on the cover. The focus of that story was CO₂ Coke's natural refrigerant of choice, which it uses in most of its new coolers and vending machines.

In opting for CO₂, Coke is more of an outlier in the foodservice industry, where other major brands, such as PepsiCo, Red Bull, McDonald's, Starbucks and Unilever, have chosen to use hydrocarbons in their self-contained merchandisers. So in this issue, as we return to highlighting the foodservice industry, our cover story looks at how end users, OEMs and component makers are embracing hydrocarbons like propane and isobutane.

Our cover subject, "Hydrocarbon Man," is symbolic of an industry that is transforming from the pedestrian clothing of HFC refrigerants to a more dynamic and efficient hydrocarbon uniform. And Hydrocarbon Man is arriving just in the nick of time to save suppliers and users

of HVAC&R equipment from the twin challenges of the Department of Energy's 2017 energy efficiency regulations and the Environmental Protection Agency's delisting in 2019 and 2020 of HFC refrigerants like R134A and R404A that are used in standalone commercial units. (See story, [page 22](#))

Though he wasn't in attendance, Hydrocarbon Man's effect on the industry was felt at the AHR Expo, held last month in Orlando, Fla. (See story, [page 50](#)) Component makers like Embraco, Tecumseh and Danfoss touted the efficiency advantages of their new hydrocarbon products. Many CO₂ components, including some for foodservice applications, were also on display.

Two major challenges remain for hydrocarbon systems. One is the fact that hydrocarbons are flammable substances. While hydrocarbon units have been proven safe in the field over many years in European markets, they still have to be handled with care by technicians. At the AHR Expo, veteran RSES trainer Arthur Miller spent the better part of a morning explaining exactly

what technicians need to know – mostly common sense stuff – to safely maintain these units. (See story, [page 26](#))

The other issue is the charge size limitations imposed on hydrocarbon systems in the U.S. – 150g (5.3 ounces) for commercial equipment and 57g (2 ounces) for domestic units. Those charges are workable in small-scale applications but increasingly retailers are seeking to deploy hydrocarbons in larger applications where the charge limitation necessitates multiple systems and higher costs.

As it happens, earlier this month, Carter Retail Equipment, a U.K. OEM, applied to the EPA's SNAP program to increase to 1kg from 150g the maximum charge of propane refrigerant permitted in food/commercial retail refrigeration standalone equipment. (See story, [page 31](#)) Carter has vast experience working with larger charges in Europe so I think its chances of boosting the charge in America are good.

I expect to see many more Hydrocarbon Man sightings in the months to come.

● MG

VOLUME 2, #12, FEBRUARY 2016

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About Accelerate America

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

<http://acceleratenamag.com>

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Saving the Day

Editor's note by Michael Garry

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for February, March and April 2016

Dealing with the Double Whammy

With two major regulatory hits on the horizon, the foodservice industry is starting to ramp up demand for natural refrigerant systems – particularly those with hydrocarbons – that cut energy consumption and GWP

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Bound for Low GWP

Raley's is evaluating two NH_3/CO_2 cascade systems as it strives to use refrigerants with a global warming potential of under 50

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DeCA's New Mission

The Defense Commissary Agency is investigating transcritical refrigeration at five commissaries, to go along with its NH_3/CO_2 test

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Pushing for CO_2 in Japan

Retail giant AEON is seeking to fulfill its commitment to CO_2 refrigeration by overcoming challenges in the Asian market

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Long-Term
Answer?

Natural Refrigerant Components on Parade

Growing interest in hydrocarbon and CO_2 systems is evident at the AHR Expo as component manufacturers unveil slew of new products

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Tapping the Incentives Spigot

Supermarkets, OEMs and utilities are collaborating on ways end users can receive utility incentives for using energy-efficient natural refrigerant systems

Coming to America

Japanese manufacturer Mayekawa is set to bring its $\text{NH}_3\text{-CO}_2$ unit, the NewTon, to the North American market, partnering with Canadian contractor Cimco.

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CO₂ and NH₃ refrigeration
technologies



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1

February 15-19, Charlotte, NC
49th Industrial Refrigeration Workshop
<http://conferences.k-state.edu/industrial-refrig/>

2

February 16-18 Las Vegas, NV
Convenience Distribution Marketplace 2016
<http://www.cdmarketplace.net/>
 twitter: @CDA_01

3

February 17-20 Tucson, AZ
Annual Convention National Turkey Federation
<http://www.eatturkey.com/meetings>
 twitter: @TurkeyGal

4

February 20-24, San Diego, CA
AFFI-CON 2016
<http://www.affi.org/events/affi-con-2016>
 twitter: @FriendsofFrozen

5

February 21-23, Nashville, TN
2016 Annual Meat Conference
<http://www.meatconference.com/>
 twitter: @MeatInstitute

6

February 22-24, Austin, TX
Smart Energy Summit: Engaging the Consumer
<http://www.parksassociates.com/events/smart-energy-summit>
 twitter: #ses2016 @SmartEnergySmt

7

February 22-24, Duluth, MN
2016 Energy Design Conference & Expo (EDC)
<http://www.duluthenergydesign.com/>

8

February 22-24, New Orleans, LA
Supply Chain Conference
<http://www.gmaonline.org/forms/meeting/Microsite/SupplyChain16>

9

February 24-25, Vancouver, BC
Buildex Vancouver 2016
<http://buildexvancouver.com/>
 twitter: #BuildexVan @BUILDEXshows

10

February 28 - March 2, Las Vegas, NV
The NGA Show
<http://www.thengashow.com/>
 twitter: #NGAShow16 @NationalGrocers

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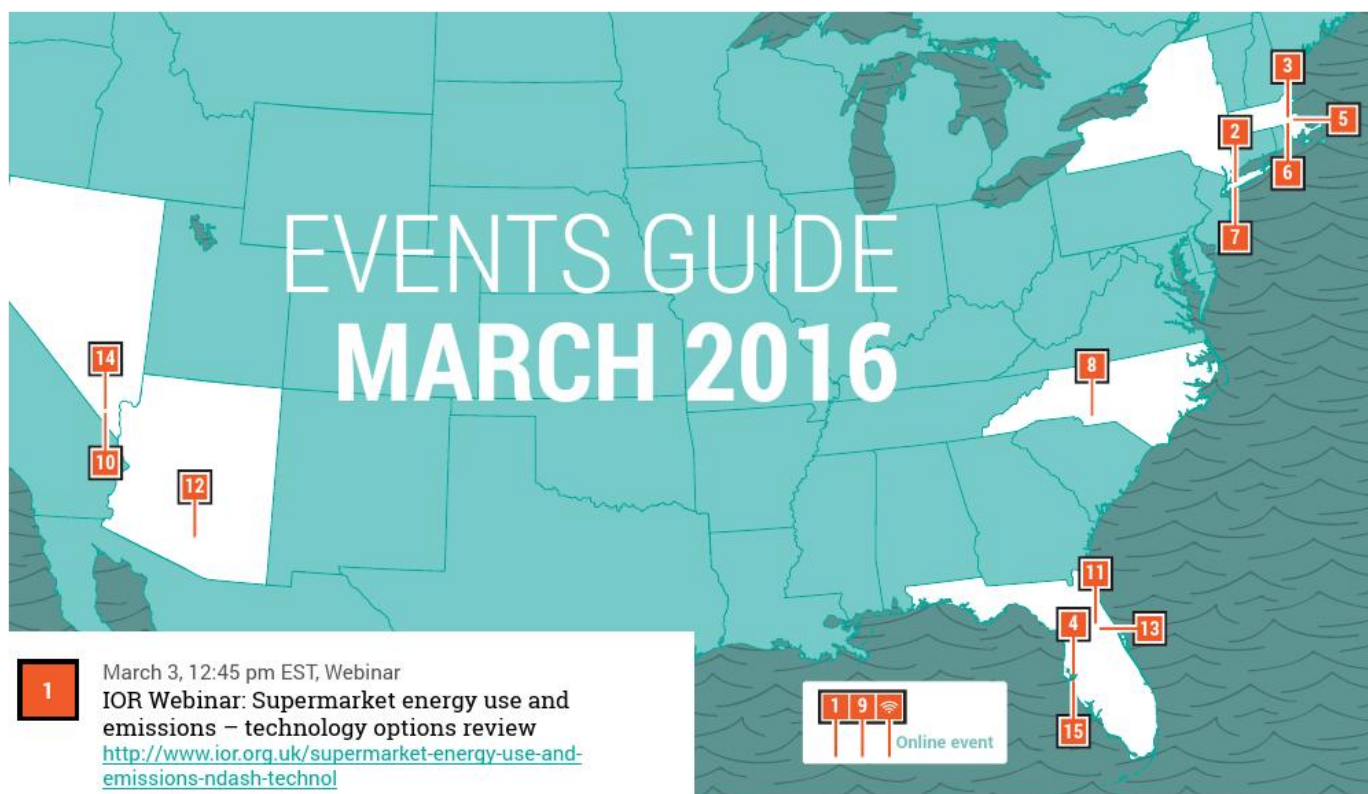
February 28 - March 2, Dallas, TX
Retail Supply Chain Conference 2016
<http://www.rila.org/events/conferences/supplychain>
 twitter: #RILAsupplychain @RILAtweets

12

February 29 - March 2, National Harbor, MD
ARPA-E Energy Innovation Summit 2016
<http://www.arpae-summit.com/>
 twitter: @ARPAE

13

February 29 - March 3, Nashville, TN
TMC Meeting & Transportation Technology Exhibition
<http://www.trucking.org/event.aspx?uid=12644f82-f735-446b-b7f7-953a8453f120>



- 1** March 3, 12:45 pm EST, Webinar
IOR Webinar: Supermarket energy use and emissions – technology options review
<http://www.ior.org.uk/supermarket-energy-use-and-emissions-ndash-technol>
- 2** March 6-8, New York, NY
The International Restaurant & Foodservice Show of New York
<http://www.internationalrestaurantny.com/Content/16.ht>
twitter: @TheFoodShows
- 3** March 6-8, Boston, MA
Seafood Expo North America/Seafood Processing North America 2016
<http://www.seafoodexpo.com/north-america/>
- 4** March 6-9, St. Petersburg, FL
36th Annual Conference & Tabletop Display, Refrigerated Foods Association
<http://www.refrigeratedfoods.org/rfa-conference-registration>
- 5** March 8-10, Boston, MA
NESEA BE16 (BuildingEnergy) - Northeast Sustainable Energy Association
<http://nesea.org/conference/buildingenergy-16>
twitter: #sustainable #building @NESEA_org
- 6** March 9-10, Boston, MA
GLOBALCON
<http://www.globalconevent.com/>
twitter: #globalcon
- 7** March 9, Flushing, NY
ABCO EXPO
<http://abcohvacr.com/abco-expo/>
- 8** March 10-13, Charlotte, NC
ACCA 2016 and the IE3 Expo
<https://www.acca.org/events/conference>
twitter: @accausa
- 9** March 15, 11:00 am EDT, Webinar
EPA Greenchill Webinar- Waitrose's Experience Using Self-Contained Hydrocarbon Systems
<https://epawebconferencing.acms.com/waitrose/>
twitter: @EPAGreenchill
- 10** March 21-23, Las Vegas, NV
National HVACR Educators and Trainers Conference
<http://www.hvacexcellence.org/nhetc/>
- 11** March 20-23, Orlando, FL
2016 IIR Industrial Refrigeration Conference & Exhibition
http://www.iir.org/IIR/WCM/Events/2016_Conference/2016_Exhibitor_Information/2016_Exhibitor_Information.aspx
twitter: @IIR2016
- 12** March 20-23, Phoenix, AZ
2016 ABA Convention, American Bakers Association
http://www.iir.org/IIR/WCM/Events/IIR_Events_2015-2016.aspx
twitter: #PowerofBaking
- 13** March 20-24, Orlando, FL
MCAA Annual Convention 2016 - Mechanical Contractors Association of America
<http://mcaaconvention.org/>
- 14** March 21-23, Las Vegas, NV
National HVACR Educators and Trainers Conference
<http://www.hvacexcellence.org/nhetc/>
- 15** March 31 - April 1, St. Petersburg, FL
Ice Cream Technology Conference 2016
<http://www.idfa.org/news-views/headline-news/article/2014/10/29/registration-now-open-for-popular-ice->



- | | |
|---|---|
| <p>1 April 4-6, Tempe, AZ
 National Frozen & Refrigerated Foods Association (NFRA) Executive Conference
 http://nfraexecutiveconference.org/
 twitter: @EasyHomeMeals</p> | <p>7 April 13-15, Chicago, IL
 2016 National Automatic Merchandising Association (NAMA) OneShow
 http://www.namaoneshow.org/
 twitter: #NAMAOneShow16 @NAMAvending</p> |
| <p>2 April 4-7, Austin, TX
 2016 ACI National Home Performance Conference & Trade Show (Formerly Affordable Comfort, Inc.)
 http://www.homeperformance.org/conference/2016-aci-national-home-performance-conference-trade-show</p> | <p>8 April 13-15, Montreal, Canada
 SIAL Canada
 http://sialcanada.com/sial/en/index.sn
 twitter: #SIAL2016 @SIALCANADA</p> |
| <p>3 April 10-13, Scottsdale, AZ
 BuildPoint 2016
 http://www.buildpointevent.com/
 twitter: #bp2016event @BuildPointEvent</p> | <p>9 April 16-20, Las Vegas, NV
 IARW-WFLO Annual Convention and Expo
 http://www.gcca.org/iarw-wflo-convention-details/</p> |
| <p>4 April 10-14, Houston, TX
 2016 Spring Meeting and 12th Global Congress on Process Safety
 http://www.aiche.org/conferences/aiche-spring-meeting-and-global-congress-on-process-safety/2016</p> | <p>10 April 12, 2pm EDT, Webinar
 EPA Greenchill webinar-Achieving Leak Reduction Goals through Effective Refrigerant Management: Case Study - King Kullen
 https://epawebconferencing.acms.com/kingkullen/
 twitter: @EPAGreenchill</p> |
| <p>5 April 12-14, Indianapolis, IN
 2016 IFMA Facility Fusion Conference & Expo - International Facility Management Association
 http://facilityfusion.ifma.org/indianapolis/home
 twitter: #facilitiesmanagement @IFMA</p> | <p>11 April 26, 2pm EDT, Webinar
 EPA Greenchill webinar-Climate-Friendly and Energy-Efficient Heat Exchanger Designs for Supermarket Applications
 https://epawebconferencing.acms.com/heatexchanger/
 twitter: @EPAGreenchill</p> |
| <p>6 April 13-14, Tacoma, WA
 Northwest Facilities Expo 2016
 http://www.fenw.facilitiesexpo.com/
 twitter: @Facilities_Expo</p> | |

Shaping Refrigeration Systems for Tomorrow

NewTon

Customer's Point of View : Maruha Nichiro Logistics, Inc.

Introduction of the NewTon refrigeration system that uses natural refrigerant has resulted in CFC phase-out measures and an average of 15 to 18%* reduced electricity consumption



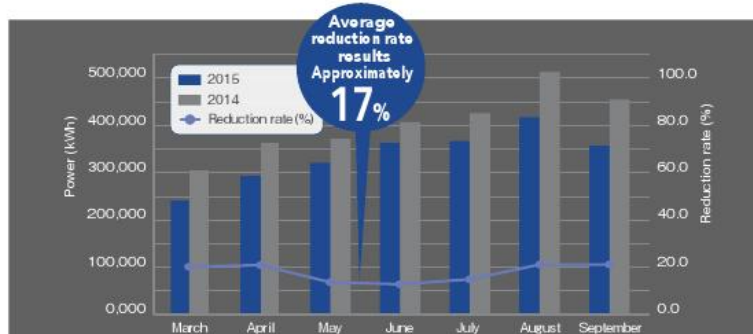
Based on the CFC Phase-out Plan, existing low-temperature refrigeration equipment in main logistics centers was updated to the NewTon refrigeration system that uses natural refrigerant. Environmental measures are promoted across the entire group, resulting in both CFC phase-out plans and energy conservation at the same time.

Deciding Factor

In addition to phasing out CFCs, the system's energy-saving properties and level of perfection has been particularly praised. One deciding factor was improvement to operation and maintenance control.

Advantages

- Compatible with complete phase-out of CFCs by 2020
- Power consumption has been reduced by an average of 15 to 18% for overall logistics centers, and by approximately 30% for individual cooling units
- A maintenance contract has enabled a more reliable operation and management control system with less need for manpower
- Safety is maintained through indirect cooling methods and hazard neutralizing equipment
- Ammonia usage is significantly reduced



■ Comparison of electricity consumption before and after NewTon renovation
(Kawasaki Logistics Center 1: March 2014 to September 2015)

Maruha Nichiro Logistics, Inc.

As a member of the Maruha Nichiro Group, Maruha Nichiro Logistics Inc., whose slogan is "From the world to the dining table", is in charge of low-temperature logistics. With 34 logistics centers focused in main trading ports around the country such as Tokyo, Osaka, Nagoya, and Fukuoka, they have built a network that spans all of Japan. They handle a wide variety of chilled and frozen foods such as seafood, livestock products, and agricultural products, providing the absolute best in freshness and quality in their safe, reassuring, authentic foods. In order to comply with the total phase-out of CFCs by 2020, they are currently engaged in efforts to renovate low-temperature refrigeration equipment in their main logistics centers across Japan.



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SHORT TAKES

— By Pilar Aleu, Elke Milner, Robert Davidson,
James Ranson and Michael Garry

How to Clean Small Condensers? It's In the Bag

"You've got to keep the condensers and evaporators clean and the fans operating," said Arthur Miller, director, Region 2 for the Refrigeration Service Engineers Society (RSES), in a workshop on the safe use of flammable hydrocarbons as a refrigerant at last month's AHR Expo.

But what's the best way to keep condensers in a self-contained bottle cooler or refrigerated merchandiser clean? A company named CoilPod LLC has come up with an eponymous product – in effect, a dust containment bag – that it believes can do the job, not only making hydrocarbon condensing units safer to operate, but substantially improving their energy efficiency while increasing their effectiveness and lifespan.

The concept is disarmingly simple: the patent-pending CoilPod bag – about 25 inches wide, 13 inches deep and 20 inches high – fits snugly over the typical condenser coil at the bottom of a plug-in merchandiser. The transparent bag has two strategic ports, one to let in compressed air that blows dust and debris off a clogged coil, and a second to vacuum it all out (both functions provided

by a standard wet/dry vacuum). The bag entraps the flying particulates – unlike current methods that are liable to leave a mess in the store.

The Professional Retail Store Maintenance Association (PRSM) designated CoilPod a "best practice" technology in 2014.

Its energy-saving potential was indicated in a study done by the Food Service Technology Center, San Ramon, Calif., which found that a six-year-old double-door merchandiser with a dirty condenser coil averaged \$1,325 in annual electricity usage (at 11 cents per kWh), while a clean coil cost \$700, a 47% savings.

The catch is that the CoilPod, which retails for \$67 at www.coilpod.com, needs to be used on a regular basis – at least every two-to-three months – to be effective. But standard operating procedure in the foodservice industry is to overlook condenser coils until they cause a problem. **"They're ignored by almost everybody,"** said Richard Fennelly, who handles marketing for CoilPod. **MG**

Walmart Using CO₂ in Buenos Aires Store

Walmart 
Save money. Live better.

Italian OEM Epta Refrigeration installed a new CO₂ transcritical refrigeration system at a Walmart store in Buenos Aires last September. The retail giant, which does not use transcritical systems in North America, hopes that the technology will reduce the store's annual energy bills by 21%.

Over the last five years Argentinian retailers have grown increasingly aware of the benefits of CO₂-based technology. **"We have talked with key supermarket chains about its energy efficiency and sustainability,"** said Germán Smitt, a director at Epta Argentina.

The project, which is the first of its kind in this region, features two packs, each comprising four compressors for medium and high temperatures and three compressors for low temperatures. The cooling capacity is 270 kW for medium-temperature cabinets and cool rooms.

To optimize energy savings in higher temperatures, the system uses parallel compression and sub-cooling systems. A special feature of this installation is its **"triple suction-line management"** with just one controller, said Nicola Pieretti, application specialist for Carel.

The uptake of CO₂ as a refrigerant in Latin America is still in its early stages. Brazil is one of the countries with the most installations so far (mainly cascade systems). **PA**

A dust containment bag for condenser coils.



Two More CO₂ Retrofits for Sobeys



The next stores that Sobeys will retrofit with a transcritical CO₂ system are in Oakville, Ontario, and Halifax, Nova Scotia.

The Canadian grocery giant, based in Stellarton, Nova Scotia, has made transcritical CO₂ its standard, not just for new stores but existing ones as well. ([See, "It Can Be Done," Accelerate America, November 2015.](#))

Each year, 15-20 stores – new and renovated, including franchises – are equipped with the systems. As of last September, 78 Sobeys stores in eight provinces used CO₂ transcritical booster systems with heat reclaim.

The two new retrofit projects, which are replacing aging R22 equipment, **"require a 100% replacement of the existing refrigeration: new cases, racks and piping,"** said Rod Petersen, Sobeys' national procurement manager (refrigeration & HVAC).

Based on experience, Sobeys believes the initial cost of a transcritical system, including all components (racks, cases, controls, etc.) is comparable to that of traditional DX systems. **"We also believe transcritical is more efficient than traditional DX with synthetics,"** said Petersen. ● EM

Walgreens Store Receives ASHRAE Technology Award



Walgreens' net-zero store in Evanston, Ill., has won the ASHRAE Technology Award in the commercial buildings category.

The award, presented at the ASHRAE 2016 Winter

Conference last month in Orlando, Fla., recognizes outstanding achievements by members who have successfully applied innovative building design and technological concepts, incorporating ASHRAE standards for effective energy management.

The store, which opened on November 21, 2013, uses CO₂ transcritical refrigeration for heating and cooling, and integrates a series of other energy-saving or green technologies, including:

- » Geo-exchange energy obtained by drilling 550 feet into the ground below the store;
- » 840 roof-mounted solar panels;
- » Two 35-foot-tall wind turbines;
- » LED lighting and daylight harvesting, and;
- » Energy-efficient building materials.

"The system has run very reliably for the first two years, and has met or exceeded our performance expectations," said Jason Robins, manager of HVAC/R programs at Walgreens. ● RD

DOE Posts Rule For Vending Machines

The U.S. Department of Energy last month released a final rule on energy efficiency standards for beverage vending machines (BVMs).

Compliance with the rule will be required for BVMs manufactured in, or imported into, the United States as of January 8, 2019.

Natural refrigerants are now used in BVMs, helping to improve their efficiency. In April 2015, the EPA listed propane (R290) as acceptable in BVM applications under its Significant New Alternatives Policy (SNAP) program. In addition, last year the Environmental Protection Agency banned use of R134a in vending machines as of Jan. 1, 2019.

The DOE said the selection of refrigerants CO₂ and R290 "was guided by visible trends within the BVM marketplace and feedback from

interested parties during public meetings, in written comments, and during manufacturer interviews".

Compared to previous standards, the DOE anticipates the new standards will save energy at a rate of 16% over a 30-year period. The cumulative reduction in CO₂-equivalent emissions through 2030 amounts to 1.16 Mt, which is equivalent to the emissions resulting from the annual electricity use of more than 160,000 homes.

The rule also includes clearer definitions of Class A and Class B vending machines and two new classes of combination machines. ● JR



NATREF GOALS FOR 2016

Food retailers who have installed natural refrigerant systems tell what they hope to accomplish this year

— By Michael Garry

Gary Cooper, director of refrigeration, Lowe's Markets, Littlefield, Texas, has led a one-store test of propane-based condensing units atop freezer cabinets. The units, cooled by a glycol loop, consume 25% less energy than condensing units using R407F.



We're still evaluating the R290 store, but energy consumption is still holding where we thought it would. I'm concentrating more on fine-tuning the [glycol] loop to maximize component life.



Harrison Horning, director of energy and facility services for the Hannaford Supermarkets division of Delhaize America, Scarborough, Maine, has overseen the installation of transcritical CO₂ systems at two stores, in Turner, Maine (2013) and North Berwick, Maine (2015).

I would say the biggest natural refrigerant goal for 2016 at Hannaford is to try and implement a transcritical CO₂ system in an existing store, as part of a planned renovation (aka, "remodel") project. We have an existing Hannaford store where the display cases and the entire central refrigeration system are at the end of their useful life. There is adequate space to install a new system while the existing system continues to run, so this store seems like a good candidate. With any luck we will have this project under construction by the end of 2016. This would be our first successful implementation of transcritical CO₂ in an existing store, and our third transcritical CO₂ system at Hannaford.

Tristram Coffin, sustainable facilities coordinator, Whole Foods Market, Austin, Texas, has spearheaded the natural foods retailer's pilot installations of a variety of natural refrigerant system, including transcritical CO₂, secondary/cascade CO₂, ammonia-CO₂, and propane self-contained systems.



We have set new goals for the year that will further our adoption of natural refrigerants. The focus in 2016 is all about data collection on the current variations of natural systems employed to date along with the implementation of two new natural system configurations, including most excitingly a hydro-carbon system. This will complete our fleet of what we believe to be the natural systems currently available to the market. From there it's all eyes on the numbers as we continue to cross-examine performance data into 2017-2018.



John DeCicco, Jr., president of DeCicco & Sons, a six-store grocery operation based in Pelham, N.Y., opened his first store with a transcritical CO₂ system in Larchmont, N.Y., in December 2015.

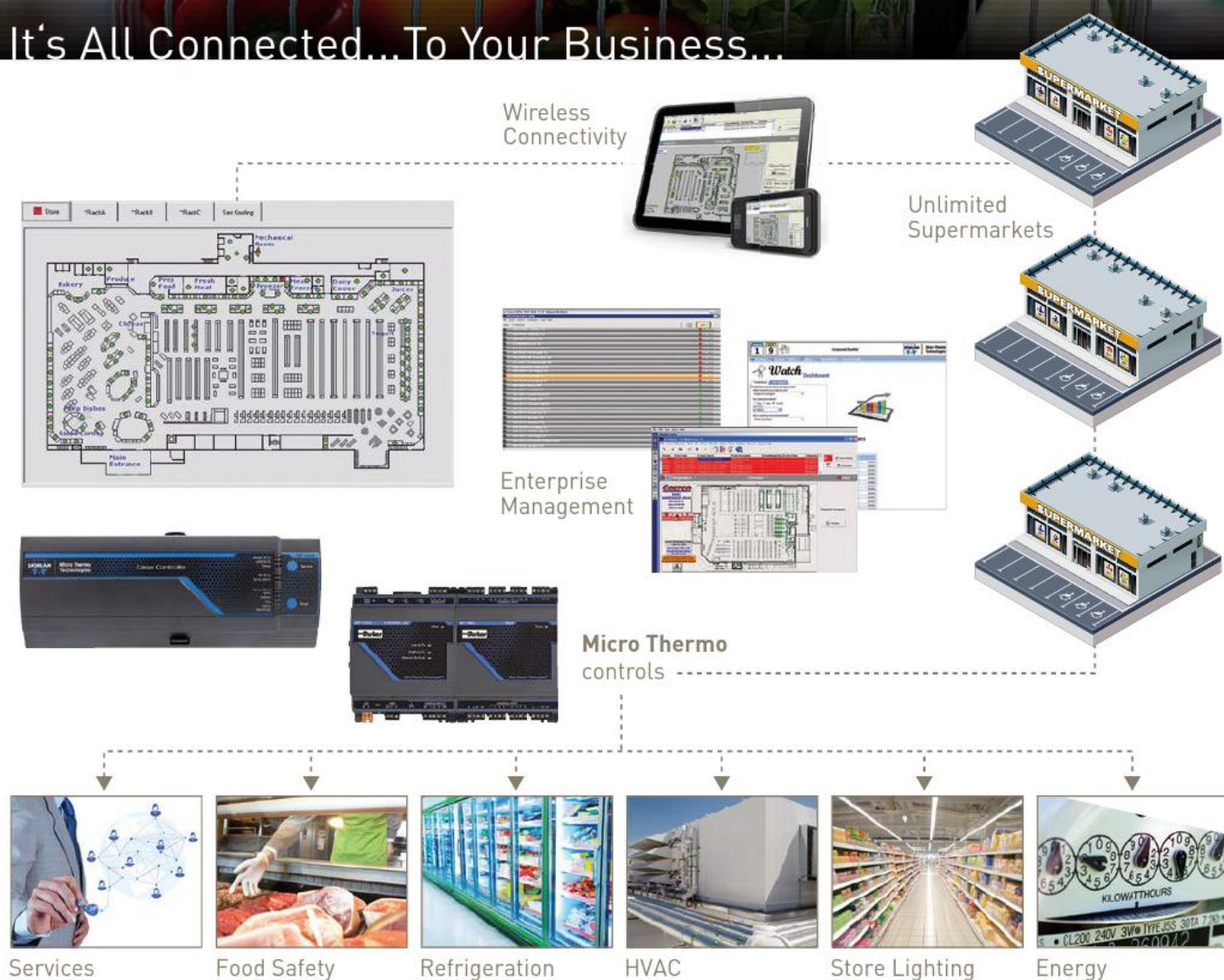
So far so good. I am very happy with the CO₂ system. The temperature control, strength of the cold, and product longevity are unmatched compared to any other refrigerant. The efficiency of the system -- in terms of the reduced electrical load and the quality and quantity of the waste heat -- is a great asset to help reduce the store's overall energy use. I plan on installing this system in both a new store we will be building in Somers, N.Y., as well as converting the system in our Pelham, N.Y., location from R22 to CO₂.

Ken Welter, manager of refrigeration and design, Mid-Atlantic, Baltic Trail Engineering (Ahold USA's refrigeration service provider), has worked on the design and installation of Ahold USA's first transcritical CO₂ pilot at a store in Springfield, Va., that opened in June 2015.



This trial project promised to be both a learning experience and a demonstration of the way forward to reach the "end game" in refrigeration design for the Ahold stores. To date, this project has delivered on its first promise. My goal for 2016 is to complete my evaluation of the total cost of ownership of a transcritical CO₂ system (in terms of first cost, energy and maintenance) to see if this project can deliver on its second promise.

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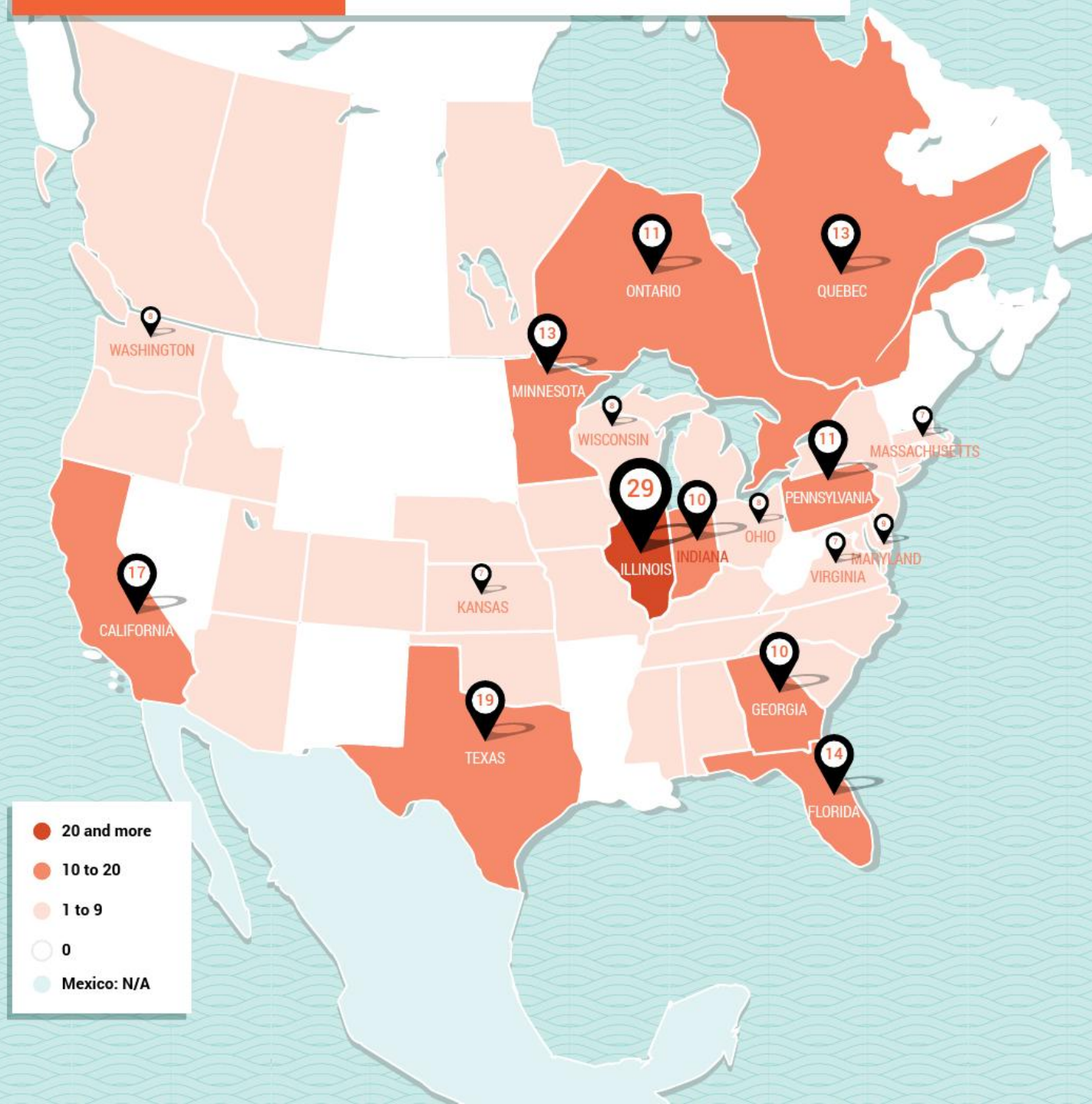
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COMPANIES SUPPLYING
NATURAL REFRIGERANT
PRODUCTS AND SERVICES
IN THE U.S. AND CANADA

* DATA AS OF FEB. 2016

THE NATURAL REFRIGERANTS MARKETPLACE

In the U.S. and Canada, the natural refrigerants industry continues to grow, providing a robust market for end users. This map shows the key areas where supply-side companies – component makers, OEMs, refrigerant suppliers, contractors, trainers etc. – are concentrated, including numerous double-digit hubs of activity.



The clear path to a smaller carbon footprint.



Emerson offers a future-proof solution through CO₂ technologies

Commercial refrigeration users throughout the world are moving towards phasing out harmful refrigerants and are looking for alternatives. Emerson CO₂ technology leads the trend to efficiency. This refrigerant's non-ozone depleting, non-flammable and near-zero global warming potential properties create an ideal solution towards reducing your environmental footprint.

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A portrait of Kendall Allen, a man with short brown hair and a light beard, smiling. He is wearing a dark blue polo shirt. The background is a textured, light-colored wall with a large, dark, triangular shape on the left side.

Kendall Allen

THE REBIRTH OF NATURAL REFRIGERANTS

Technology advances – like 5mm coil tubing in evaporators and condensers – are overcoming the challenges hydrocarbons and CO₂ faced 85 years ago.

– By Kendall Allen

I believe that everyone in the HVAC&R industry knows there is a worldwide effort to move refrigeration working fluids towards zero ozone depleting potential (ODP) and near-zero global warming potential (GWP). While the traditional chemical industry works to come up with solutions to these requirements, part of the market has been quietly working with natural refrigerants as a viable solution.

Ironically, the most readily used refrigerants prior to the 1930's were the natural refrigerants carbon dioxide, ammonia and hydrocarbons. But due to the limitations of technology at that time, the challenges associated with natural refrigerants – the flammability of hydrocarbons, the higher pressures of CO₂ and the toxicity of ammonia – could not be overcome. So the chemical industry came up with high-ODP and high-GWP chlorinated fluorocarbon refrigerants to take their place.

But vast advances in refrigeration technology over the past few decades have brought natural refrigerants back into the commer-

cial and residential mainstream. In this article, I will show how one of those technologies – 5mm coil tubing – supports the use of hydrocarbons and CO₂.

Within boundaries, 5mm tubing can be adapted to many uses, such as a condenser, evaporator, gas cooler, oil cooler, or even a small water coil. Attention to pressure drop across the coil must always be considered, but this is no different from any coil design.

The 5mm coil designs can work well as an alternative to microchannel coils by offering several advantages, such as being easily brazed/repaired, allowing complex circuitry more easily on round copper tube coils, and offering alternative fin materials, such as aluminum, copper, corrosion-resistant coated aluminum, and even entirely E-Coated for extreme corrosion protection.

“One way to limit the quantity of refrigerant required in a system is to use smaller tube coils in evaporators and condensers.”

SAFETY CONSIDERATIONS

When you mention “higher pressures” or “flammability,” the first response is often “is it safe?” Safety is not an absolute measurement, but rather based on an assessment of a situation within certain limits. Some of today’s HFCs can be flammable, but only at very high temperatures. I recall that when R410a came out in the market, the “high pressure” was a huge concern among service technicians. Many people balked at the pressure as being unsafe, and refused to deal with it (for a time anyway). Fifteen years later, I doubt that concern is mentioned much anymore.

We need to consider safety for sure, but education and preparation – even prior to the design phase – are the keys to achieving it. How do we prepare to make these systems safe?

To make propane generally safe, one must consider the space that the refrigerant could leak into, and the final mixture with air that will result. In most cases, quantities within a refrigeration device are limited to just 150 grams (5.3 ounces). Thus, it behooves the system designer to come up with a design that reduces the refrigerant charge to that low level. One way to limit the quantity of refrigerant required in a system is to use 5mm tube coils in evaporators and condensers.

In fact, by keeping the charge low, 5mm coils offer the potential to use hydrocarbons in larger appliances like air conditioners.

When I started in the HVAC&R industry, R12, R22, and R502 ruled the space in the technician’s truck. These refrigerants operated at low to moderate pressures. If you had an R22 HVAC system operating at 500 psi, something had really gone wrong. Now we are used to R410a, its higher operating pressures, and the new set of gauges that go with it.

When talking about the design of pressure-boundary materials, higher working pressure generally requires a thicker tube wall. However, making coils out of smaller diameter tubes can help handle higher pressures while keeping metal weight in check and cutting costs.

The smaller a tube’s diameter, the thinner the wall material you can use for the same pressure applications. For instance, a 5mm tube rated for 700 psi can be 0.0082-inch thin, while a 3/8-inch tube rated for 700 psi needs to be 0.0134-inch thick. This means that 5mm copper-tube coils can be designed for CO₂ gas coolers, with operating pressures upwards of 140 bar (2030 psi).

By the way, all of the refrigerants that we are discussing are heavier than air and displace oxygen. This means that when working in an enclosed space or below grade (ground level), you should understand the risk that a large leak can pose. Smaller charges could mean a reduced risk, but remember that it depends upon the size of the space in which you are operating.

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→ BOOSTING EFFICIENCY

There is much to energy efficiency (that is, coefficient of performance, or COP) that depends on the complete design of the system, including the choice of working fluids and the design of the system.

The impact of refrigerant selection is evident in a study by MTL Cool, a Canadian manufacturer of point-of-purchase display systems. The company designed a new refrigerated point-of-purchase display system, the NRC2, using both a 5mm condenser and 5mm evaporator. R134a was used as the benchmark for performance. Two different hydrocarbons were used in the test: R290 (propane) and R441a (an ethane, butane, propane, isobutane blend).

With an ambient temperature of 75°F, a relative humidity of 45%, and a final interior temperature of 38°F the test found the following energy results: R134a (10.5 ounce charge): 443 watts; R290 (4.95 ounces): 424 watts; and R441A (4.1 ounces): 351 watts. The combination of smaller-diameter tubes and the hydrocarbon refrigerant delivered promising results.

Efficiency can also be enhanced by physical design changes. From an evaporator or condenser coil design standpoint, COP is traditionally improved by increasing the coil surface area; this is done by making the coil face larger and reducing the number of rows. But with a 5mm-tube coil, COP can go up without the need to increase the surface area. That's because the 5mm tube design minimizes tube presentation to airflow, reducing static air pressure, while increasing the surface-to-volume ratio of the refrigerant.



“ We already possess many of the tools, knowledge, and products to make natural refrigerants work.”

These two factors work together to increase COP.

Reduction of compressor power can be realized via lower condensing temperature or higher evaporator temperature. Key factors determining condensing temperature include coil design and the air temperature flowing over the condenser.

In contrast to a more traditional 3/8-inch (9.52mm) or even a 7mm tube, a 5mm-tube design offers the ability to stack more tubes into an area, potentially reducing the condensing temperature of the system.

The smaller diameter tubes – and the reduced spacing between them – create the 5mm coil's advantage over larger tubes: improved heat transfer coefficients due to increased efficiency on the extended (fin) surface, and reduced boundary layer thickness on the outside of the tube.

In the end, we find ourselves able to seriously consider this “old” set of refrigerants in our current market, as hydrocarbons and CO₂ offer opportunities that synthetic refrigerants don't. Used properly and with good design, these alternative refrigerants can be safe, energy efficient, and ecologically sound. We already possess many of the tools, knowledge, and products to make them work. ● KA

Kendall Allen works as a sales application engineer for Super Radiator Coils in Richmond, Va. He holds seven U.S. patents, as well as four in Canada, one in Mexico, and one in Europe, on HVAC&R related equipment and designs. He has been involved in HVAC&R for more than 22 years as a systems engineer, a research and design engineer, a component engineer, and an installation technician.



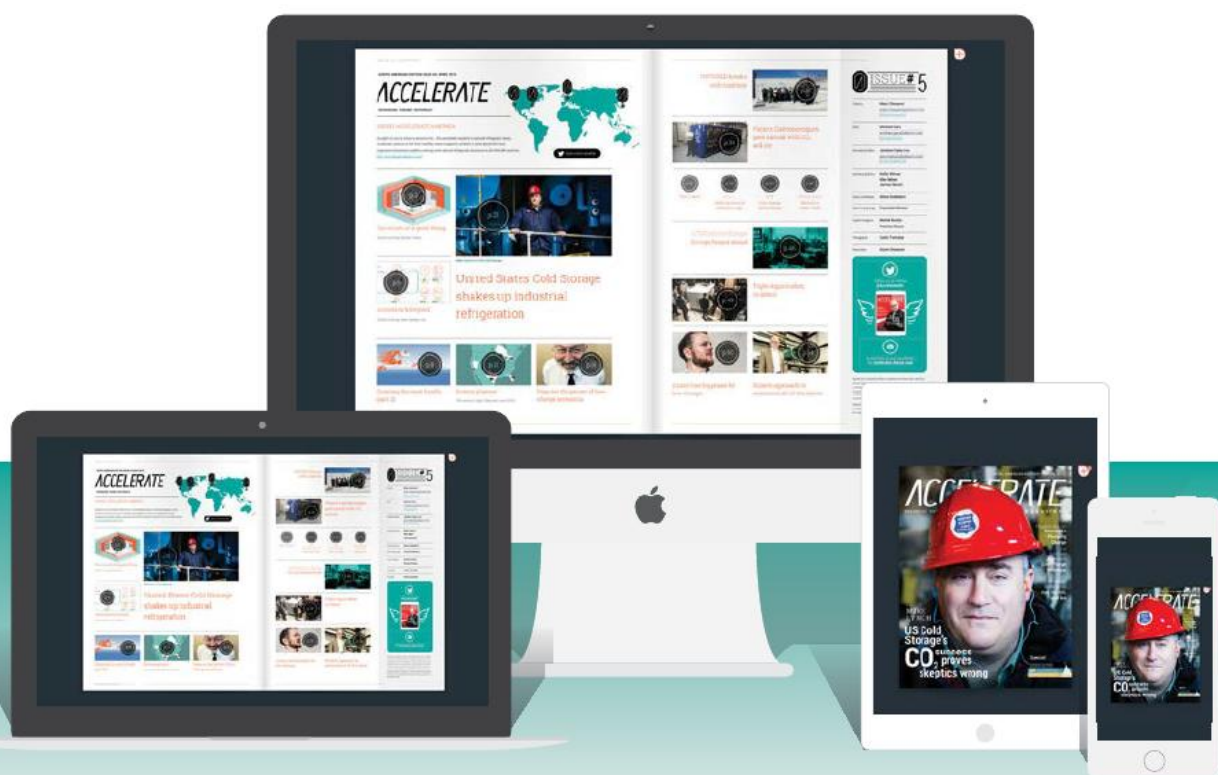
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DEALING WITH THE DOUBLE WHAMMY

With two major regulatory hits on the horizon, the foodservice industry is starting to ramp up demand for natural refrigerant systems – particularly those with hydrocarbons – that cut energy consumption and GWP

– By Michael Garry

Over the next four years, two major federal regulations are converging in the U.S. marketplace with the predictability and force of a hurricane to challenge manufacturers of refrigeration and HVAC equipment, as well as technicians and end users.

Those are the Department of Energy's demanding efficiency requirements for foodservice equipment that take effect next year (pending the outcome of litigation; see story, page 30), and the Environmental Protection Agency's SNAP delisting of high-GWP HFC refrigerants used in that equipment that will be phased in over the next four years, again, barring successful legal challenges. (For more details on these regulations, see page 28.)

The effect of the regulations has been "a tremendous drive for change in the marketplace," said Doug Schmidt, commercial sales manager, North America Region, for Brazilian compressor maker Embraco.

This change is generating heightened interest in natural refrigerants – which address both regulations with high efficiency and extremely low GWP – especially hydrocarbons like propane (R290) and isobutane (R600a), and to a lesser degree CO₂.

"Equipment designers see that they've got to change refrigerants to meet the energy guidance," said Schmidt. "That's pulling in hydrocarbons ahead of the EPA [delisting] regulations. Some people are still using HFCs but the leaders are jumping forward."

Arthur Miller, director, Region 2 for the Refrigeration Service Engineers Society (RSES) and a longtime instructor with experience as a refrigeration technician, agreed that there's a significant movement to hydrocarbons in the U.S. "It's mostly commercial now, but domestic applications will happen."

Because of their status as an ASHRAE-rated flammable (A3) refrigerant, until 2011 the EPA had confined hydrocarbons to industrial process refrigeration, where there is limited public access. However, given hydrocarbons' safe and widespread use as a commercial refrigerant in Europe, the EPA has gradually expanded their allowable use in commercial and residential refrigeration.





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LIGHT COMMERCIAL UNITS USING NATURAL REFRIGERANTS

→ In 2011, the EPA approved R290 for commercial food refrigeration, and R600a and R441A (a hydrocarbon blend that is waiting for compressor companies to certify its use in their machines with UL or ETL) for domestic refrigeration. Last year, the agency expanded the regulations, allowing R290 in domestic refrigeration and R600a and R441A in commercial refrigeration. (The EPA has yet to approve hydrocarbons for ice makers or water coolers.)

The charge limits for commercial and domestic applications, in line with UL standards, were set at 150g and 56g, respectively. But there has been widespread interest among food retail and food-service end users and OEMs in increasing the allowable hydrocarbon charge in order to expand the range of equipment in which it can be used. This month, U.K. firm Carter Retail Equipment submitted an application to the US Environmental Protection Agency to increase the maximum charge of propane permitted in food/commercial retail refrigeration standalone equipment to 1kg from 150g. (See story, page 31.)

While training is regarded as a major challenge for natural refrigerant systems, it's not as much of a concern for light commercial equipment using hydrocarbons or CO₂. That's because many of the units are self-contained and come with modular condensing units that can be swapped out for fresh models and shipped out for repair; in addition, training for natural refrigerant systems in foodservice is not as daunting, as it is based on knowledge of conventional systems.

Still, the flammability of hydrocarbons makes training a critical safety issue for technicians. (See story, page 26.) Red Bull has in the past 1.5 years mandated and provided specialized training on end of life and repair of its R600a ECO-Coolers for all technicians handling the equipment.

DRAMATIC GROWTH SINCE 2013

According to the *Guide to Natural Refrigerants in North America*, published by shecco (publisher of *Accelerate America*) in September 2015, the number of number of foodservice (light commercial) refrigeration units using natural refrigerants in North America, which stood at around 5,000 in 2013, shot up to 291,036 in 2015. Of that total, 82% are hydrocarbon units, while the rest use CO₂.

Mexico leads the field with 188,371 units, compared to the U.S.'s 94,493 and Canada's 8,172. Hydrocarbons make up 85% of the units in Mexico, whose warmer climate favors hydrocarbons over CO₂.

So far, large multinational consumer brands, including McDonald's, Red Bull and Starbucks, have been the key drivers for the uptake of natural refrigerants, particularly hydrocarbons, in light commercial refrigeration equipment like beverage coolers, upright freezers and vending machines. Coca-Cola has been the exception, pursuing the CO₂ route for its coolers and vending machines. (See ["Coke's Convinced That CO₂ Is the 'Right Bet,'" Accelerate America, July/August 2015](#)).

On the manufacturing side, there are also signs of interest in natural refrigerants. Out of the 550 companies that are members of the North American Association of Food Equipment Manufacturers (NAFEM), about 150 use refrigerants in their



CANADA

8,172

4,375

CO₂

3,797

HC



U.S.

94,493

17,493

CO₂

77,000

HC



MEXICO

188,371

29,064

CO₂

159,307

HC



CASE STUDY:

THE IMPACT OF A VARIABLE-SPEED COMPRESSOR WITH R290 IN A VERTICAL FREEZER

COMPRESSOR	refrigerant	GWP	L	n	m	α	E	β	TEWI
FIXED SPEED	R507A	3,300	0.003	10	0.420	0.90	5,047.5	0.171	8,868.8
FIXED SPEED	R290	3	0.003	10	0.1	0.90	3,607.3	0.171	6,168.6
VARIABLE SPEED	R290	3	0.003	10	0.110	0.90	3,153.9	0.171	5,393.3

The environmental impact (TEWI) of the equipment using a compressor with a variable-speed compressor and R290 is **40% lower** than the equipment with R507A and a fixed-speed compressor.

Total Equivalent Warming Impact (TEWI) equals the sum of direct and indirect emissions

Direct effects:

- L – leakage rate (kg/year)
- n – Life time (years)
- m – refrigerant charge (kg)
- α – recycling factor (%)

Indirect effects:

- E – Energy consumption (kWh/year)
- β – Emission from energy generation (kgCO₂/kWh)

Source: Embraco

products, noted Charlie Souhrada, director of member services for NAFEM. Asked whether natural refrigerants could help NAFEM member companies meet the DOE and EPA requirements, he commented that “you can’t suggest that a couple of solutions are fine” in an industry as diverse as the food service equipment industry. Natural refrigerants like CO₂ and propane, he added, “could be appropriate,” but NAFEM has not polled its members to determine how many have tested these refrigerants.

However, at last year’s biennial NAFEM Show held in Anaheim, Calif., a number of equipment companies showcased hydrocarbon refrigeration, notably OEM True Manufacturing, which featured signs at its booth declaring, “Hydrocarbon Refrigerant: The Future, Now.” Other companies in this category included Fogel, Traulsen, Beverage-Air, and Manitowoc. ([See “NAFEM’s Coming Out Party for Hydrocarbons,” *Accelerate America*, March 2015](#)).

True also declared its commitment to hydrocarbons at a White House-sponsored, private-sector meeting last September. The company stated that as of September 2014, it pledged to use only low-GWP refrigerants in all future refrigeration development, and to develop low-GWP replacements for its existing products over the next five years. To that end, True expected that 24 hydrocarbon models would be available by the end of 2015 in its foodservice product line.

Industry groups have also been playing an important role in promoting the use of natural refrigerants in foodservice applications. For example, Refrigerants, Naturally!, a global, nonprofit consortium of companies in the food and drink, food service and consumer goods sectors, works to promote a shift in point-of-sale cooling technology towards natural refrigerants, including hydrocarbons and CO₂. Its current membership comprises PepsiCo, Red Bull, The Coca-Cola Company, SABMiller and Unilever.

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ACHIEVING EFFICIENCY VIA PROPANE

In a presentation at the AHR Expo last month, John Prall, technical support, North America region for Brazilian compressor manufacturer Embraco, explained with three case studies how propane (R290), working in concert with a variable-speed compressor like Embraco’s Fullmotion unit, can help considerably in meeting the 2017 Department of Energy efficiency standards.

In the first example, he compared a six-speed compressor with a variable-speed compressor, each using R134A to refrigerate a beverage cooler. The variable-speed compressor used 25% less energy, saving \$682 over five years, and cut the pull-down time in half.

In a vertical freezer study, a fixed-speed compressor with R507A, a fixed-speed compressor with R290, and a variable-speed compressor with R290 were compared. The combination of R290 and the variable-speed compressor consumed 38% less energy than the fixed-speed compressor with R507A, saving \$1,260 over five years. The R290/fixed-speed compressor consumed 29% less than the R404A/fixed-speed compressor.

In an analysis of the TEWI (total equivalent warming impact) of the three systems in the vertical freezer study, the R290/variable-speed compressor system showed a 40% lower overall environmental impact than the R507A and a fixed-speed compressor. TEWI includes the GWP of the refrigerants and their leak rates (direct emissions) as well as the energy consumption of the system (indirect emissions).

In the third study, a fixed-speed compressor with R290 was compared with a variable-speed compressor with R290, both in a bottle cooler. The latter consumed 12% less energy than the former, while cutting cool-down time by 1.5 hours.

Prall’s last slide summed up the results of the studies: “Natural refrigerants are the best choice for the world.”

TUTORING TECHS ON HYDROCARBON SAFETY

The EPA doesn't require technicians to be certified to work with hydrocarbons (as it does for fluorinated refrigerants), but the agency does "recommend" that they get training on the flammable (A3) refrigerants, noted Arthur Miller, director, Region 2 for the Refrigeration Service Engineers Society (RSES). "You need to know what you're up against."

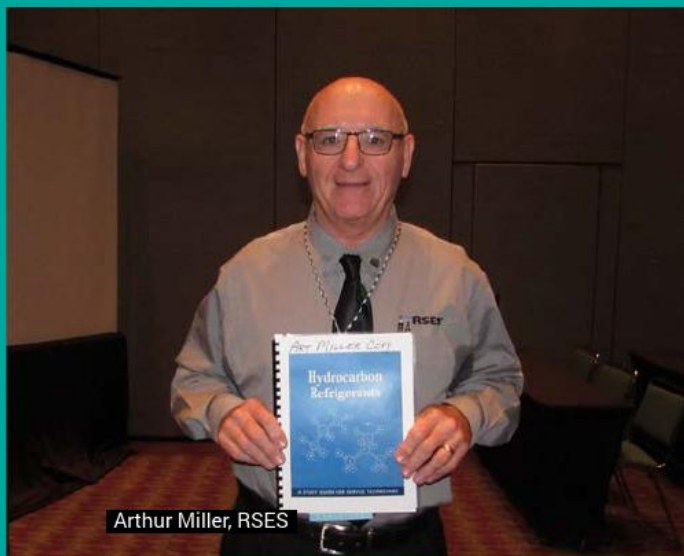
To that end, Miller, using a folksy delivery honed across decades of teaching, provided a close-to-three-hour training session on hydrocarbon safety practices to a sizable group of refrigeration technicians last month at the AHR Expo in Orlando, Fla.

RSES offers online training in hydrocarbon safety practices at <http://www.rselearning.org>, and a certificate upon the successful completion of the class.

While experience in Europe and elsewhere has shown that hydrocarbons can be used safely as a refrigerant in commercial and domestic applications, they can be quite flammable under certain conditions, which Miller spelled out in his AHR Expo class.

He listed the following causes of hydrocarbon fires or explosions:

1. A lack of awareness of the properties of flammable fluids
2. Lack of training.
3. Poor installation and maintenance. "You've got to keep the condensers and evaporators clean and the fans operating."
4. Exposure to heat, as from a radiator.
5. Inadequate control of ignition sources. Hot surfaces and electrical arcs are the principal potential ignition sources for HVAC&R appliances, according to UL (Underwriters Laboratories).
6. Electrostatic discharges. Miller suggested using a "banding strap to ground yourself."
7. Heating refrigerants above their auto-ignition temperature.
8. Improper disposal of equipment and refrigerant.
9. Improperly moving equipment from storage.
10. Improperly dispensing hydrocarbons from a container (using leaky hoses, for example).
11. Improperly charging or evacuating a system.
12. Improperly dealing with spillage.



Arthur Miller, RSES



"Refrigerants, Naturally! sees 2016 as a promising year for further progress on the accelerated transition to natural refrigerants for point-of-sale and light commercial equipment," the group said, in a statement.

Last month, the Consumer Goods Forum (CGF), a Paris-based global consortium of more than 400 retailers and manufacturers, published its first "Refrigeration" booklet, a collection of case studies showing steps that its members have taken to reduce HFC usage by deploying natural refrigerant-based systems.

Many CGF members signed a resolution in 2010 to begin replacing HFC refrigerants no later than 2015. "I am happy with the progress we've made," said Ignacio Gavilan, CGF's director, environmental sustainability. "Our members have replaced systems in over 4,000 supermarkets, 4 million ice cream and drink chiller units, and industrial plants worldwide, with the majority [of the replacements] being natural refrigerants."

The group plans to develop "next steps to strengthen our commitment beyond the original resolution to develop the next phase of the refrigeration market's transformation," said Gavilan.

CGF MEMBERS TOUT NATREF PROGRESS

The following are examples taken from the CGF's Refrigeration booklet.

PepsiCo uses hydrocarbon refrigerants in its point-of-sale equipment (coolers, vending machines and fountain dispensers) in furtherance of its goal to purchase only non-HFC equipment in the U.S. by 2020. The company announced that goal in September 2014 at a White House meeting attended by numerous private-sector companies. PepsiCo has also joined a private-sector initiative led by the Obama Administration to reduce cumulative global consumption of HFCs by the equivalent of 700 million metric tons of carbon dioxide through 2025.

Unilever, owners of Vermont-based Ben & Jerry's ice cream, since 2004 has been replacing point-of-sale ice cream freezer cabinets with environmentally friendly equipment that uses hydrocarbons (propane and isobutene), which it says are about 10% more energy efficient.

continued on p.28



POWERFUL THINGS ARE POWERED BY NATURE.

TRY A **COOLING SOLUTION** WITH A **NATURAL REFRIGERANT.**

Besides of having **no impacts on the environment**, natural refrigerants such as R600a and R290 have an important role on the reduction of the equipment's **energy consumption**, which means that it solves both direct and indirect emissions at once.

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Know more about natural refrigerants at:
www.naturalrefrigerants.info

embraco POWER **IN.**
CHANGE **ON.**

Combining the effects of HCs and other energy efficiency measures, “our newly purchased cabinets have an average energy reduction of over 30% compared to 2008 models,” said Unilever, which has nearly 2 million point-of-sale freezer models globally. “We have been working with our suppliers and contractors to ensure all safety aspects in design and service are incorporated in the HC implementation.”

Heineken has developed the iCool fridge, which is 70% more energy efficient than related beverage coolers used in 2010. It has established four green criteria for driving higher efficiency in its coolers: replacing HFCs with hydrocarbon refrigerants; replacing standard lighting with LED illumination; introducing an energy-management system; and installing energy-efficient fans.

In 2014, when Heineken purchased 152,000 fridges, almost all met one or more of its green criteria, and two-thirds were compliant with all four.

Nestle, as of 2015, stipulated that all of its new ice cream freezers worldwide will use natural refrigerants. By the end of 2014, all of the company’s new ice cream freezers in Europe already used natrefs. The new ice cream units, which represent 70% of Nestle’s investment in freezers, consume 50% less energy than previous models.

SABMiller, which last year joined Refrigerants, Naturally!, is committed to purchasing 100% HFC-free store fridges by 2020 for its bottled beer. It started the process in Europe, purchasing about 8,000 new propane fridges for its Polish retail network, and then scaling up that strategy. Last year, up to 85% of new fridges purchased in Europe were HFC-free.

All of SABMiller’s pilots have confirmed the viability of natural refrigerants if the required technical expertise and maintenance capacity are available. “We work closely with suppliers in this regard,” the company said.

SABMiller has also developed user-friendly guides and training tools for its sales representatives and retailers to guide them on the safe and sustainable operation of the fridges. “Useful tips on the placement, condition and operation of the fridges ensure optimal cooling of the beer, and energy and cost savings for the retailer,” said SABMiller.

Coca-Cola, which was instrumental in securing an HFC-free commitment from CGF’s full membership in 2010, has invested over \$100 million over the past decade in environmentally friendly beverage coolers.

Currently, of the 1.7 million HFC-free units Coke has in the global marketplace, about 40% are CO₂-based; Coke has stated its preference for CO₂ rather than hydrocarbons as an HFC replacement.

Last year, Coke placed about 300,000 units of HFC-free equipment worldwide, approximately 40% of its total new equipment purchases. “Our HFC-free new equipment purchases are going up each year as we work toward our 100% goal,” said the company.

Energy efficiency is also a part of Coke’s cooler strategy. “We have certified 260 cooler models as meeting our performance standards,” the company said. “More than three-quarters of these certified models are more energy efficient than legacy models, and 60% have higher cooling capacity. Nearly 40% are certified to perform in hot or humid conditions.”

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KEY ELEMENTS OF THE REGULATORY CHANGES

- » Barring successful legal action taken by the HVAC&R industry, as of March 2017 the U.S. Department of Energy plans to institute stricter efficiency standards for commercial refrigeration equipment. These would call for an energy reduction of between 30% and 50% in kWh/day for closed-door reach-ins (self-contained) and for other display cases (including remote). Efficiency standards for walk-in food-service coolers and freezers are being renegotiated.
- » As of Jan. 1, 2020, several high-GWP refrigerants, including R134a, R404A, R407A and R507A, will be unacceptable for new standalone low-temperature and commercial equipment, per the EPA. The refrigerants will be unacceptable for medium temperature units as of Jan. 1, 2020, if the unit uses a compressor with a capacity of 2,200 BTU/hr or more and contains a flooded evaporator; if the medium-temperature unit lacks those features, the delisting starts Jan. 1, 2019.

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INDUSTRY CHALLENGES DOE

Last September NAFEM and the Air-Conditioning, Heating and Refrigeration Institute (AHRI) filed suit against the U.S. Department of Energy in the U.S. Court of Appeals for the Seventh Circuit in Chicago, asking that the court remand its efficiency standards rule for commercial refrigeration equipment to the DOE "so the DOE can fix it," said Charlie Souhrada, director of member services for NAFEM.

In addition, "we would like a working group [including manufacturers] to negotiate the types of products defined in the [rule] and how best to handle them." The DOE has separately been negotiating with the industry on new efficiency standards for walk-in coolers and freezers.

The outcome of the case was still pending at press time.

NAFEM believes the 2017 deadline for efficiency changes is unrealistic "given that the DOE refers to certain types of components that are not available today or don't exist," said Souhrada.

NAFEM also objects to the DOE's decision to base its 2017 efficiency rule on refrigerants R134a and R404A, which the EPA is delisting as of 2019 and 2020 in new standalone equipment.

"Our members are facing the challenge of balancing energy efficiency requirements and environmental requirements," said Souhrada. "Some are meeting the challenge well and some are having a difficult time." The DOE and EPA, he added, "need to coordinate their efforts more closely."

AHRI
Air-Conditioning, Heating,
and Refrigeration Institute

NAFEM
North American Association of
Food Equipment Manufacturers

COMPONENT MAKERS SUPPORT HCS

The interest in components for hydrocarbon refrigeration systems was much in evidence at the AHR Expo last month.

"Oh my gosh, yes," said Brian Porter, corporate director of sales for Blissfield Manufacturing, when asked at his AHR Expo booth whether he's getting more requests from beverage cooler OEMs for Blissfield's 5mm propane evaporator/condenser coils made of copper-aluminum alloy.

This year he expects a 50% jump in requests, though Blissfield looks for orders that are large enough to justify full-container load shipments from its Chinese suppliers.

Blissfield makes evaporator/condenser coils for CO₂ systems as well as propane systems, though the latter is by far the majority choice in the beverage cooler and vending machine business, Porter said.

Most of the requests for natural refrigerant systems are from larger companies, Porter added. "The smaller companies are lagging behind."

Embraco introduced three new hydrocarbon products for the North America market at the AHR Expo. (See story, Page 50.) Engineers, OEMs and end users are in "a high degree of testing and investigation" of hydrocarbon foodservice units, said Schmidt, Embraco's commercial sales manager. As a result, he expects "at least 10%" of Embraco's North American market to move to hydrocarbons this year. End users of the equipment range from quick-service restaurants and family restaurant chains to schools and hospitals.

Currently, Embraco's biggest market for hydrocarbon compressors is Europe, with at least one million units. Mexico is the largest market in North America with "hundreds of thousands" of units, while the U.S. has "tens of thousands."

Schmidt believes that a service infrastructure for hydrocarbon refrigeration equipment is "coming fast."

In regard to the flammability of propane, Michel Moreira, Embraco's global product manager for commercial refrigeration, said that in the last year, following training and webinars aimed at Embraco's OEM customers, there has been a "huge improvement in understanding of the impact of natural refrigerants and an acceptance of propane." Sharing its positive experience with hydrocarbons in Europe has helped Embraco build confidence in the U.S., he added.

The 150g charge maximum for propane has not been an issue for light commercial equipment in Europe, said Moreira. Where a larger compressor using more than 150g is required, multiple smaller compressors can be used cost competitively, he said. Still, Embraco is working to expand the hydrocarbon charge limit from 150g to 1kg, leading a committee on the IEC (International Electrotechnical Commission).

Compressor maker Tecumseh sees the OEM marketplace for its compressors divided into two camps, one that embraces hydrocarbons and one that avoids them. The first group "likes the efficiency R290 gives them and are concerned about SNAP and DOE regulations," said Anthony Carstensen, Tecumseh's director of product marketing, North America. "There's no reluctance about flammability."

The other camp "doesn't want to deal with that uncertainty or the cost of updating their manufacturing line," said Carstensen.

The U.S. government, he added, is not clear about what manufacturers using hydrocarbon equipment need to have in place in their plants to prevent leaks and ensure ventilation. "The rules are still evolving."

Semi plug-in hydrocarbon condensing units, connected to a water loop to cool off the condensers, "seems to be gaining traction in the U.S.; we're getting a lot of inquiries" said Jim Knudsen, food retail North American segment manager for Danfoss, at the company's AHR Expo booth. "It gives small, non-traditional retailers an opportunity to get into natural refrigerants without a big CO₂ system."

Companies from outside the U.S. are sensing the opportunity to sell propane wares in the United States. For example, Kulthorn, a Thai manufacturer of compressors, has marketed R290 (propane) compressors for a number of years in Europe, and is now bringing them to the U.S. via its exclusive U.S. distributor, San Diego-based Elco.

In the near future, Elco will also be distributing the Thermocraft R290 condensing unit, which includes a Kulthorn compressor.

"There is a demand for R290 compressors in the U.S.," said Dean Rafiee, director of market development for Thermocraft, at Elco's AHR Expo booth. "Many OEMs are testing R290 compressors in the 1/5 to 1.5 HP range."

A chart displayed at the Elco booth demonstrated the superior efficiency of R290 compressors vs. R134a compressors in beverage coolers. For example, in a beverage cooler with between 950 and 1,100 watts of cooling, the COP (coefficient of performance) of the R290 compressor is listed as 2.0 to 2.2, while the COP of the R134a compressor is listed as 1.65 to 1.70

One more reason to use hydrocarbons.

MG

Doug Schmidt, Embraco

CARTER APPLIES TO EPA TO RAISE CAP ON PROPANE

In a move long and eagerly awaited in the food retail and food service sectors, U.K. OEM Carter Retail Equipment earlier this month submitted an application to the US Environmental Protection Agency's SNAP (Significant New Alternatives Policy) program to increase to 1kg from 150g the maximum charge of propane refrigerant permitted in food/commercial retail refrigeration standalone equipment.

Carter also separately applied to have the hydrocarbon R1270 (propene, also called propylene) accepted under SNAP for food/commercial retail refrigeration standalone equipment; if R1270 is accepted, Carter asked that the EPA allow up to 1kg as the maximum charge size; R1270 is currently only recognized for industrial applications.

In the U.K. Carter's hydrocarbon cases are widely used by the Waitrose supermarket chain throughout stores that average 35,000 square feet. Waitrose's cases contain between 300g and 1,000g of R1270, in concert with an R290-chilled water loop that removes 80% of the condensing heat from the cases. R1270 can also be used in air-cooled plug-in cases.

In a three-year study Carter did at a Tesco store in Thailand comparing its R1270 cases to an HFC DX system, the cases experienced a 60% drop in maintenance, a 90% reduction in charge and an 8% decrease in energy consumption.

Carter's SNAP application follows the rationale of international standards and reflect "all the safety and compliance we've done working with A3 [flammable] refrigerants," said Geoff Amos, Carter's head of sales and marketing.

Even with SNAP approval, Carter will need to change the 150g charge maximum set by UL (Underwriters Laboratories) and ASHRAE – what Amos called "the next piece of the puzzle." He acknowledged that city and state building codes could also represent a hurdle for end users that want to use systems with larger hydrocarbon charges until the UL and ASHRAE standards are revised.

Carter is also looking for test stores in "various U.S. climates" to pilot higher-charge hydrocarbon equipment. Amos sees potential for his cases in the U.S. market, especially given their low maintenance requirements.

There has been widespread interest among food retail and food service end users and OEMs to increase the allowable hydrocarbon charge in order to expand the range of applications to which hydrocarbons can be applied.



BOUND FOR LOW GWP

— By Matthew Cullinen and Michael Garry

Raley's is evaluating two NH₃/CO₂ cascade systems as it strives to use refrigerants with a global warming potential of under 50

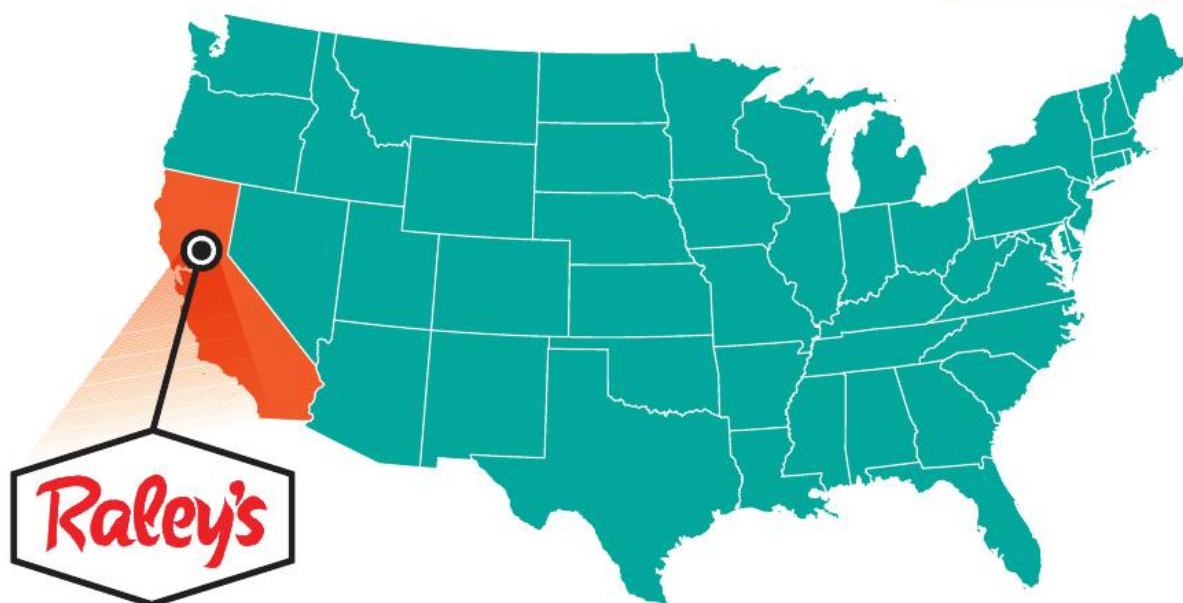
California is well-known as an environmentally proactive state, which, among many initiatives, is planning through its Air Resources Board to pursue measures this year to dramatically reduce emissions of HFCs and other short-lived climate pollutants.

For example, the Air Resources Board expects to propose to its governing board a cap of 150 on the global warming potential (GWP) of refrigerants in new stationary refrigeration for all sectors (commercial, industrial and residential) starting Jan. 1, 2021. ([See "Leading by Example, Accelerate America, December 2015/January 2016."](#))

Given this impending regulation, food retailers in California are seriously evaluating what path to take with refrigeration technology. One such retailer, Raley's Family of Fine Foods, shared how it is doing this analysis at a workshop in Montreal in late November 2015 called "Advancing Ozone & Climate Protection Technologies: Food Cold Chain." The event was sponsored by a number of organizations, including the Environmental Protection Agency, the Climate & Clean Air Coalition and UNEP Food Cold Chain. The event was sponsored by a number of organizations, including the Environmental Protection Agency, the Climate & Clean Air Coalition and UNEP.

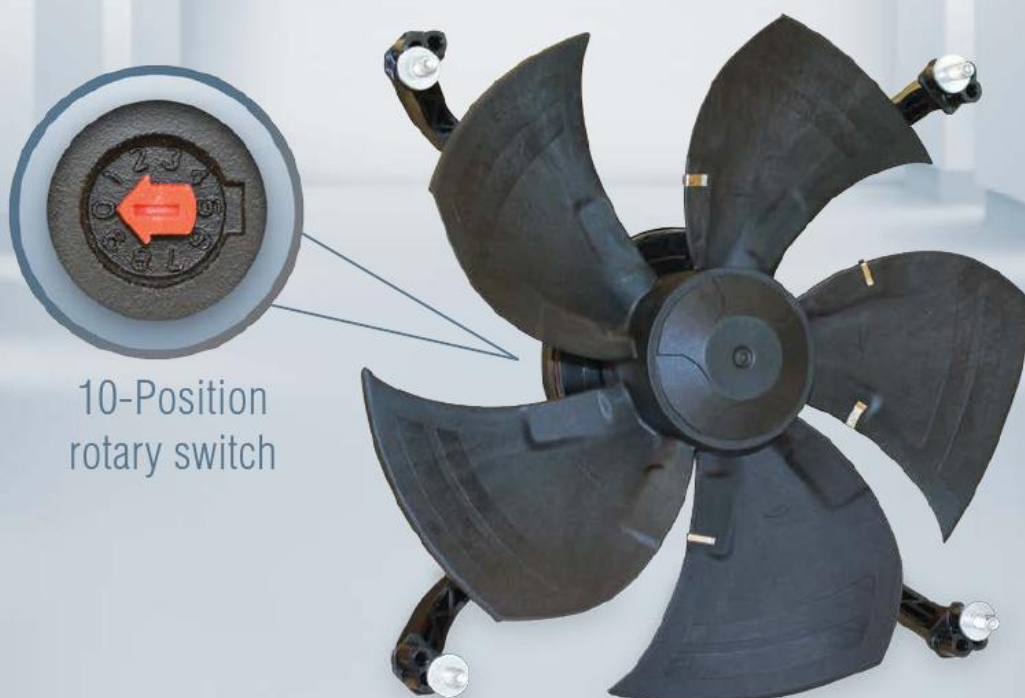
Raley's is a privately held, family-owned supermarket chain with 130 stores in Northern California and Nevada that includes the Bel-Air Markets and Nob Hill Foods brands, in addition to Raley's Supermarkets. For reducing its refrigeration-related emissions, the chain was recognized as "2013-2014 Distinguished Supermarket Partner" by the EPA's GreenChill Partnership, which Raley's joined in 2009.

continued on p.34 →





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Being private, with owners who care about the environment, I am given the latitude to research and test new innovative and forward thinking energy-saving concepts.”

→ LEAVING A BETTER PLACE

At the Montreal meeting, Randel Walthers, Raley's manager of energy and utilities, outlined the company's efforts to evaluate refrigeration options that reduce both energy and the use of high-GWP refrigerants in preparation for new stores slated to open in late 2016. The selection would also factor in the technical skills available for installations and maintenance.

Expressing a desire to leave the world “a better place for my 15 grandchildren,” Walthers said in his presentation that Raley's is looking for a system “that will lead us to a GWP of under 50.”

Raley's is including natural refrigerants in its review. Over the next five years, the chain expects that adoption of CO₂ systems, including secondary, cascade and transcritical, will grow, as will use of flammable refrigerants in self-contained and walk-in systems.

Walthers described a study the chain is conducting that looks at five cascade refrigeration options, compared to a baseline system at a store in Santa Rosa, Calif., that uses R449A as a refrigerant. All five options use CO₂ as the secondary refrigerant, and two of the options employ ammonia as the primary refrigerant. The other three use an HFO (R1234yf) or HFO blends (R449A and R513A) as the primary refrigerant.

“Being private, with owners who care about the environment, I am given the latitude to research and test new innovative and forward thinking energy-saving concepts,” Walthers said.

Raley's uses refrigeration loads in a proposed Sacramento, Calif., location to estimate the performance of the baseline and options in the study. The baseline is a two-stage system using open-drive compressors with a variable-speed drive in the lead compressor. Heat is rejected through four-fan adiabatic condensers.

One of the cascade NH₃/CO₂ systems is a combined medium-temperature pumped/low-temperature DX system using an adiabatic condenser; the other is the same except that it uses an adiabatic fluid cooler (not condenser) and an enclosed flooded evaporator rather than a direct-expansion evaporator.

MEETING GWP OBJECTIVE

The two NH₃/CO₂ systems satisfy Raley's under-50 GWP, objective as does the system using R1234yf; however, the latter refrigerant has not been approved for commercial use by the EPA. The other two options (R449A and R513A) are well above 50 GWP.

In terms of estimated energy consumption, the NH₃/CO₂ system using an adiabatic condenser was the closest of the five options to the baseline, consuming just 1.4% more electricity annually. That NH₃/CO₂ system was the best performing system with respect to estimated annual system emissions, including direct emissions of the refrigerants and the indirect emissions of electricity consumption; it's overall emissions were 78.9% less than those of the baseline system. The NH₃/CO₂ system using a fluid cooler came in second at 75.6% under baseline.

One drawback of the NH₃/CO₂ systems is their higher initial cost. The adiabatic condenser system cost an estimated 41.2% more than baseline, while the fluid cooler system cost 48.6% more. That also drove up their estimated 20-year life cycle cost vs. baseline, to 33.3% more than baseline and 40.5% more, respectively. However, California is developing an incentive program that could help defray the the additional costs retailers pay for a natural refrigerant system.

In making its final selection of a refrigeration system, Raley's does not want to “repeat the mistakes of past refrigerants,” which were seen as viable replacements only to be phased out later for environmental reasons, said Walthers. “I want to pick one that becomes our standard system we can use for years to come.”

“

I want to pick one that becomes our standard system we can use for years to come.”

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A new commissary at the Spangdahlem Air Base in Germany where DeCA has installed a transcritical refrigeration system.

Photos by Miguel Garcia

DECA'S NEW MISSION

The Defense Commissary Agency is investigating transcritical refrigeration at five commissaries, to go along with its NH_3/CO_2 test

— By Michael Garry

Current and former members of the U.S. armed services enjoy certain perks, as well they should for defending the nation. One of them is to buy food and household items at an average discount of 30% compared to conventional grocery prices at 240 military commissaries around the globe.

These commissaries all fall under the supervision of the Defense Commissary Agency (DeCA), a division of the Department of Defense formed in 1991 to consolidate four separate commissary agencies into one. Although DeCA receives a government appropriation and runs its commissaries as nonprofit entities, the agency still strives to cut operating costs and preserve the environment in order to best serve the taxpaying public.

To that end, DeCA, which did \$5.5 billion in sales in its fiscal 2015, has started testing environmentally friendly refrigeration systems that use natural refrigerants at some of its commissaries. DeCA is investigating more than one natural refrigerant system because it is not convinced that a single system will fit every commissary.

The agency's first foray into natrefs took place at a remodeled 117,000-square-foot commissary at the Lackland Air Force Base in San Antonio, Texas, where an ammonia- CO_2 cascade refrigeration was installed in November 2014 and went fully operational in August 2015. ([See "NH₃/CO₂ System Ready for Takeoff," *Accelerate America*, July/August 2015.](#)) This year, DeCA is taking on CO_2 transcritical refrigeration in a series of commissaries in the U.S. and Germany.



In part, DeCA is responding to the Obama Administration's Climate Action Plan, which includes a call for agencies to reduce emissions of conventional HFC refrigerants. But DeCA is also "using good business sense," said John Stuit, the agency's chief, design & construction. "We're looking to the future, and we know that HFCs and high-GWP refrigerants are not what the future will be. So we're doing tests to determine the best business plan for refrigeration."

WIDESPREAD TRANSCRITICAL TESTS

The agency's first transcritical system was installed last year in a new commissary at a base in Spangdahlem, Germany, which will open by early summer; the system is a CO₂OLtec unit from Carrier. In the U.S., four transcritical systems will be deployed in existing commissaries where the legacy refrigeration unit has run its course. The first of these is at a base in Newport, R.I., which will be followed by three more, at Edwards Air Force Base in Southern California, Everett Naval Station in Seattle, and at Mountain Home Air Force Base in Southwestern Idaho.

The installation at the 45,844-square-foot Newport store began last month and will be phased in during 2016. The others are under design and will be installed in 2017. All systems will include an adiabatic condenser/gas cooler to maintain the system's efficiency on warm days; the Southern California commissary will be assessed to see how the transcritical system performs year-round in a warmer climate. "Adiabatic condensing goes a long way toward allowing transcritical to be energy efficient in hot climates," said Stuit, though "it remains a possibility we will use NH₃/CO₂ systems in hot climates."



John Stuit, DeCA

Facing the EU's F-Gas Regulation, DeCA has already indicated that transcritical would be its standard for new refrigeration systems in Northern Europe, which has colder climates. "Transcritical is a mature technology in Europe," said Stuit. "Manufacturers and service companies understand it." However, in the warmer climates found south of the Alps, DeCA will consider transcritical on a case-by-case basis.

In assessing its natural refrigerant systems, DeCA will be looking at lifecycle costs, especially the cost of energy, using a traditional HFC system as a baseline. In addition to bottom-line considerations, "we don't want to trade low-GWP refrigerant for a global warming increase through higher energy usage," said Stuit.

Ultimately, DeCA is seeking energy savings that will pay for the cost of a system over its lifetime, typically 15 years. That's a much longer payback period than what conventional grocers employ, which is typically three to five years, Stuit acknowledged. "We take a long-term view. Once we install a system, it will be there a long time. So we want to make sure we install a system that's maintainable and meets regulatory requirements for a long time."

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The commissary in Spangdahlem, Germany, will open by early summer.

→ ENERGY-SAVING NH₃/CO₂ SYSTEM

NH₃/CO₂ cascade system cost significantly more to acquire and install than the transcritical systems. However, the long-term energy savings "may help us pay for the [NH₃/CO₂] system and prove it to be cost effective," said Stuit. A study by CTA Architects Engineers estimated that the NH₃/CO₂ system would consume 7.9% less energy than a four-rack R404A DX system, but Stuit is waiting to have a year's worth of field data, based on submetering the refrigeration system, before coming to any conclusions.

Before going live with the NH₃/CO₂ system, DeCA conducted a "plume study," with the help of the Environmental Protection Agency and the National Renewable Energy Laboratory, to ensure that any leaked ammonia would not pose a hazard. The system consists of nine rooftop ammonia-refrigeration modules, each containing nine pounds of ammonia (which is lighter than air), so if one of the modules leaks its charge (the most likely scenario), the study found, it would not harm the public regardless of weather conditions.

In one instance, the compressor in one of the ammonia modules did leak nine pounds into the atmosphere with no ill effects. The compressor issue has since been addressed. "We shut that module and the other eight continued to run with no effect on capacity," said Stuit.

The NH₃/CO₂ system also includes 1,800 pounds of CO₂ used to chill cases via a low-temperature DX system and a medium-temperature pumped secondary system.

The biggest challenge DeCA is facing with natural refrigerant systems is finding trained maintenance technicians. "The systems are available; the question is, do the technicians have the competence to maintain them successfully?" said Stuit.

"We're looking to the future, and we know that HFCs and high-GWP refrigerants are not what the future will be."



Transcritical rack at the Spangdahlem, Germany, commissary.

In both Germany and the U.S., DeCA uses third-party contractors, trained by system manufacturers, to maintain its natural refrigerant systems. At the Lackland NH₃/CO₂ commissary, manufacturers had "baby-sat" the system until recently when the maintenance contractor took over. The technicians "are nervous about the system because it's unfamiliar to them," said Stuit, adding, "My perception is that maintenance technicians are more concerned about the toxicity of ammonia than the higher pressures of CO₂." But he expects those concerns to diminish with time. **■ MG**

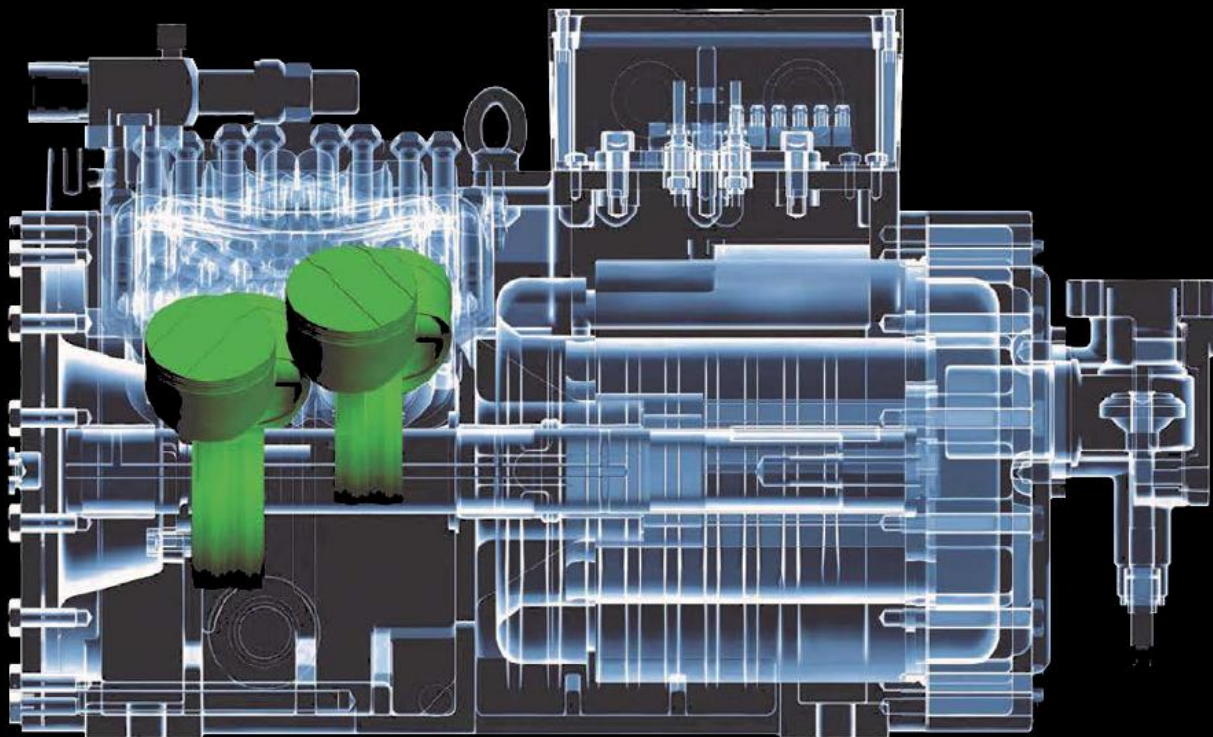
DeCA in a Nutshell

- » No. of commissaries as of 2/11/16: 240, including 177 in the U.S.
- » Global presence: 13 countries, two U.S. territories
- » Fiscal 2015 sales: \$5.5 billion
- » Customer base: About 5.3 million households.

System Specs

The transcritical CO₂ system being installed at a commissary in Newport, R.I., has the following characteristics:

- » OEM: Hillphoenix
- » Installing contractor: Summit Construction
- » Controls supplier: Danfoss
- » Adiabatic gas cooler provider: Baltimore Aircoil
- » Total compressor horsepower: 131
- » System loads: 180 MBTUH (low-temperature) and 450 MBTUH (medium-temperature)



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Bitzer

METRO AG DRIVES GLOBAL ENVIRONMENTAL CHANGE

The German retail giant is committed to making natural refrigerants an integral part of its trailblazing sustainability strategy

— By Janaina Topley Lira and Nina Masson

 ne of the largest international retailing companies, Düsseldorf, Germany-based METRO AG (also known as METRO Group) has made a name for itself as an environmental leader.

The Dow Jones Sustainability Index, the most well known sustainability ranking, rated METRO AG the best performing company in the Food & Staples Retailing Industry in 2015. On top of that, METRO was included in the FTSE4Good Global and FTSE4Good Europe Index.

Cementing the Group's reputation is its pioneering F-Gas Exit Program. A cornerstone of the company's emissions reduction strategy, it will see METRO phase out f-gases by 2025, replacing them with natural refrigerants in all store locations worldwide, where technically feasible.

The man whose job is to oversee this change is Olaf Schulze, director, facility energy and resource management. Trained as a lawyer, Schulze is a fast talker and a quick thinker. After joining METRO AG in 2005, he initially found success working on the retailer's energy reduction strategy. In less than two years he managed an impressive 10% decrease in energy consumption.

Now an expert on the subject, he has authored several scientific papers on energy management, and has even published his very first book "CSR und Energiewirtschaft" (Energy and Corporate Social Responsibility).

In 2013 Schulze embraced a new challenge. Following the decision by the METRO AG Sustainability Board to transition away from f-gases, Schulze has been working hard to ensure the company adopts natural refrigerants as part of its efforts to green its image. Under his leadership the company has already introduced natural refrigerants at 14 distribution centers in addition to installing CO₂ transcritical systems in 42 stores throughout Europe.

Schulze believes CO₂, and to a lesser degree propane, refrigeration represent a huge opportunity for METRO to move away from a technology of the early nineties and implement a technology that will help the company to "future-proof" its business.





Olaf Schulze, METRO AG

With great power, great responsibility

METRO was founded in 1964 by Otto Beisheim in Mülheim an der Ruhr, Germany. Its revolutionary cash-and-carry concept was an instant hit. Customers flocked to the first self-service, bulk-buying store and it wasn't long before several more opened.

Today, the Group operates around 2,200 stores in 31 countries, including 800 METRO stores and 300 hypermarkets. Its sales divisions include METRO/MAKRO Cash & Carry stores, a leader in self-service wholesale; Real hypermarkets; Galeria Kaufhof, Europe's top department store chain; and Media Markt and Saturn, its consumer electronics stores.

With sales in 2013/2014 of around \$68 billion, METRO AG is the fourth biggest retail group in the world. A global player, METRO's size and influence come with certain responsibilities. One of these, according to Schulze, is the obligation to be a technology front-runner. "We have to use our strengths, such as our internationality and our first-mover mentality, to pilot and test new technologies."

It is precisely this ambition that led the company to pilot its first CO₂ refrigeration installation in a store in Hamburg, Germany, in 2008. With refrigeration responsible for more than 20% of the company's greenhouse gas emissions, METRO AG was eager to find a way to reduce this negative environmental impact.

Two years later, METRO publicly committed to the Consumer Goods Forum's pledge to begin phasing out climate-warming HFCs in 2015. To that end, the company published plans to use only natural refrigerants in new refrigeration equipment installations. This commitment was made not only by the METRO AG board in Germany, but also by the local boards of the 27 METRO countries.

The decision to introduce natural refrigerants across all of the Group's stores worldwide was not an easy one. But in July 2013, after considerable debate and discussion, the Sustainability Board agreed to introduce the F-Gas Exit Program. Its priority: to replace existing refrigeration equipment with natural refrigerant technology.

One of the Group's biggest investment plans, the F-Gas Exit Program costs an estimated \$1 billion. The sheer scale of the investment underlines the company's commitment to natural refrigerants. "It costs a lot of money, but represents a huge opportunity to save our environment and reduce our energy demand," said Schulze.

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“I believe that in ten or eleven years time the roll-out of natural refrigerants across all our stores will be almost finished.”

→ Reassessing old equipment

An important part of the Program is “business as usual.” This means taking the opportunity to introduce state-of-the-art refrigeration technology when current equipment is near the end of its life, which can be anywhere between 18 and 25 years after its initial start-up.

To illustrate this point, Schulze uses an automotive analogy. “My old car is ten years old and when I have to replace it, I am not going to buy a new vehicle built using old technology. I am going to buy a new car, built to new standards. The same is true of refrigeration equipment. We have to buy new equipment built to modern standards, not new equipment built to old standards.” For METRO AG, state-of-the-art, or modern, means using natural refrigerants.

Deciding where to begin exchanging refrigeration systems, however, was a difficult task. It required an analysis of METRO’s entire installed base of refrigeration systems, taking into account refrigerant type, age of the system, leakage rate, depreciation status, and whether the equipment was located in an EU or non-EU country.

“We undertook extensive internal research, looking at all our equipment, and in the end we came up with a five-level ranking system,” Schulze explained. “We calculated a system’s depreciation time as being on average 15 years. Then we decided that for each negative aspect of a system we would award one point. Very old equipment, older than 20 years for example, received an extra point. For refrigerant type, the use of R404A was awarded five points. The use of R134a on the other hand, was awarded only one point, primarily because under the EU’s revised F-Gas Regulation, R134a will still be allowed after 2020.”

Based on the results of this analysis, the Group plans to replace f-gas equipment with natural refrigerant solutions in 58 stores in 2016, 62 stores in 2017, and 37 stores in 2018.



Olaf Schulze



METRO uses CO₂ and in some cases propane as natural refrigerants.

Challenges to overcome

For any international company, one of the key challenges in switching to a new technology is having qualified technical support on the ground. METRO stores are spread far and wide across the globe; thus the switch to natural refrigerants has required significant investment in technician training and education.

"One of the lessons we have learned is that you cannot expect to find the same level of technical knowledge as you find in Central Europe all around the world," said Schulze. "This has been our experience in India, for example, which is one of the countries in which we are expanding rapidly. We currently have 16 stores in India and in order to transition to natural refrigerants we have had to ensure we have fully trained technicians who can provide support, maintenance and repair."

The availability of service technicians is one of the elements that need to be in place for METRO to get buy-in from store operators in countries like China, Russia and India. "We [also] have to convince people that this technology is [safe and] widely available, produces the same cooling quality, and will not result in higher operating costs."

Another challenge is the negative impact high ambient temperature has on the efficiency of CO₂ refrigeration technology. For METRO to successfully switch to naturals, this newly adopted technology has to operate efficiently in all of the countries in which the Group operates. Fortunately, the very latest CO₂ refrigeration advances, which include parallel compressions and ejectors, have made this possible.

"To roll out natural refrigerants worldwide, the technology had to work in our stores in Spain, Portugal, Turkey and India," said Schulze. "And I am happy to say that the latest CO₂ innovations have enabled us to open our very first CO₂ transcritical store in Madrid, Spain, and that in the 2016 fiscal year we will open our first transcritical store in Portugal." The Madrid store employs a parallel compressor system to compensate for high ambient temperatures.

For METRO Group, using waste heat is also important. "Our dream is to avoid the need for additional heat sources in stores where we have CO₂ refrigeration system installed," said Schulze.

METRO is now installing what Schulze considers to be "CO₂ technology 3.0," and he is enthusiastic about the future. "Who knows what the technology will look like in 2025. We may not be talking about ejectors anymore, but another new, cutting-edge technology. Whatever it is, we hope to be the front-runner when it comes to using the next generation of this technology."

Some fluorinated equipment was installed just before the F-Gas Exit Program was introduced. Their lifecycles will not come to an end until 2026 or 2027. These will have to be converted to natural refrigerants after 2025. Overall, though, Schulze has full confidence that the F-Gas Exit Program will prove a success. "I believe that in ten or eleven years time the roll-out of natural refrigerants across all our stores will be almost finished."

By 2025, Schulze estimates that METRO will have stopped using f-gases in around 90% of its food stores.

"We are on track to open, on average, 50 natural refrigerant stores every year," said Schulze, adding that the F-Gas Exit Program is not a fast-moving strategy. "It is a long-term plan, one which required a relatively long time to prepare and one which will take a relatively long time to execute."

One of three pillars of the F-Gas Exit Program, the shift to natural refrigerants, goes hand in hand with leakage prevention through proper maintenance, and maintenance of detailed records for each refrigeration system, known as the refrigeration system logbook (LOCS). "Although we have a way to go to achieve our long-term target of a 5%-6% leakage rate, we are succeeding in our efforts to reduce the number of leaks," said Schulze.

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A NON-STOP LEARNER

Once an officer in the East German army, Olaf Schulze, director, facility energy and resource management for METRO Group, is no stranger to discipline and the importance of good management.

Perhaps it was this experience that taught him to lead by example and to take good care of the people under him, traits that have in turn enabled him to drive drastic change within the METRO Group. "A good manager," he said, "is someone who is sufficiently inspired to motivate others, and who has loyal, enthusiastic employees. I am not alone. Behind me are many colleagues who share the same convictions."

So how does Schulze find the inspiration to motivate his colleagues? He never stops learning, visiting the stores of his competitors to find out about the latest environmental technologies. For example, on a recent family vacation to Ireland, he took the opportunity to see the country's first "eco" store in Tramore, designed to the internationally recognized PassivHaus standard. During a trip to visit his oldest son in Iowa, he drove his entire family to Wichita, Kan., where he checked out first Walmart Neighbourhood Market to feature all-LED lighting.

Schulze's insatiable curiosity and ability to apply a systematic approach and attitude to thinking and acting have helped to make him an expert in energy management and sustainable building innovation. But is it his belief that each of us has a responsibility to preserve the natural environment that really pushes him forward. "For me it is clear that we have to save our environment for our children."

The father of four sons, Schulze is keen to instil in them a sense of environmental responsibility. As such, in the Schulze household, from March to October, all the men in the family shower in the garden, using the wastewater to water the plants. Being a good environmental steward is much more than just a day job for Schulze.

■ JTL & NM

→ Learning from other countries

A key advantage METRO has enjoyed as its move towards natural refrigerants is its ability to exchange best practices between countries. "To accelerate the roll-out, we must learn from each other," said Schulze.

Knowledge sharing is central to METRO's plans to open its first CO₂ transcritical store in China in 2016. This follows the opening of the company's first CO₂ cascade system in the country in 2014; a collaborative effort between local companies Fute and General Fushi, METRO's Weifang store uses 18% less energy than a comparable store built in 2012. For the METRO Group, one thing is certain. Its expansion into China will rely on the use of CO₂ refrigeration.

The company is also one of only a few retailers investing in natural refrigerants in Russia. "We will install natural refrigerant systems in five new stores this year, for which of course we will need to ensure we have sufficient local expertise to guarantee system maintenance," said Schulze.

But Schulze is optimistic. "The bottom line is that technology change is possible, and we are making it possible in Russia."

While discussions with international partners on how to transition to natural refrigerants have been largely fruitful, Schulze said the company has encountered opposition. "We sometimes encounter technical resistance from local governments. As a result, it is not possible for us to select from all of the available natural refrigerant solutions. Our options are narrowed, forcing us to focus on one technology."

China is again a case in point. METRO is not allowed to install AHT's propane refrigeration solutions, a technology allowed in many other countries. Seeking to overcome this issue, METRO is working closely with local associations and trade unions to drive regulatory change.

Alongside these discussions, METRO is also investing in pilot installations that people can visit to see the safety and efficiency of different natural refrigerant technologies. In Namur, Belgium, for example, an all-propane METRO Cash and Carry store was recently opened.

Could the decision to use natural refrigerants, and in particular CO₂ transcritical refrigeration, change? Not according to Schulze. "As a result of our efforts, I am confident that this decision is irreversible. All of the refrigeration systems planned in 2013 and built in 2015, and those that we will build in 2016 and so on, will use natural refrigerants. Every year we further entrench the use of natural working fluids, including CO₂, in METRO Group operations."

■ JTL & NM

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PUSHING FOR CO₂ IN JAPAN

Retail powerhouse AEON is seeking to fulfill its commitment to CO₂ refrigeration by overcoming challenges in the Asian market

— By Yukari Sahashi



AEON Co. Ltd., the holding company for AEON Group, is the largest retailer in Japan as well as Asia as a whole, and one of the biggest global retailers. It is also one of the most ambitious proponents of natural refrigerants in the world.

AEON, based in Chiba, Japan, staked out that position in 2011 when the group issued its "AEON Declaration on Natural Refrigerants," committing to introduce natural refrigerants, specifically CO₂, at all new stores opening in and after fiscal year 2015 (ending March 31, 2016), while also converting 3,500 existing stores to natural refrigeration. The company was the first retailer in Japan to use CO₂ refrigeration in its stores.

As of the end of its 2015 fiscal year, AEON will have installed CO₂ transcritical condensing units at 45 stores, somewhat behind schedule. But the company is working hard on overcoming the challenges that are impeding its progress.

The air-cooled condensing units, from Panasonic, typically use 15 or 20 HP and are located either on the

roof or next to the building. A supermarket between 20,000 and 45,000 square feet would employ 10-20 of these condensing units.

The massive scope of its operation underscores the daunting nature of AEON's environmental initiatives. In Japan alone, as of February 2015 it had 541 general merchandise stores, 1,929 supermarkets, and 2,151 convenience stores. It operates 207 shopping malls and over 4,600 convenience stores in Asia outside Japan. All told, it runs over 18,700 stores across 13 worldwide businesses (mostly Asia), with its largest food-store representation in Japan, The Philippines, South Korea, China and Thailand. Its total revenue in fiscal year 2014 came to 7,078 billion yen (\$63 billion), the most among Japanese retailers.

First in Japan

AEON began its natural refrigerants journey in 2009. To give the technology a try and see for itself what results it would bring, AEON launched a CO₂ refrigeration system — the first in Japan — in the food section of one of its supermarket stores. The results suggested that the increased initial costs should eventually be recovered through the reduced energy consumption and running costs, creating a positive momentum within the group towards a full-scale adoption of the system.



Haruko Kanamaru, AEON



CO₂ showcases at AEON's Kisarazu store

Once it confirmed the safety of the system and was able to achieve a 20% energy reduction – which was larger than expected – compared to conventional HFC equipment, “we reached the conclusion that natural refrigerants are what we are to pursue in the future,” said Haruko Kanamaru, general manager, corporate citizenship department for AEON.

Between 2009 and 2011, AEON piloted a Panasonic refrigeration system using CO₂ at its MaxValu Express store in Tokyo, with financial support from the New Energy and Industrial Technology Development Organization (NEDO).

The pilot served as an important stepping-stone for AEON Group, which at that time was moving towards the adoption of CO₂ refrigeration system for its energy-saving benefits. Since then, the Group has since been expanding its use of CO₂ refrigerant, as described in a presentation by Kanamaru at ATMOSphere Asia conference organized by shecco in November 2014.

Following the pilot introduction of the CO₂ refrigeration system in 2009, AEON continued the installation of CO₂ at a MaxValu store in Fukuoka Prefecture in 2010, and a MaxValu store in Hyogo Prefecture in 2011. At that point, each of these stores demonstrated about a 10% reduction of energy use and a 50% drop in CO₂ emissions compared to conventional refrigeration

units, providing the company with an adequate basis to evaluate the safety and stability of the new system.

In 2012 and 2013, the Japanese Ministry of Economy, Trade and Industry (METI) chose AEON for the funding program “Pilot Projects to Reduce HCFC and HFC Emissions Through Energy-Saving Technology.” With that help AEON installed CO₂ refrigeration equipment at five supermarkets. For small-scale stores like AEON's Ministop convenience store chain, the company set a goal of reducing energy consumption by 20% compared to conventional Freon-based equipment; some of the freezer cases installed at Ministop locations exceeded the goal by achieving as much as a 30% reduction.

Since 2014, AEON has received funding from the Ministry of Environment (MOE) under its project “Promotion of Energy-Saving Natural Refrigerant Equipment Based on Advanced Technology.” This allowed the company to increase the number of its general merchandise and convenience stores using CO₂ refrigeration, with 28 stores getting equipment in 2014.

In addition to Panasonic systems, some of these stores are equipped with Mitsubishi Electric Corporation's self-contained CO₂ showcases for beverage and alcohol products. AEON is willing to consider other natural refrigerants, such as propane-based self-contained refrigeration showcases, “as long as the safety and reliable performance are assured,” said Kanamaru.

Dealing with challenges

While AEON is set on pursuing CO₂ installations in new and existing stores, it has encountered a number of challenges and concerns along the way. So far, its deployment is behind schedule; in particular, the conversion at existing stores is not making smooth progress.

One factor is the long business hours of its convenience stores and supermarkets, making it difficult to temporarily stop operations to replace the refrigeration equipment “It is, realistically speaking, extremely difficult to convert to natural refrigeration at all our existing stores,” said Kanamaru.

The natural refrigerant market is another issue. When AEON made its natural refrigerants declaration in 2011, it expected market

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→ conditions to improve with time, but they haven't, said Kanamaru. "The major bottlenecks remain the same."

One of those remains high capital and installation costs of natural refrigerant equipment. Panasonic currently provides nearly 90% of the CO₂ equipment used at AEON stores, and more competitors are not in the immediate future.

But Kanamaru sees several counterbalancing factors. One is that she has high expectations that the funding scheme for introducing natural refrigerant equipment administered by the Ministry of Environment will continue "until it is only natural for each company to choose natural refrigerants without financial concerns."

She also notes that the running costs of natural refrigerant systems are less than those of legacy systems, and that natural refrigerants are the "future-proof choice" as they are not among those refrigerants to be prohibited by Japan's revised F-gas regulations.

Moreover, she anticipates more system manufacturers will join the market and develop natural refrigerant systems, rather than engaging with the repeated question of "demand first or supply first," which prevents the number of such manufacturers from increasing. Kanamaru also believes that

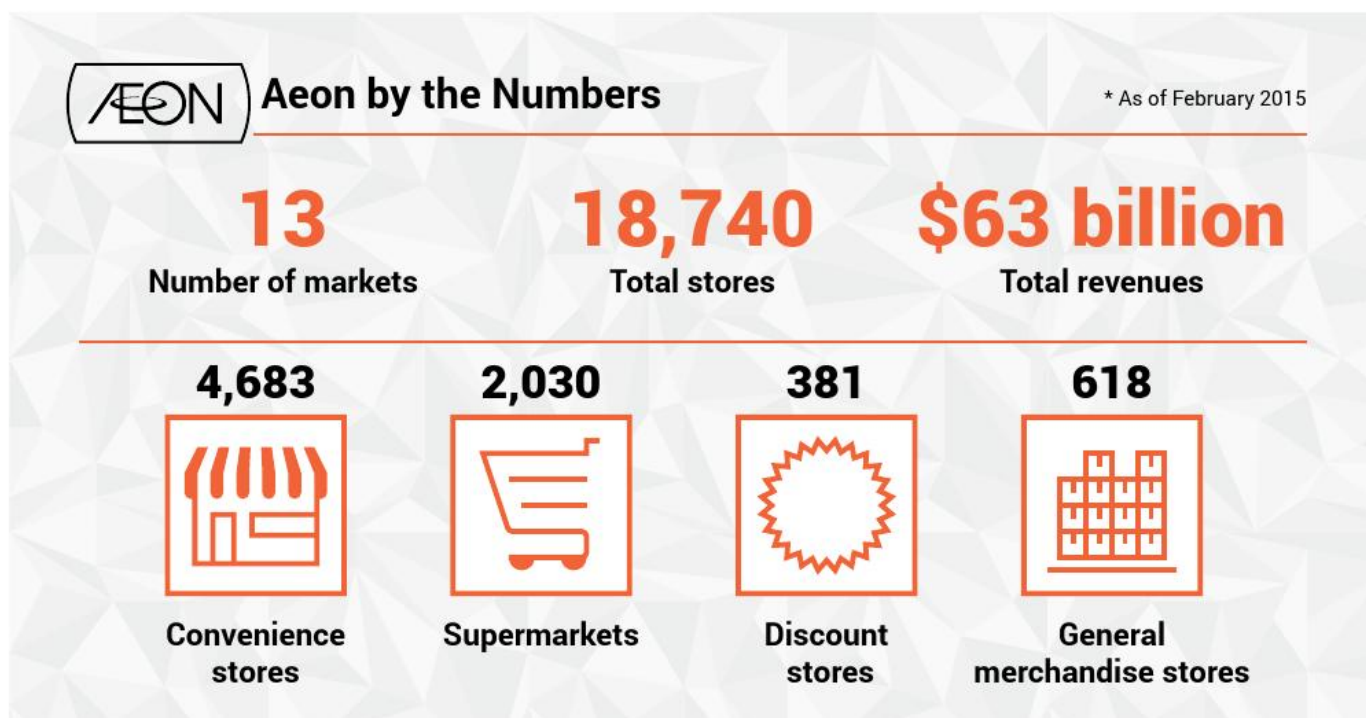
developments in the U.S. market are important elements "to bring changes to the Japanese market."

Kanamaru also thinks that further technological progress will help solve the cost-related issues. For example, the development of larger CO₂ systems and showcases to meet the needs of bigger food sections would cut down on the additional costs of installing numerous small-scale systems.

AEON hopes to play a leading role in boosting the entire market by working in close cooperation and exchanging information with other businesses in the industry. For example, it offers store visits and tours for those in the retail industry and promotes the sharing of knowledge through the Japan Chain Stores Association.

In an effort to communicate information on natural refrigerants to its consumers, AEON describes its initiatives in annual reports for consumers and investors, as well as applying labels and point-of-purchase ads in stores.

These activities are aimed at motivating consumers to ultimately ask other companies: "Why have you not made the decision to go natural?" **YS**





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NATURAL REFRIGERANT COMPONENTS ON PARADE

Growing interest in hydrocarbon and CO₂ systems was evident at the AHR Expo as component manufacturers unveiled a slew of new products

— By Michael Garry

Despite travel havoc caused by Winter Storm Jonas, the AHR Expo held true to form last month, attracting almost 61,000 attendees to its mammoth exhibit floor at the Orange County Convention Center in Orlando, Fla.

Occupying the equivalent of 20 football fields, the Expo featured 2,063 exhibitors showcasing all manner of air conditioning, heating and refrigeration equipment, 334 participating for the first time. A multitude of educational sessions were also on offer.

Ninety of those exhibitors showcased components related to natural refrigerants, particularly hydrocarbons and carbon dioxide, and to a lesser degree ammonia. In an effort to discover new natural refrigerant-based products and see where the market is heading, *Accelerate America* crisscrossed the exhibit floor, wading through throngs of contractors, OEMs and plant managers, past endless arrays of fixtures and gas tanks, and the occasional steam-emitting pipe.

Here's what we found:

HYDROCARBONS

Brazilian compressor maker Embraco unveiled three hydrocarbon products: an on-off compressor, a variable-speed compressor and a condensing unit.

The EM3 on-off propane compressor, a third-generation model manufactured in Mexico, is designed for the light commercial market in North America, delivering up to 1,400 BTUH of capacity. It will be available in the third quarter of 2016.

The EM3's applications include beverage coolers, vending machines and ice makers. Using its suction tube for gas return, the compressor offers a 30% energy efficiency improvement over traditional compressors sold in the U.S., said Michel Moreira, Embraco's global product manager for commercial refrigeration.

The Fullmotion variable-speed compressor, a best seller in Europe, is new to the North American market for glass-door upright freezer, reach-ins and other applications. It will be available in the fourth quarter of 2016.

The Fullmotion's dual-voltage capability (100-127V and 208-240V) allows OEMs to use it in products sold in North America and abroad. Offering between 1,100 and 4,000 BTUH of capacity, the compressor, using propane, is up to 9% more energy efficient than other variable-speed compressors, said Moreira.

Finally, Embraco's Plug n' Cool propane condensing unit is a pre-charged, sealed system. It includes its own evaporator, and is cooled by a water loop while sitting atop reach-in cabinets and other equipment. The plug-and-play unit "allows some of our OEM customers to step up their efficiency with a minimum of effort," said Moreira. It will be available in the second quarter of 2016.

The Plug n' Cool unit can be used as a less expensive alternative to a rack system in smaller footprint grocery and convenience stores, said Moreira. At the same time it is scalable, so that multiple units can be used in large case configurations.

Tecumseh Products, Ann Arbor, Mich., unveiled a new platform of small compressors, the TC series, designed for hydrocarbons R290 (propane) and R600a (isobutane).

The compressors, which will be in production by the end of 2016, have a capacity range of 300-1,500 BTUH, and would typically be used in self-contained/stand-alone beverage coolers, reach-in refrigerators and freezers, and vending machines.

Tecumseh also announced that for self-contained/stand-alone commercial refrigeration equipment with capacities of less than $\frac{1}{2}$ HP, Tecumseh continues to support propane as the refrigerant of choice, within the charge limitations (150g) and safety requirements mandated for A3 refrigerants. "R290 offers a 25% energy savings," said Anthony Carstensen, Tecumseh's business unit director, at the company's annual AHR Expo press conference. "It's the best option where you can use 150 grams and a $\frac{1}{2}$ horsepower or less."

Danfoss showcased a pressure switch recently designed for R290 (propane) and a new 1.5-cubic-inch filter drier, designed for small low-charge propane units. Also on display was a fractional horsepower R290 compressor, new to the U.S. market.



Tecumseh's TC series hydrocarbon compressor



Embraco's Plug n' Cool R290 condensing unit



Danfoss's fractional horsepower R290 compressor

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CARBON DIOXIDE

In January, Emerson Climate Technologies launched production on a new line of small, semi-hermetic compressors – 5, 7 and 9 HP – for transcritical CO₂ systems. The compressors are designed for “smaller CO₂ condensing units” on the medium-temperature side, offering a capacity of 40,000 to 64,000 BTUH, said Andre Patenaude, director, CO₂ business development, Emerson Climate Technologies, in a conversation with *Accelerate America* at Emerson’s AHR Expo booth.

A condensing unit with these compressors would be an appropriate fit for foodservice applications at convenience stores (for four or five cases) or restaurants, though to date they have been mostly used in this way in Europe. The unit would typically go outside the store with refrigerant piped to evaporators, though they could be close to cases as “they are incredibly quiet,” Patenaude said.

At the AHR Expo, Emerson also showcased its new EX3 electronic expansion valve for CO₂ systems that automatically closes in a power outage to prevent flooding in the evaporator and compressor. The company also displayed a redesigned liquid line filter drier that received UL approval for a top previously used in European models; the top’s pressure rating was upgraded to 47 bar.

Speaking about the overall transcritical CO₂ market, Patenaude observed that it is still being held back by the higher cost of the systems – such as cases that require electronic expansion valves. “In North America, other than Sobeys, everyone is still in the trial mode, trying to find out what the true cost is,” he said. “I’ve never heard end users talk so much about total cost of ownership [TCO].”

To swing the conversation in the direction of natural refrigerant systems like transcritical, the efficiency of the systems needs to be emphasized, said Patenaude. “It’s not just about having effective equipment, but equipment that runs at peak efficiently continuously.” To that end, there needs to be a structured “apples to apples” way for end users to compare the efficiency of transcritical systems to that of traditional HFC systems, he added.

Among the AHR Expo’s Innovation Award winners, Baltimore Aircoil Company (BAC) received honorable mention in the refrigeration category for its transcritical CO₂ TrilliumSeries Condenser, an adiabatic gas cooler. BAC is also doing well in the marketplace with the product, selling it to retailers in the southern part of the U.S. where transcritical systems need a way to operate efficiently despite ambient temperatures that often exceed 88 °F (CO₂ critical point). “It doesn’t make economic sense to use transcritical CO₂ without an adiabatic gas cooler in half of the U.S.,” said Paul Noreen, BAC’s director of sales for North America.



Emerson's CO₂ electronic expansion valve



Danfoss's transcritical rack and condenser controller.

The first southern store to use the BAC TrilliumSeries Condenser was a Sprout's Farmer's Market store in Dunwoody, Ga. BAC has recently sold five of the units to Trader's Joes, which will be using it with transcritical systems in Florida and Louisiana, said Noreen. Aldi, he added, has ordered between 40 and 50 TrilliumSeries Condenser units for stores that will be opening up in California. And Whole Foods Market has purchased one for a transcritical system going into a “365 by Whole Foods Market” lower-price format store in Los Angeles. “We’re seeing a lot of movement for transcritical systems in smaller footprint stores,” said Noreen.

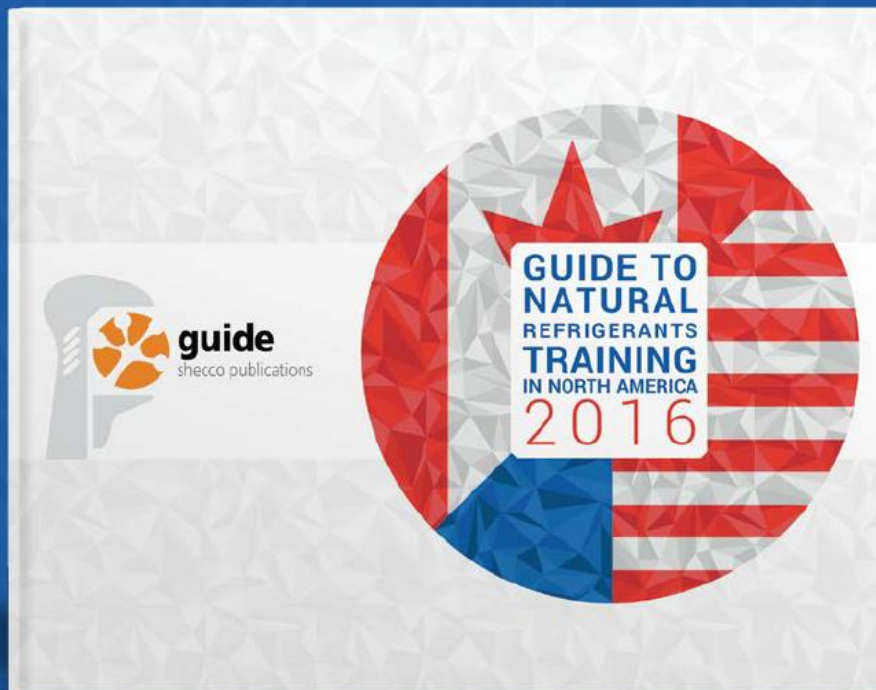
The BAC TrilliumSeries Condenser increases the cost of the transcritical system by two-three times, but because of the greater efficiency it produces, the ROI for the unit is under two years, said Noreen.

With the growing demand among food retailers in North America for transcritical CO₂ systems, hybrid CO₂ systems “are pretty much dead,” said Jim Knudsen, food retail North American segment manager for Danfoss. “There’s no reason to have a hybrid system in a supermarket if you can get a transcritical system to operate efficiently.” He believes that the technology allowing transcritical systems to operate efficiently in warm climates “is either there or will be shortly.”

The first cost of transcritical systems in warm climates still needs to drop, but Knudsen is confident that will happen, in part because “there’s really no alternative.” HFOs, he said, are too expensive and don’t offer an advantage in supermarket refrigeration. “I don’t think retailers are waiting for the next miracle molecule. If you run multiple stores with R22, R404A and R507, do you look ahead at this HFO blend and then another HFO blend? At some point you’ve got to put a stake in the ground and say ‘I need a strategy that will work for me long-term.’”

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Report on Natural Refrigerants Training in **North America**



2016

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SANDEN TO LAUNCH CO₂ HEAT-PUMP WATER HEATER

With plans to launch its residential CO₂ heat-pump water heater in the U.S. by early second quarter 2016, Sanden prominently featured the product at its AHR Expo booth.

Sanden, which has successfully marketed the CO₂ heat pump in Japan, its home country, as well as in Australia and Europe, is aiming at a U.S. residential market dominated by electric resistance water heaters (4.2 million units sold annually) and gas water heaters (4.5 million), and a smattering of synthetic-refrigerant heat pumps (120,000).

The 4.5 kW Sanden heat pump is a split system with an outdoor unit paired with storage tanks of varying sizes. It is capable of delivering about 16,000 BTUH and can produce 149 °F water with outdoor temperatures as low as -15 °F.

Using CO₂, the heat pump is "almost four times more energy efficient than any electric resistance water heater, and 40% to 50% more efficient than any synthetic refrigerant heat pump," said John Miles, general manager, Eco Systems, Sanden International USA, based in Plymouth, Mich.

As for gas hot-water heaters, the CO₂ heat pump has a 3.5 energy factor compared to a .96 for the best gas heater, said Miles. However, because the price of gas is so low, the overall total cost of ownership for a gas heater is better, he acknowledged.

The initial cost of the CO₂ heat-pump water heater is 20% to 25% higher than that of a larger capacity synthetic heat pump, and considerably more than an electric water heater. However, taking advantage of utility or Energy Star rebates, plus the almost quadruple gain in efficiency, the CO₂ heat pump can offer a four-to-six year payback on the cost difference over an electric water heater, said Miles.



John Miles, Sanden, with CO₂ heat-pump water heater



Baltimore Aircoil's transcritical TrilliumSeries Condenser



Parker Hannifin's transcritical flash gas bypass valve and gas cooler valve

At the AHR Expo, Danfoss showcased its AKPC781 CO₂ transcritical rack and condenser controller, whose newest feature allows control of heat reclaim. The company also displayed its AKCC550 case controller, which is new to the U.S.; it manages electronic expansion valves, anti-sweat controls and a food safety sensor, among other functions.

Guntner's AHR Expo booth was dominated by the presence of its new adiabatic CO₂ gas cooler, which can be used with transcritical refrigeration systems or as a fluid cooler. "It allows a [transcritical system] to run in subcritical mode in southern [U.S.] states to remain efficient," said John Miranda, president, Guntner US.

The adiabatic unit "modulates the water flow to the pads to save water," said Miranda. It is also WiFi-enabled, allowing users to monitor power or water usage via a smart device.

Bitzer, which showcased its 30 HP transcritical CO₂ compressor at its booth, plans to introduce a 50 HP version in April, said Joe Sanchez, application engineering manager, Bitzer US. The larger compressor "should greatly reduce the cost of the rack" because it will lower the number of compressors needed, he added. The 50 HP model will have one of the highest HPs on the market.

At its booth Carel promoted its CO₂ transcritical technology, which supports over 5,000 transcritical installations in Europe and is gaining a foothold in the U.S. market, said Mike Tokarsky, Midwest regional sales manager for Carel USA.

In expansive signage, Carel featured such products as the pRack controller for transcritical CO₂ compressor racks; the E3V-C high pressure electronic expansion valve, rated for 2,030 psi and used in CO₂ booster systems to manage back pressure and flash gas; and the ChillBooster controller that controls evaporative cooling for CO₂ gas coolers.

Responding to requests from OEMs to raise the maximum-rated-pressure of valves for subcritical CO₂ refrigeration systems, Parker Hannifin did so for several products that it displayed at the AHR Expo.

For example, Parker raised the pressure rating for its solenoid valves (E2 through E10) and its electronic expansion valves (SER AA, A, B and C) to 70-bar/1,015 psig from 48-bar/700 psig. In the second quarter, Parker plans to introduce ball valves with a pressure-relief check feature, also rated for 70-bar/1,015 psig.

Parker also showcased its transcritical products, including gas cooler valves released last fall, and flash gas bypass valves due out in the first quarter of 2016. They are rated for 140-bar/2,030 psig. Also displayed were transcritical filter driers, rated for 155-bar/2,250 psig.

THINKING OUTSIDE-THE-BOX AT THE HELIX

On December 17, Emerson Climate Technologies, Sidney, Ohio, held a "soft opening" of its 40,000-square-foot Helix Innovation Center at nearby University of Dayton, with a grand opening scheduled for April 27

In the meantime, the Helix has already been the scene of "six to seven workshops, with many more scheduled," said Rajan Rajendran, Emerson's vice president, system innovation center and sustainability, during an "E360 Forum" presentation at Emerson's booth at the AHR Expo in Orlando, Fla.

Emerson is also demonstrating a CO₂ subcritical compressor for low-temperature industrial applications at the Helix. The two-cylinder, open-drive reciprocating compressor delivers a capacity of 50 TR and temperatures down to -30 °F. "A lot of ammonia plants are trying to keep ammonia below the 10,000-pound [regulatory] threshold," said Andre Patenaude, director, CO₂ business development, Emerson Climate Technologies, in a conversation with *Accelerate America* at Emerson's AHR Expo booth. "So we're starting to see them turn to CO₂ in plant enlargements, especially for low-temperature applications."

At the Helix, Emerson hopes to lead a new style of innovation in the HVAC&R industry, one that invites ideas from outside the company and even outside the industry. "Helix is as much or more about a way of thinking – how we innovate, how we collaborate with everybody, and how we put speed and the real world in front of us in everything that we do," said Rajendran.

He emphasized that innovation has to take place in "weeks, not months or years," and to that end Emerson has put together a 10-week process it intends to follow at the Innovation Center. After an idea of problem is identified, the first step, during weeks one to six, is "problem exploration." This includes building a "diverse team" that may include people within the HVAC&R industry (contractors, component makers, OEMs, academics and end users) as well as from fields other than HVAC&R who can "open your mind to a lot of great ideas."

Weeks seven through nine focus on "ideation" – coming up with solutions and putting them to the test in the Helix's "real-world" facilities, including a kitchen and a store. Week 10 starts the process of taking ideas and turning them into a viable business – "the most important step," said Rajendran.

To find out how to participate in an innovation workshop at the Helix, contact Rajendran at rajan.rajendran@emerson.com.

AMMONIA

With the U.S. Environmental Protection Agency warning of impending SNAP refrigerant proposals aimed at industrial refrigeration, Bitzer is ready with its line of compressors designed for distributed, low-charge ammonia and ammonia-CO₂ systems.

"Distributed ammonia means smaller [open-drive screw] compressors," said Joe Sanchez, application engineering manager for Bitzer U.S., at Bitzer's AHR Expo booth. "And that fits into our wheelhouse."

Bitzer is also getting more inquiries about its 30 hp subcritical CO₂ compressors that are used in NH₃-CO₂ cascade systems for industrial settings like food processing. "CO₂ is gaining popularity in industrial applications," said Sanchez. NH₃-CO₂ systems also operate at much-reduced ammonia charges compared to conventional systems.

While the market penetration of low-charge ammonia is low, Sanchez expects 20% to 30% growth annually for the next several years. "It's going to be like CO₂ transcritical in Europe, where 30% annual growth is expected for decades."

One development helping the low-charge ammonia market is the EPA's plan to propose a rule aimed at preventing the use of HFCs as a replacement for ammonia in cold storage and food processing facilities, said Sanchez. The EPA has previously delisted high-GWP HFCs for supermarket and food service applications. "This will have a big effect on HFCs."

Another company at the AHR Expo promoting an ammonia-CO₂ system was Chinese manufacturer Fujian Snowman. The company, also known for its ice machines, showcased a large NH₃-CO₂ cascade system for the first time in the U.S.; it includes compressors and a heat exchanger with connections to a condenser and an evaporator. **MG**



Fujian Snowman's NH₃-CO₂ cascade system



Joe Sanchez, Bitzer U.S.

Aaron Daly, Whole Foods Market

TAPPING THE INCENTIVES SPIGOT

Supermarkets, OEMs and utilities are collaborating on ways end users can receive utility incentives for using energy-efficient natural refrigerant systems

— By Matthew Cullinen



Throughout the country, supermarkets and other businesses with significant cooling and refrigeration needs are considering a transition to natural refrigerants. Such systems are often more energy efficient than traditional systems using HFCs, resulting in a lower operating expenditure.

However, the initial capital costs of natural refrigerant systems are typically higher than that of HFC systems — and this may present a barrier to adoption.

In order to help lessen the upfront-cost pain, some U.S. utility companies are working with end users, manufacturers and third-party consultants to calculate the energy saved by installing systems that utilize natural refrigerants, and to offer incentives for the installation of these systems (sometimes as part of a larger package of energy-saving technologies)

The participating utilities have thus far proven to be open to different technologies and applications; they have worked with end-users to develop incentives for scenarios ranging from low-charge ammonia systems at light-industrial companies to transcritical CO₂ systems in food retail. Still, the utility incentives opportunity remains largely untapped, or can be an arduous, lengthy process to negotiate.

Last month the U.S. Environmental Protection Agency's Green-Chill Partnership hosted a webinar exploring the challenges and benefits associated with utility incentives for natural refrigerant

“ [Customized incentive programs] can be complicated, but they offer the biggest opportunities.”

technology. The conclusion? Utilities are showing more willingness to explore how they can incentivize reductions in energy use for HVAC&R applications, including prescriptive (fixed) incentives for straightforward systems and customized incentives for more complex and variable systems.

For example, self-contained hydrocarbon display cases in supermarkets lend themselves well to prescriptive utility incentives, said Aaron Daly, global energy coordinator at Whole Foods Market, during the GreenChill webinar. On the other hand, customized incentive programs can work for large integrated refrigeration systems; “these can be complicated, but they offer the biggest opportunities,” he added.

Whole Foods received a customized rebate from Sacramento Municipal Utility District (SMUD) in 2014 for a cascade CO₂ system in a retrofit store. (See [“Getting an Energy Rebate the Whole Foods Way, Accelerate America, June 2015.”](#))

ADDRESSING THE COMPLEXITIES

One of the main reasons that developing customized incentives for new systems can be complicated is that, unlike with prescriptive incentives, there is no obvious baseline to compare the system against. As a result, “it is difficult to figure out how the [efficiency] benefits can be quantified and monetized,” said R. Ryan Hammond, senior energy advisor at SMUD, during the webinar. The baseline could be a “prototypical store,” or other stores owned by the same end-user in the same climate, if they exist. Daly suggested that the baseline could theoretically be part of an ASHRAE standard (ASHRAE 90.1), or part of Title 24 in California.

For retrofits the calculation can be easier, because you already have an established baseline in the legacy system, though the end user will still need to do modeling in order to comply with ASHRAE standards (and Title 24 in California), if the system is for a full building. However, it may be possible to take advantage of what some utilities call “custom-express” programs. These programs allow end-users to “take advantage of some modeling capability, but simplify some of the other aspects, much like what is being done in a prescriptive program,” Daly said.

Manufacturers of refrigeration components and systems that utilize natural refrigerants are helping their customers take advantage of utility incentives, and working with utilities to design rebate and incentives programs. Hillphoenix for example has been collaborating with the New York State Energy Research and Development Authority (NYSERDA) to calculate energy savings on behalf of customers like Aldi. (See [“Educating Utilities,” Accelerate America, June 2015.”](#))

“[NYSERDA] has been extremely receptive to using natural refrigerants within a grocery store and the energy savings that are associated with it,” said Leigha Joyal, energy analyst at Hillphoenix during the webinar.

Perhaps the biggest challenge facing system manufacturers is educating utilities about natural refrigerants. “A lot of these utilities do not have experience with refrigeration systems in general, let alone a natural refrigerant system,” she said. “Therefore there is a lot of handholding, for lack of a better word, that needs to be done by the customers, the contractors, and by the manufacturers in educating the utilities on how these systems work and why they’re the best fit.”

THE NEXT INCENTIVES FRONTIER

Some utilities are now willing to consider offering incentives for the reduction of non-energy related CO₂-equivalent emissions. This could be big news for natural refrigerants, whose emissions’ impact (global warming potential) is far less than that of traditional f-gas refrigerants. “More and more utilities are coming under scrutiny for their carbon impact,” said Keilly Witman, owner of KW Refrigerant Management Strategy during the webinar. “[Natural] refrigerants bring a lot of bang for the buck in reducing emissions.”

Taking another approach, SMUD’s Commercial Services Group is considering whether to develop incentives for end users who transition to natural refrigerants above and beyond the energy savings that may result. “We are a community owned, not-for-profit utility, so we have a lot of freedom to try these kinds of programs, if we can convince the board and rate payers that a program makes sense,” Hammond said. “With investor-owned utilities it takes longer [to develop these kinds of programs].”



Leigha Joyal, Hillphoenix

So there is still more work to be done before a more expansive approach can take hold in the industry. “Unfortunately right now, the incentive has to be tied to kWh savings, but utilities are definitely open and receptive to exploring how they can take new technology and potentially offer incentives,” Leigha said. **MC**

WHAT'S THE BEST LONG-TERM ANSWER?

Whether the industry should use natural refrigerants or HFOs, the latest attempt at a synthetic solution, was the subject of a recent debate in the U.K.

— By Robert Davidson

The emergence of HFOs (hydrofluoroolefins) as the latest generation of synthetic gases presents the HVAC&R industry with a classic case of, as the noted baseball sage Yogi Berra once put it, “déjà vu all over again.”

In the 1990s CFCs were banned for depleting the ozone layer per the Montreal Protocol. Then in the early 2000s the phase-down of HCFCs was set in motion for the same reason. HFCs, the replacement for HCFCs, are on their way out globally because of their high global warming potential (GWP). And now the latest synthetic refrigerant class, HFOs and HFO blends, is being marketed as the solution for both ozone depletion and global warming.

But should the HVAC&R industry go down the synthetic road again now that natural refrigerants like CO₂, hydrocarbons, ammonia and water are demonstrating their mettle as efficient, safe and environmentally benign alternatives?

That question was addressed on January 14 in a debate sponsored by The Institute of Refrigeration (IOR), the U.K.-based “knowledge hub for refrigeration and air conditioning,” at South Bank University in London.

Titled, “Are HFOs the best long-term environmental solution?” the debate pitted Nacer Achaichia, refrigerant technology leader at HFO producer Honeywell, against Daniel Colbourne, a member of the UNEP Refrigeration Technical Options Committee (RTOC) for the Montreal Protocol.

TAKING IT CASE BY CASE

Colbourne began the debate by noting that to narrow this discussion down to a “yes” or “no” question on whether HFOs are the best long-term environmental option was slightly ambitious, adding that the parameters of performance are so vast that applications should be considered on a case-by-case basis:

“In a small number of cases, the proposal is quite correct, but, conversely, for the majority of cases, it is probably not the case,” he said.

This claim was substantiated by Colbourne’s dissection of the chemical process for creating synthetic refrigerants. The emissions associated with the production of HFOs, he observed, are two-to-five times larger than those of the HFC R134a.

Another cause for concern is the availability of fluorine, a key resource for the production of HFOs. Colbourne explained that fluorine is a substance that is being depleted in the earth’s crust; he gives it little more than 30 years. One quarter of fluorine goes into refrigerants, with HFOs using more fluorine than traditional HFCs. Moreover, the servicing costs of HFOs are currently 10-to-20 times higher than that of HFCs, potentially causing further price increases in the future.

Achaichia suggested using synthetic solutions such as L20 and R455a for air conditioning applications. But Colbourne asserted that these were blends that

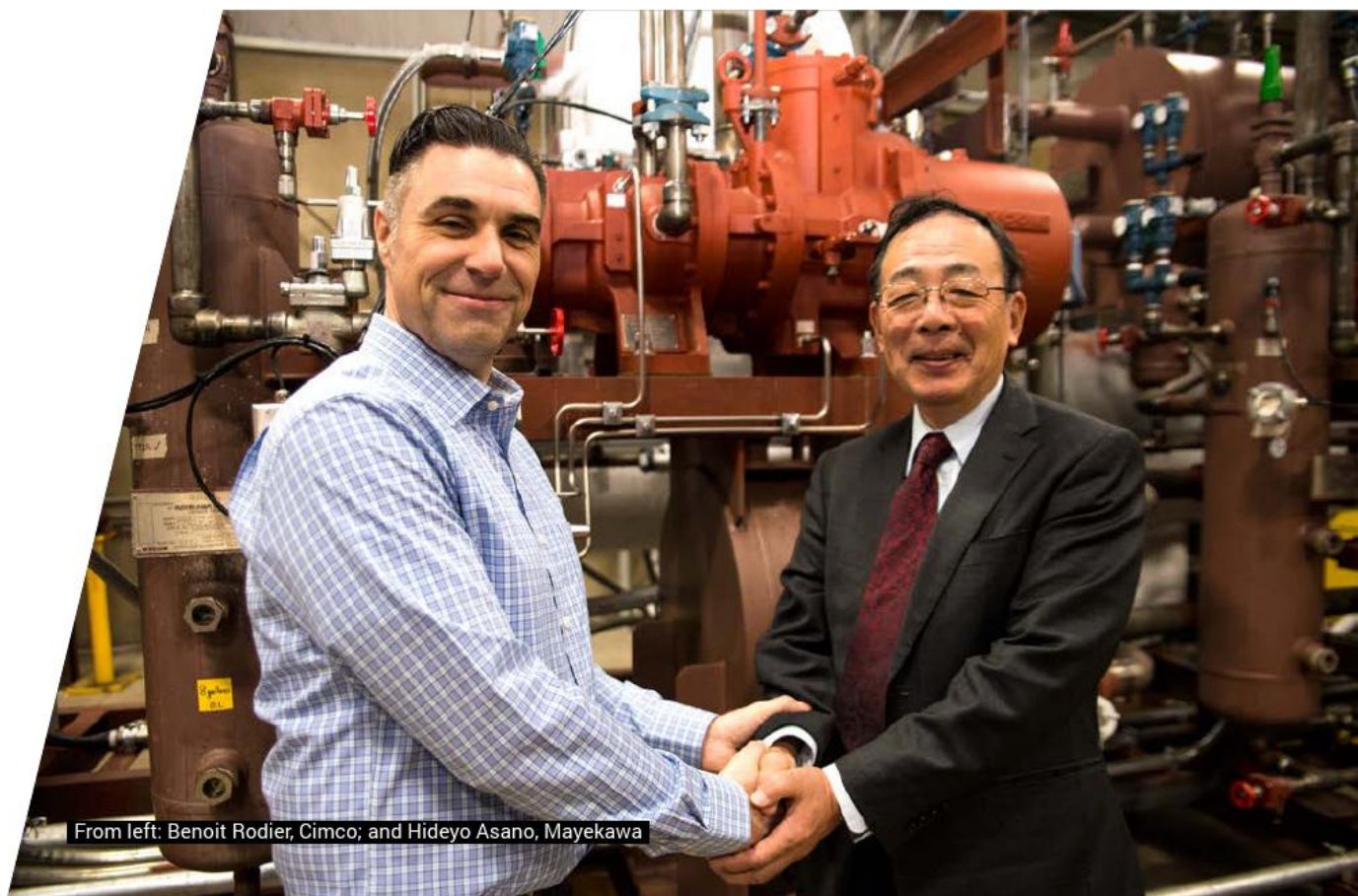


utilize high-GWP HFCs, which means that they are subject to regulatory controls. As such they were outside the realm of the debate, which was intended to focus on lower GWP HFOs.

As a rebuttal, Achaichia responded that “pure HFOs that are commercialized are those three molecules [R1234yf, R1234ze and R1233zd], but to get them to a high capacity and pressure, we have to blend them with other HFCs, there is no secret about that. It is a slightly higher GWP, but if you see we have a replacement for R404A, and it has a GWP with less than 150.”

For air conditioning applications that have yet to find a pure HFO substitute, Colbourne noted the availability of natural refrigerant substitutes, namely propane (R290) and R1270 (propylene).

An audience member put the issue in perspective: “We introduced HCFCs on the grounds of safety, we then introduced HFCs on the grounds of them being environmentally better, so I am slightly skeptical of this next progression. We were wrong, we weren’t looking at the right parameters. We know better now, how are we to know it won’t happen again?” **RD**



From left: Benoit Rodier, Cimco; and Hideyo Asano, Mayekawa

COMING TO AMERICA

Japanese manufacturer Mayekawa is set to bring its $\text{NH}_3\text{-CO}_2$ unit, the NewTon, to the North American market, partnering with Canadian contractor Cimco

— By Blanka Zoldi and Marc Chasserot



The NewTon is assembled in Nashville, Tenn.



"We want to change our business by using NewTon; this is our global mission," said Quinn Vo, corporate engineer at Mayekawa Canada, in an interview last month with *Accelerate America*.

The NewTon follows the low-charge ammonia trend in the U.S., and goes one step further than many models — it reduces the ammonia charge to zero in the cold storage room, only pumping CO_2 throughout the plant. Vo expects that North America will be a "huge market" for the NewTon.

Toronto-based Cimco Refrigeration, which will be the only company distributing NewTon in the North American market, has been producing ammonia systems for 103 years. "Working more and more with CO_2 is a game changer; that's a whole new business for us," said Benoit Rodier, director of business development at Cimco, adding that together with Mayekawa, Cimco would like to be the leader of low-charge ammonia systems in North America. Mayekawa is assembling the product in Nashville, Tenn.

Cimco has a long-term relationship with Mayekawa, which has evolved over 50 years. "We have been using most of their products, now in our ice rink equipment," said Rodier. "We have a huge network in North America, and Mayekawa felt that it could use our boots on the ground to introduce this equipment in North America."

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→ Tad Kimura, COO of Mayekawa US, added that Mayekawa's "NewTon concept" is created not only for North America, but also for the Latin American and East Asian market. "We believe in the equipment," added Rodier. "In terms of energy efficiency, maintenance cost, operation, noise, vibration, dimensions and space, it's truly the solution for the future. We want to drive this in partnership with Mayekawa."

SEQUESTERING AMMONIA

There is a current trend in the US market to reduce ammonia charge in refrigeration systems, based on the OSHA's PSM (Process Safety Management) standards. Though a number of manufacturers offer products with reduced charge, many still operate with ammonia in the cold storage area. The NewTon equipment is a similarly sized, smaller scale, dedicated system, but it does not pump ammonia in the storage space.

"The ammonia stays in the mechanical room, pumping CO₂ throughout the plant," explained Rodier. "We can do very low temperature, with very low pressure drop, with very small pipes, and a very small amount of CO₂ being pumped."

Kimura pointed out the safety benefits of having zero ammonia charge in the facility and freezers: "Ammonia is kept in isolated areas, in engine rooms, machine rooms. People would not be exposed to any potential ammonia leaks."

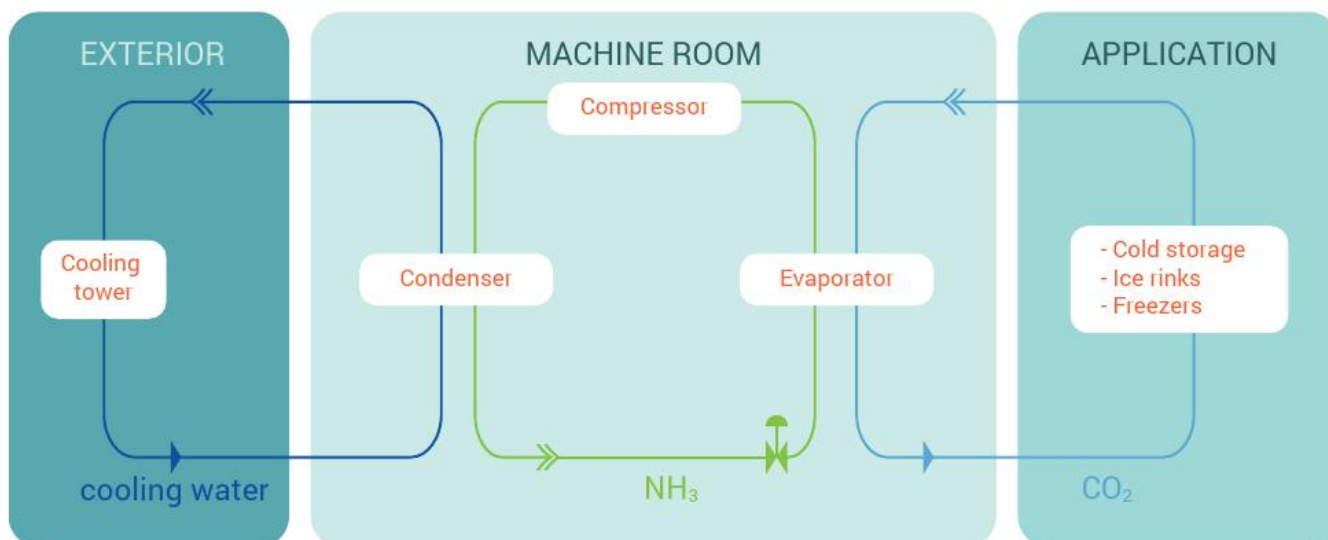
Vo called CO₂ a "viable option to reduce ammonia charge." Low ammonia charge, he added, is the reason why Mayekawa has been successful in promoting this technology, with 800 NewTon packages already operating in Japan and 50 in Southeast Asia.

Besides eliminating ammonia from the facility, NewTon's compressor is also unique in the market, according to Rodier. The semi-hermetic ammonia compressor uses an aluminum winding instead of copper, which is not compatible with ammonia. "The motor is inside the casing, which means we have no more ammonia leakage inside the mechanical room," he explained. "The motor is equipped with a VFD (variable frequency drive) that can adapt to the load of the machine by changing the speed from zero to 5000 RPM."

Mayekawa has worked on the compressor for two years to develop a new, integrated package. Vo noted that with this technology the company created a brand new production line, which will change the way Mayekawa approaches the market. "We designed the compressor in-house, using the know-how that we accumulated over 90 years," he said. "The IPM motor that is the best fit for our compressor is also created in-house."

According to Josh Bell, team leader of service sales, industrial refrigeration at Cimco, the noise and vibration level of NewTon is extremely low. This is important for the health and safety of employees, and can prevent leakage issues that are caused by vibration running through the piping. "We get rid of the coupling, which sometimes can be an issue in terms of vibration," said Rodier.

Format of the NewTon



Rodier added that the location of the mechanical room has also been problematic because of the vibration and the noise. To counter that, “we are trying to be as close as possible to where the load is,” said Rodier. “The further you are, the more pressure drop you have, the more pipes you have to use, and the more money you pay.”

With the pre-fabricated, compact NewTon package, end users are less restricted. “If you had to put it on the rooftop, you don’t have to be concerned because of the vibration,” said Bell. “They can almost be like a rooftop unit, in a way.”

Mayekawa and Cimco are targeting midsize food industry companies in North America with their NewTon. As synthetic refrigerants are gradually being phased out in the market, they are focusing especially on small- and mid-range customers that traditionally use Freon systems. Ammonia users are their secondary market – end-users who are keen on reducing the ammonia charge below the 10,000 pounds regulatory threshold in their facility, according to Vo.

“This equipment is really dedicated to smaller systems, for example a small food producer who will use a spiral freezer, in a range of 20 tons to 200 tons.” Rodier added that the plug-in solution makes it easier for end users to replace their old systems.

Mayekawa’s portfolio currently includes three NewTon package sizes – the 3000, 6000 and (Mega NewTon) 8000 – which are adjustable to the needs of the customer. With the flexibility of modular design, Mayekawa can match the unit’s capacity with various liquid CO₂ temperatures, depending on the ambient temperature of the cold storage. On average, end users employ two to five NewTon units.



3-5 YEAR PAYBACK

Compared to end users’ replaced Freon systems, “our technology can create up to 40% of efficiency gain,” said Vo. Nonetheless, “changing the game” is difficult, observed Rodier. “The North American market has been dominated by ammonia refrigeration for many years, so we are potentially taking market from them as well, not only from the Freon business,” he said. “The only way we can put [the NewTon] in the market is calculating total cost of ownership based on a 20 years horizon. Once you understand this, when you see the bigger picture, you have no doubts.” The NewTon, he added, offers users a three-to-five-year payback period.

When asked about the maintenance costs of the system, Rodier recited his own experience with an end user. “In Japan I visited a NewTon installation that has been running for six years. I asked the owner: ‘How much money have you put into your system since its installation?’ And he was really puzzled, and I understood that the only thing he did in the past six years was an oil change.” In comparison, Kimura pointed out that with Freon installations, leaks and compressor failures are common and have to be taken care of by the end user.

Talking about efficiency savings, Rodier emphasized the importance of their holistic approach whereby the NewTon is integrated with the heating and ventilation system. “NewTon is the heart of this holistic approach,” he said. “It is producing cold on one side, and heat on the other side.”

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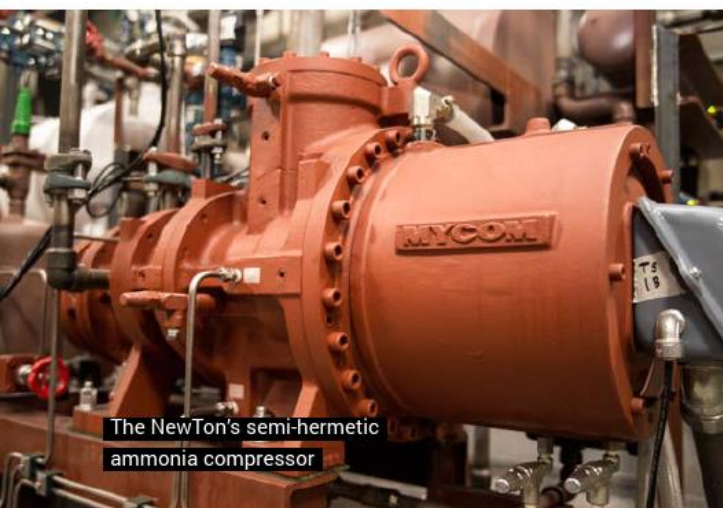
→ The system uses a closed-loop flip cooler with glycol, which heats to 95-200 °F. The glycol can be used for various purposes, such as heating underneath the freezer, or for preheating the portable water for sanitation and cleaning.

"When I discuss heat reclaim with a customer, if you install a system that can save 25% of your heating cost; that's a huge advantage," said Bell. "This is also a differentiator from other low-charge ammonia systems, and definitely from Freon."

Mayekawa sold one NewTon to Japanese confectionary company Imuraya, which sells ice cream in California. In the company's cold-storage area, Mayekawa will compare its NewTon with an identical system using R507. This will provide a direct comparison in terms of energy efficiency and performance.

Cimco expects to start sales in North America in the next quarter of the year, and have installations of the new technology by the summer, the first one being a showcase technology in Canada.

"The unit is already certified and tested by all the relevant authorities -- ASHRAE and UL in the U.S.," said Rodier "In Canada, it meets the regulation of the [CSA] B52 and local authorities as well."



The NewTon's semi-hermetic ammonia compressor



Mayekawa executives, from left: Tomo Hashimoto, Tad Kimura, Hideyo Asano and Quinn Vo.

PREDICTIVE MAINTENANCE

After installation, every NewTon package will be monitored from Mayekawa's head office in Japan, which will collect data from the equipment for analysis and maintenance. "We call it predictive and preventive maintenance," said Tomo Hashimoto, president of Mayekawa Canada. "With our cloud-based monitoring system, we are watching the NewTon's operating conditions, and we can even anticipate failures." Mayekawa is also monitoring the system's performance to see how it can fine-tune the package in the future.

In case of a failure, Mayekawa will not service the compressor on site, but change the entire NewTon unit. With a modular system of several units, this can be done with minimal downtime, as the load can be distributed. Mayekawa plans to stock spare units in Tennessee, so that they can be shipped in 5 days.

"This is a new approach in the market," said Vo. "So far, packages have been more custom-built, but now we are standardizing as much as we can. By standardizing this product at the highest quality, we are eliminating human error. If they are maintained properly, the life expectancy of the units is 30 years." **BZ MC**

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A M E R I C A

Accelerate America is published 10 times per year by shecco America. All issues are available in digital form at AccelerateNA.com. Printed copies are mailed to end users and other key HVAC&R industry players, and distributed at key industry events.*

Issue #11

Dec. 2015/Jan. 2016

Publication date: Jan. 12

Focus: The impact of regulations, standard and codes.

Distribution at AHR Expo Orlando, Jan. 25-27

Ad submission deadline: Dec. 31

Supplement to Issue #11

GUIDE to Natural Refrigerants at AHR Expo, Orlando

Publication date: Jan. 19

Distribution at AHR Expo Orlando, Jan. 25-27

Issue #12

February 2016

Publication date: Feb. 16

Focus: Food service (light commercial) refrigeration. Includes coverage of AHR Expo.

Ad submission deadline: Feb. 5

Issue #13

March 2016

Publication date: Mar. 15

Focus: Industrial refrigeration including food processing, wineries and breweries.

Distribution at IAR Industrial Refrigeration Conference & Exhibition, March 20-23

Ad submission deadline: Mar. 4

Issue #14

April 2016

Publication date: Apr. 12

Focus: Industrial refrigeration including cold storage and seafood. Includes coverage of IAR Industrial Refrigeration Conference and Seafood Expo.

Distribution at IARW-WFLO Convention, April 17-19

Ad submission deadline: Apr. 1

Issue #15

May 2016

Publication date: May 10

Focus: Commercial and industrial HVAC.

Ad submission deadline: Apr. 29

Supplement to Issue #15

GUIDE to Natural Refrigerant Contractors in North America

Publication date: May 10

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Ad submission deadline: Apr. 29

Issue #16

June 2016

Publication date: Jun. 9

Focus: Utilities & incentives.

Distribution at ATMosphere America (June 16-17), FMI Connect and Global Cold Chain Expo (June 20-23)

Ad submission deadline: May 27

Issue #17

July-August 2016

Publication date: Jul. 19

Focus: Accelerate America Award Winners. Includes coverage of ATMosphere America, FMI Connect/Global Cold Chain Expo.

Ad submission deadline: Jul. 8

Issue #18

September 2016

Publication date: Sep. 6

Focus: Food Retail.

Distribution at FMI Energy & Store Development Conference, Sept. 11-14.

Ad submission deadline: Aug. 26

Supplement to Issue #18

GUIDE to Natural Refrigerants Training in North America

Publication date: Sep. 6

Print distribution to commercial and industrial end users.

Ad submission deadline: Aug. 26

Issue #19

October 2016

Publication date: Oct. 11

Focus: Transport refrigeration. Includes coverage of FMI Energy & Store Development Conference.

Ad submission deadline: Sep. 30

Issue #20

Nov. - Dec. 2016

Publication date: Nov. 15

Focus: Regulations and Standards.

Ad submission deadline: Nov. 4

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- » Mobile Air Conditioning
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