NOVEMBER - DECEMBER 2017

ACCELERATE

ADVANCING HVAC&R NATURALLY

AMERICA

30 LEADING END USERS OF NATURAL REFRIGERANTS

> *We want to convert the companies and people who hesitate, doubt and question the value proposition of natural refrigerant-based technologies.*

Volume 4, Onwards and Upwards!

— By Marc Chasserot

Three years, three volumes and 30 issues of *Accelerate America*. We've amassed thousands of readers in both digital and print along with multitudes of podcast listeners. We've featured Target, Aldi US, Whole Foods Market, Campbell's Soup, US Cold Storage, Coca-Cola, Source Refrigeration and many more on our covers. We've provided in-depth coverage of low-charge ammonia, transcritical CO_2, hydrocarbons in commercial refrigeration, utilities and incentives, the policy revolution in California, and much more.

When Michael Garry and I set out to create North America's leading source of news and expertise on natural refrigerant-based technologies, we chose to be different. Not only did we bring great journalism, design and photography to the industry, but we also chose to focus on the movers and shakers who are disrupting the HVAC&R industry every single day. Our focus was not only about technology. I truly believe that people matter in this industry. You can have a great technology, but with the wrong person behind it nothing will change.

Accelerate America is all about fostering this change, for a better, more sustainable future, for our industry and beyond.

So, what next? *Accelerate America* has captured the fast-growing natural refrigerant share of our industry. We have become THE reference. Anyone who's job depends on knowing the latest and greatest about natural refrigerants reads us in either digital or print, or listens to our podcasts. We have the early adopters. We have the 10%.

Next, we want to capture the other 90%. We want to convert the companies and people who hesitate, doubt and question the value proposition of natural refrigerant-based technologies. This will be challenging, but we are up to the task and each day think of new ways to get our content in front of people.

We will expand our team of writers and technical experts. We will develop new industry partnerships, and each month look beyond commercial and industrial refrigeration, with commercial and residential HVAC being the priority.

We will expand our digital readership across more channels and publish twice-monthly podcasts. We will reinforce the quality of our data through sheccoBase, our repository of natural refrigerant information. And we will invest heavily in print distribution, with more copies to more readers across North America. The print experience will become a key differentiator for *Accelerate America*.

Thank you for your loyalty.

Happy reading and #gonatrefs ■ MC

Good News from America

— Editors's note by Michael Garry

As 2017 winds to a merciful close, and the holiday season kicks in, it seems like a good time to take stock of where the natural refrigerants industry in North America, particularly the U.S., finds itself.

For much of the year, the prospects for any kind of environmental progress in the U.S. have been shadowed by the decidedly anti-environment posture of the Trump administration, highlighted by its rejection of the Paris climate accord and its radically anti-regulatory Environmental Protection Agency.

And in August, the EPA's longstanding ability to regulate HFCs under its Significant New Alternatives Policy – which smooths the way for natural refrigerants – was upended by a highly questionable ruling from a three-judge panel in the U.S. Court of Appeals for the District of Columbia; a response from the court on an appeal to that ruling was pending at press time.

But then November brought a flurry of news that, particularly for natural refrigerants, was strikingly positive. Let's start with the EPA's proposal to increase the charge limit for propane, isobutane and R441A to 150 g from 57 g in new household refrigerators and freezers under the SNAP program, a move that would open the U.S. domestic market to hydrocarbon-based refrigeration appliances (page 28). The EPA will take comments on its proposed rule, but it appears to be on track for adoption.

That wasn't the only action taken by the Trump administration in support of natural refrigerants. In a Thanksgiving Day statement at the Montreal Protocol meeting in Montreal (MOP29), a U.S. State Department official, Judith Garber, said the U.S. has "initiated the process to consider U.S. ratification of the [Kigali] Amendment," which calls for a global phase-down of HFCs (page 34). Garber said the U.S. support[s] the goals and approach of the Amendment."

The U.S. Senate would still have to ratify the Kigali Amendment, but for an administration that repudiated the Paris accord, this is encouraging news indeed.

Of course, the U.S. is now the only country in the world not supporting the Paris agreement. But even that sad fact is counterbalanced by the America's Pledge initiative, which was introduced in a report to the international community on November 11 at the United Nations COP 23 Climate Change Conference in Bonn, Germany (page 30).

The America's Pledge report finds that a major swath of the U.S. – 20 U.S. states, 110 U.S. cities, and over 1,400 businesses – has adopted quantified greenhouse- gas (GHG) emissions reduction targets. One of the GHGs targeted by the report is HFCs, with reference to the Kigali Amendment's reduction goals. The report also mentions that natural refrigerants like CO_2 and hydrocarbons represent alternatives to HFCs.

So it's particularly fitting that our cover story this month, "30 Leading End Users of Natural Refrigerants," features many U.S. companies contributing to HFC reduction via natref installations (page 40).

These developments are enough to buoy the spirits for the holidays. Happy holidays, everyone! ■ MG

No matter what size your store footprint, from a small format store to a large chain grocery store, Hillphoenix, the pioneer in HFC-free CO_2 refrigeration systems has a CO_2 system sized to fit your exact needs. Why CO_2? It's a less expensive refrigerant option. It poses no threat to the environment. It's an abundant, renewable resource. It solves any compliance issues you'll likely see for today and the future. And it is where all the refrigeration technology is heading.

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VOLUME 4, ISSUE #30, NOVEMBER / DECEMBER 2017

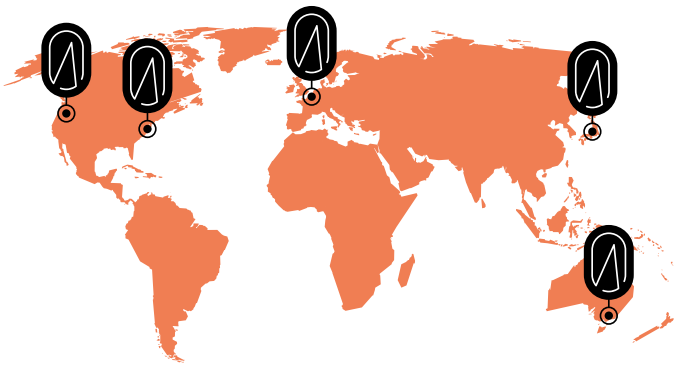
ACCELERATE

ADVANCING HVAC&R NATURALLY AMERICA

About *Accelerate America*

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

http://acceleratena.com



@AccelerateNA

POLICY

EVENTS

TECHNOLOGY

Letters to **the Editor**

Opportunities for NatRefs in California

In regard to the Editor's Note in the October 2017 edition of *Accelerate America* ("A Better Solution for Comfort Cooling"), Southern California Edison's (SCE) Emerging Products group has the responsibility for investigating new refrigeration and air conditioning technologies that can save energy and reduce electricity demand. When regulations in California push for lower GHG emissions from stationary sources, then our customers are faced with options that in some cases can increase energy consumption.

We are currently investigating packaged low-charge ammonia systems with the Electric Power Research Institute (EPRI) and Creative Thermal Systems (CTS) to understand the performance aspects of these new systems. In industrial applications, they are safer and more efficient, than large central systems; some individual low-charge packaged units installed at California facilities have capacities ranging from 22 to 40 TR. Advanced controls, better heat exchangers, and variable speed drives on everything provide opportunities to save electricity. When compared to systems that use synthetic refrigerants, we are not only seeing benefits from more efficient mechanical components, but from more efficient refrigerants for many common industrial end-uses.

The development of these systems into the commercial market is happening at lightning speed. Low-charge ammonia, CO_2, and propane systems are available, and will be added to our list for evaluation. Being able to provide incentives to our customers for safe, efficient equipment that also reduces GHG is the goal.

HVAC and refrigeration account for more than half of all the electricity loads in California. With sixteen climate zones and a directive to use climate-appropriate equipment, the opportunities with natural refrigerants provide sustainable solutions that not only reduce electricity consumption, but reduce the impact on the environment, including GHG.

The technological developments regarding new systems are overwhelming, but exciting. We look forward to more and more opportunities with smaller systems for residential and small commercial systems.

Paul Delaney
Senior Engineer, Emerging Products
Southern California Edison Company
Rosemead, Calif.

CO_2 for Air Conditioning in U.S.

You mentioned in your Editor's note in the October 2017 issue ("A Better Solution for Comfort Cooling") that "[t]here are a growing number of examples in Europe of how transcritical CO_2 refrigeration systems can be tapped for heating and comfort cooling …" It should be noted that it is not yet legal in the U.S. under the EPA's SNAP Program to use CO_2 in residential air conditioning and light commercial AC, and it is not yet legal to integrate air conditioning into a commercial CO_2 transcritical refrigeration system.

However, the North American Sustainable Refrigeration Council's Codes and Standards Progress Group is gathering a group of interested companies together to develop and submit two SNAP applications: one for the integration of AC into a CO_2 transcritical refrigeration system and one for independent commercial CO_2 AC units. Anyone interested in participating in this effort should contact the NASRC's executive director, Danielle Wright, at danielle.wright@nasrc.org.

Keilly Witman
Owner
KW Refrigerant Management Strategy
Boise, Idaho

LETTERS ARE WELCOMED!

Accelerate America invites readers to submit letters to the editor at michael.garry@shecco.com. They can be about a recent article; anything related to the ATMOsphere America 2017 conference; an industry issue that readers would like us to cover in greater detail; or the value of Accelerate America and ATMOsphere America in educating the industry about natural refrigerants, including what we can do better. Letters may be edited for clarity or length.

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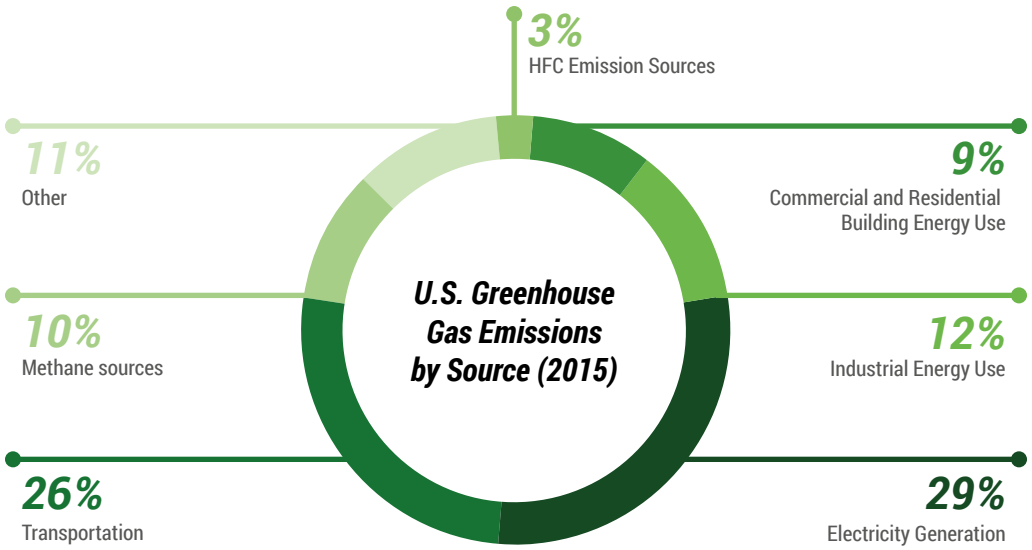
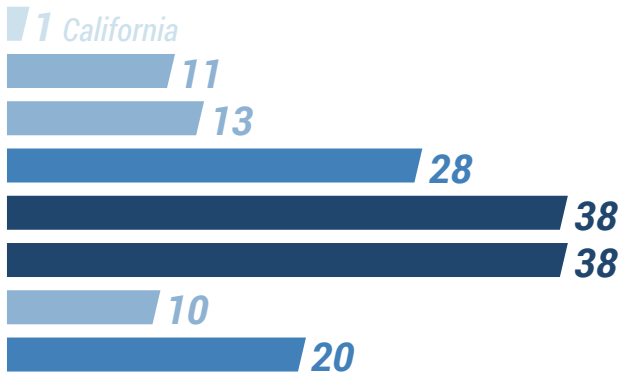
U.S. Actions to Address ***Climate Change***

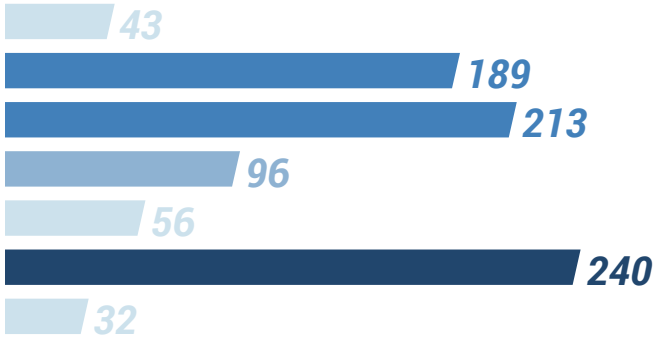
The America's Pledge report, presented at the United Nations COP23 Climate Change Conference in Bonn, Germany, outlined the measures being taken by U.S. states, cities and businesses to reduce greenhouse gas emissions. Here are some top-level findings.



Examples of Climate-Friendly Policies Adopted by U.S. States



Examples of Climate-Friendly Policies Adopted by U.S. Companies



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EVENTS GUIDE

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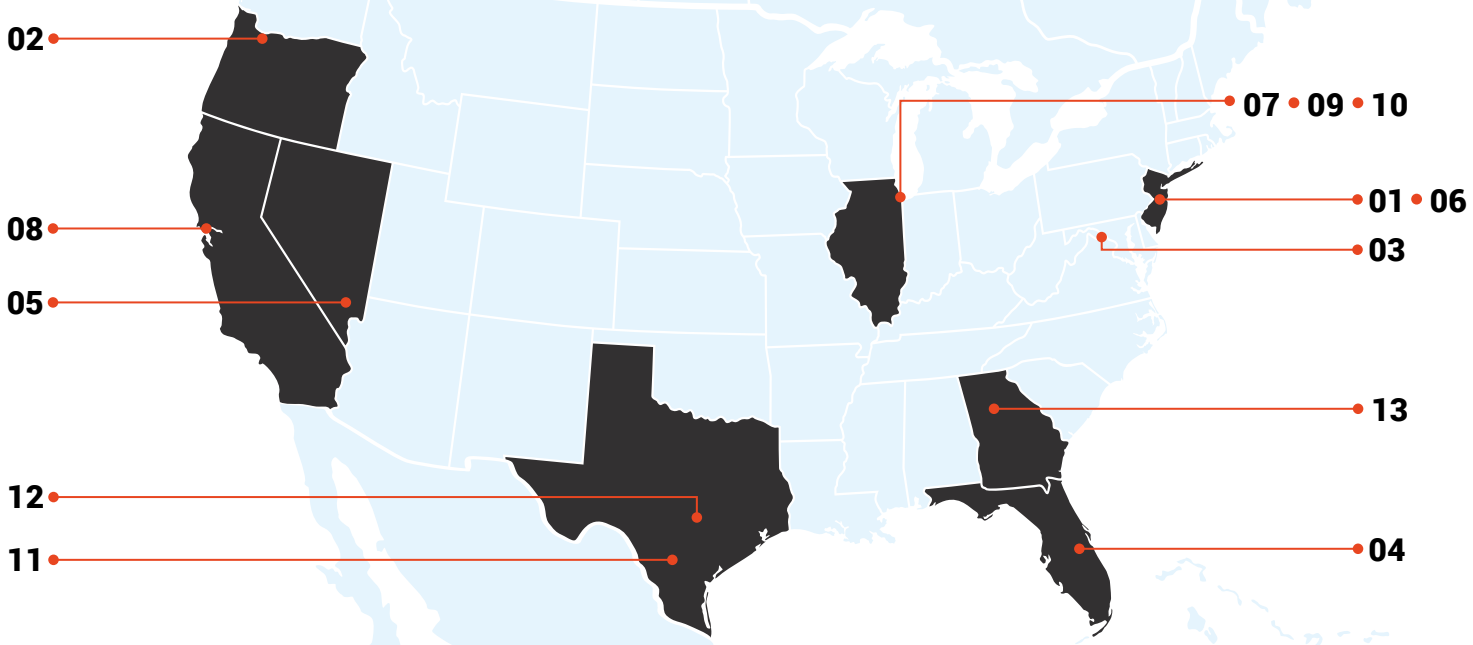


01 December 11-14, New York, N.Y.
The New York Produce Show and Conference
www: https://www.nyproduceshow.com

02 January 8-10, Portland, Ore.
Northwest Food & Beverage World
www: www.foodandbeverageworld.org

03 January 8-11, Washington, D.C.
Building Innovation 2017
www: http://www.nibs.org/page/conference2018

04 January 9-11, Orlando, Fla.
Kitchen/Bath Industry Show
www: https://www.kbis.com
@KBIS

05 January 9-12, Las Vegas, Nev.
2018 International Consumer Electronics Show (CES)
www: http://www.ces.tech/Register-Plan.aspx

06 January 14-16, New York, N.Y.
National Retail Federation (NRF) Retail's BIG Show 2018
www: https://nrfbigshow.nrf.com

07 January 20-24, Chicago, Ill.
2018 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Winter Conference & International AHR Expo
www: https://www.ashrae.org/membership--conferences/conferences/2018-ashrae-winter-conference

08 January 21-23, San Francisco, Calif.
Winter Fancy Food Show
www: https://www.specialtyfood.com/shows-events/winter-fancy-food-show

09 January 22-24, Chicago, Ill..
The International Air Conditioning, Heating, Refrigeration (AHR) Expo
www: https://ahrexpo.com
@ahrexpo

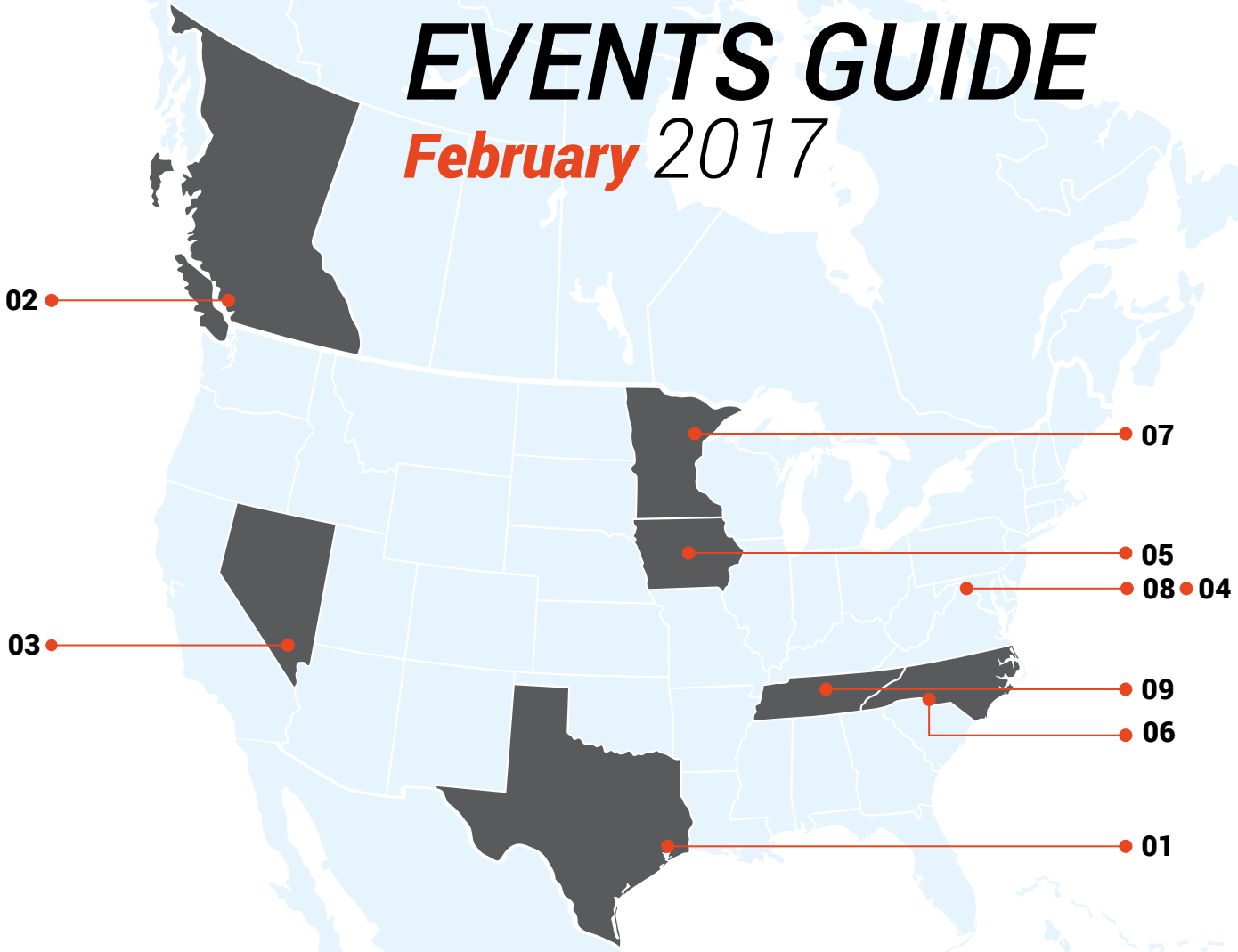
10 January 22-24, Chicago, Ill.
Indoor Air Quality Association (IAQA) 21st Annual Meeting
www: www.iaqa.org/annual-meeting

11 January 23-25, San Antonio, Texas
DistribuTECH
www: http://www.distributech.com/index.html
twitter: @DistribuTECH # DTECH2107

12 January 24-25, Austin, Texas
Build Expo – Austin 2018
www: http://buildexpousa.com/index.html

13 January 30 - February 1, Atlanta, Ga.
International Production & Processing Expo
www: http://www.ippexpo.org

EVENTS GUIDE
February 2017



01 February 4-8, Houston, Texas
Cooling Technology Institute (CTI) Annual Conference
www: http://www.cti.org/meetings.php

02 February 6-8, Vancouver, B.C.
Cargo Logistics Canada Expo & Conference
www: http://cargologisticscanada.com
twitter: @CargoLogistics # Cargo2018

03 February 11-14, Las Vegas, Nev.
The National Grocers Association (NGA) Show
www: http://www.thengashow.com
twitter: @NationalGrocers

04 February 12-14, Washington, D.C.
Indoor Environment & Energy Expo (IE3) Show
www: http://www.ie3show.com

05 February 13-14, Des Moines, Iowa
Agribusiness Showcase & Conference
www: http://www.agribizshowcase.com
twitter: @AgribusinessIA

06 February 19-23, Charlotte, N.C.
Industrial Refrigeration Workshop
www: http://conferences.k-state.edu/industrial-refrig

07 February 19-21, Duluth, Minn.
Energy Design Conference & Expo
www: http://www.duluthenergydesign.com

08 February 21-22, Washington, D.C.
USBevX 2018 – U.S. Wine & Beverage Expo
www: http://www.usbevexpo.com
twitter: @USBevX

09 February 25-27, Nashville, Tenn.
Annual Meat Conference
www: http://www.meatconference.com

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IN BRIEF

CO_2

SEACO OPTS FOR CO_2 SHIPPING CONTAINERS

Singapore-based Seaco Global Limited has ordered 100 of Carrier Transicold's NaturalLINE shipping container refrigeration units. NaturaLINE is the first container refrigeration system to use CO_2 and is an environmentally sustainable alternative for overseas shipping of perishable goods. Seaco's move is another demonstration of natural refrigerants' penetration into the maritime sector following a September decision by Maersk Line – the world's largest shipping container company – to begin testing 100 refrigerated shipping containers fitted with the NaturaLINE system. "With a refrigerated fleet of 170,000 containers, Seaco monitors the new technology being developed to meet environmental legislation and supports all measures toward protection of the planet," said Paul Merritt, Seaco's chief operating officer.

More information at:
http://bit.ly/2ne3QdG

HYDROCARBONS

UNMANNED STORES: OPPORTUNITY FOR HCs

In a sign of what's to come for retail, Holo General Equipment Co. Ltd. – a Hong Kong-based commercial retail consultancy and equipment distributor – showcased its 24-hour unmanned fully automated convenience store concept at ChinaShop 2017. The company has partnered with hydrocarbon system suppliers AHT and Husky to supply energy-efficient, stand-alone cases and plug-in freezers for the unmanned convenience stores. Customers enter a store by scanning a QR code with their mobile phone, and pay for items the same way. The unmanned convenience store concept is currently one of the hottest trends in retail in China and is quickly gaining further popularity.

More information at:
http://bit.ly/2hYIPya

AMMONIA

U.S. SEAFOODS TO REPLACE R22 WITH NH_3

U.S. Seafoods of Seattle will install ammonia freezer equipment after being found guilty of violating the Clean Air Act for releasing ozone-depleting refrigerant R22 from two of its fish-processing vessels in Alaska. Environmental Protection Agency (EPA) investigators discovered that in 2012 the freezers on two vessels owned by U.S. Seafoods were leaking R22, an HCFC with a GWP of 1,700 and an ODP of 0.05. U.S. Seafoods must pay a $135,000 penalty, replace "some or all" of its current R22 freezers with units that use ammonia, and retire those not replaced. The company will also implement enhanced leak detection and repair practices.

More information at:
http://bit.ly/2k8lG0w

RESEARCH

CUTTING HFCs CAN HELP SUSTAINABLE DEVELOPMENT

A new research paper in the journal Nature Climate Change demonstrates how reducing HFCs and other short-lived climate pollutants (SLCPs) can help countries meet all 17 Sustainable Development Goals (SDGs), which were developed at the 2012 Rio+ 20 United Nations Conference on Sustainable Development. "Many short-lived climate pollutant mitigation measures provide multiple near-term Sustainable Development Goal benefits, which can generate an appetite for even greater action," said report co-author Andy Haines, professor of public health and primary care at the London School of Hygiene & Tropical Medicine.

More information at:
http://bit.ly/2zKpCaM

HYDROCARBONS

AHT TO OPEN FIRST U.S. PRODUCTION SITE

AHT Cooling Systems USA recently announced plans for a new production site at its headquarters in Ladson, S.C. The expansion follows AHT's installation of over 1,000 self-contained propane cases in North American stores this year, and is indicative of the continually growing market for such cases. This is the Austrian-based company's first U.S. production site and will include assembly of commercial refrigeration and freezing equipment. The manufacturing site will be added to an existing 150,000-sq.-ft AHT facility, where North American operations are overseen and distribution, repairs and product development currently take place. The expansion project is slated for completion by the end of this year.

More information at:
http://bit.ly/2jtYdCZ

POLICY

AHAM: ENERGY STAR SHOULD RETURN TO DOE

The Association of Home Appliance Manufacturers (AHAM) has petitioned the House Subcommittee on Energy and Power to transfer administration of the ENERGY STAR program for home appliances from the Environmental Protection Agency (EPA) back to the Department of Energy (DOE). In 2009 the ENERGY STAR program was transferred from the DOE to the EPA, a move that AHAM says created complications that ultimately undermine the program's efficiency. The House of Representatives is currently reviewing the Energy Star Reform Act – which would permanently transfer administration of the program from the EPA to the DOE, among other changes aimed at strengthening the program.

More information at:
http://bit.ly/2zxBs84

Don't Use HFOs in ***Industrial Refrigeration***

Ammonia is a superior refrigerant, and low-charge systems are improving safety and reducing the regulatory burdens of NH_3

– By Gerard von Dohlen

Ammonia has been used successfully and safely as a refrigerant by more than 90% of the industrial refrigeration industry for around 150 years.

However, ammonia regulation in the U.S. – largely through the Occupational Safety and Health Administration's Process Safety Management (PSM) program and the Environmental Protection Agency's Risk Management Plan (RMP) – has become grossly and unnecessarily burdensome and costly.

These regulations, which strictly regulate systems with more than 10,000 lbs of ammonia, result in unnecessarily high costs with unreliable results. European regulations seem better formulated and more reasonably enforced. The U.S. regulatory climate desperately needs to be extensively revised.

Useful regulation must encourage the safe and economic use of ammonia and other natural refrigerants. This can be accomplished by reducing charge sizes, moving charges from spaces occupied by people and products, automating monitoring and response systems, and incorporating leak-minimization designs. Small and remote charges can be achieved, for example, by using secondary packaged systems, with minimal energy penalties. Modern small-charge, leak-free ammonia refrigeration systems offer a low TGWI (Total Global Warming Impact).

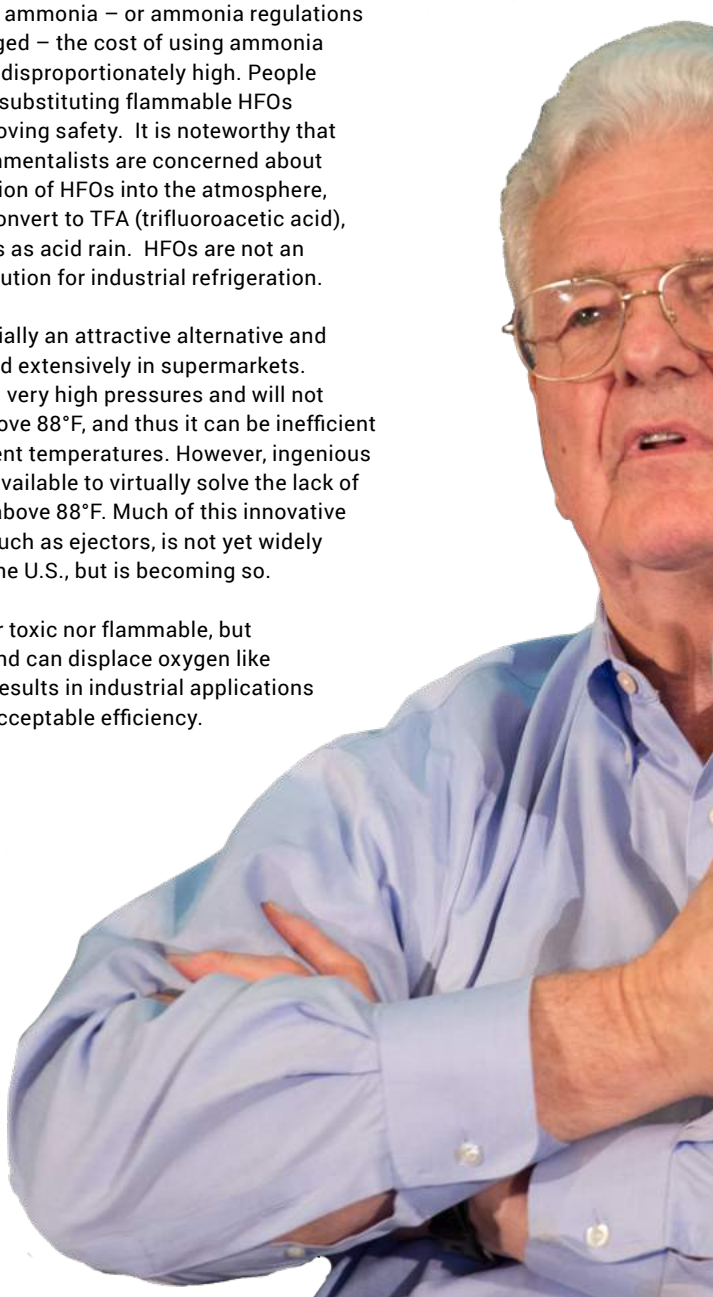
Meanwhile, the advent of a group of F-gases called HFOs has raised another set of issues. Chemical manufacturers Chemours and Honeywell have invested heavily in HFOs such as R1234yf (and the HFC R32) to replace R134a – an HFC that is prolific in vehicular air conditioners. HFOs are also being considered for use in industrial refrigeration.

Though touted as low-GWP refrigerants, R1234yf and other HFOs represent an equal or greater flammability risk than ammonia. Moreover, their poisonous products of combustion are of greater concern than those of other fluorinated refrigerants. And while HFOs are classified in toxicity group A (minimally toxic), they can displace oxygen at breathing levels in occupied spaces and cause suffocation.

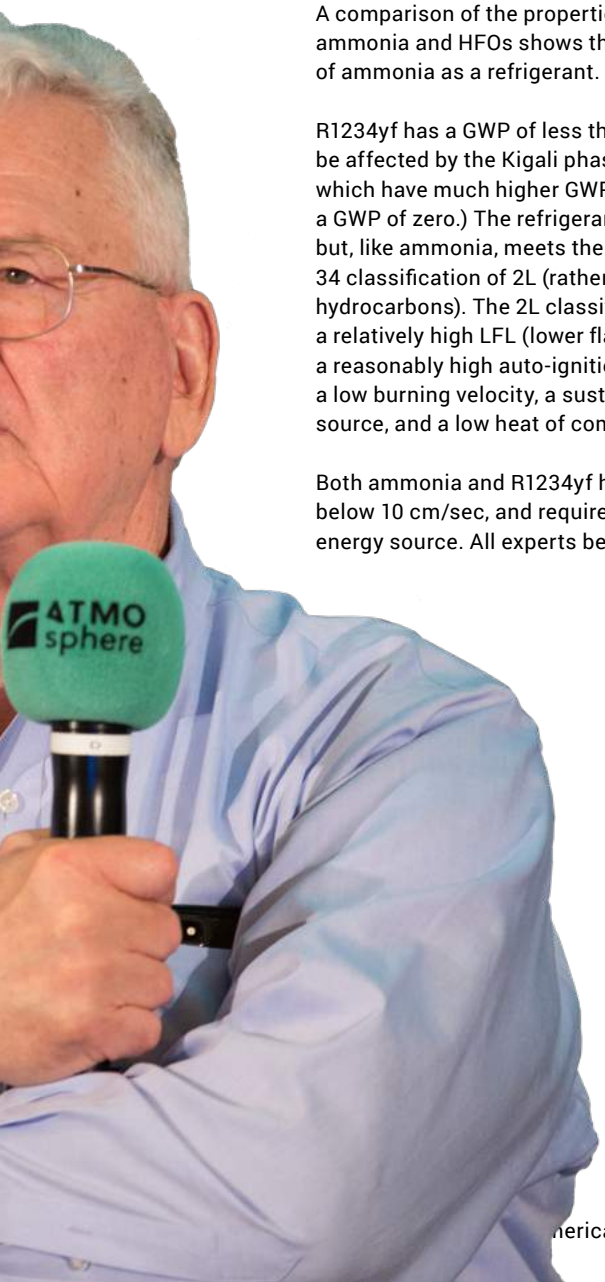
If HFOs are not subject to the same level of regulation as ammonia – or ammonia regulations are not changed – the cost of using ammonia may become disproportionately high. People will resort to substituting flammable HFOs without improving safety. It is noteworthy that some environmentalists are concerned about the proliferation of HFOs into the atmosphere, where they convert to TFA (trifluoroacetic acid), which returns as acid rain. HFOs are not an attractive solution for industrial refrigeration.

CO_2 is potentially an attractive alternative and has been used extensively in supermarkets. It operates at very high pressures and will not condense above 88°F, and thus it can be inefficient in high ambient temperatures. However, ingenious designs are available to virtually solve the lack of condensing above 88°F. Much of this innovative equipment, such as ejectors, is not yet widely available in the U.S., but is becoming so.

CO_2 is neither toxic nor flammable, but is odorless and can displace oxygen like HFOs. Early results in industrial applications indicate an acceptable efficiency.



> *If HFOs are not subject to the same level of regulation as ammonia – or ammonia regulations are not changed – the cost of using ammonia may become disproportionately high.*



Favorable ammonia characteristics

A comparison of the properties of ammonia and HFOs shows the advantages of ammonia as a refrigerant.

R1234yf has a GWP of less than 10 and will not be affected by the Kigali phase-down of HFCs, which have much higher GWPs. (Ammonia has a GWP of zero.) The refrigerant is flammable, but, like ammonia, meets the ASHRAE Standard 34 classification of 2L (rather than 3 like hydrocarbons). The 2L classification includes a relatively high LFL (lower flammability limit), a reasonably high auto-ignition temperature, a low burning velocity, a sustained flame source, and a low heat of combustion.

Both ammonia and R1234yf have a flame velocity below 10 cm/sec, and require a high ignition energy source. All experts believe it is important to eliminate ignition sources, install effective leak detection, and provide sufficient forced ventilation when a leak is detected.

But here's where ammonia and R1234yf part ways. The auto-ignition temperature of ammonia is 1,204°F, while that of R1234yf is 761°F. Ammonia's LFL is 15%-16% vs. 6.25%-12.3% for R1234yf. The refrigeration effect (latent heat of vaporization), measured in Btu/lb, is 589 for ammonia, 93 for R134a, and 77 for R1234yf. For R1234yf to produce as much refrigeration capacity as ammonia, an R1234yf system would be required to circulate 7.6 times as many lbs as an ammonia system.

Most believe the entire process of reacting to a leak – detection, abundant exhausting, elimination of the leak source by pump down, and isolation of the charge in a suitable vessel – should be automated. Thay way, it always operates upon detection of the refrigerant and doesn't require human intervention, which unnecessarily introduces errors and risk.

When it leaks, ammonia responds well to water spray such that combustion is suppressed when the water vapor is 9%-11%. Ammonia absorbs water readily; one part of ammonia will absorb 700 parts of water.

Ammonia has a significant advantage in that its vapor density (expressed as specific gravity relative to air) at standard air temperature and pressure is .6, whereas R1234yf's is 4.0, or 6.66 times that of ammonia. As a result, the exhaust of ammonia, particularly in a compressor room, is relatively easy to deal with because the ammonia vapor rises and

Gerard von Dohlen *is president of Newark Refrigerated Warehouse, Newark, N.J., which incorporates two public refrigerated warehouses using innovative refrigeration systems. He is an active member of several trade associations, including the Global Cold Chain Alliance, for which he chairs the Refrigeration and Energy Committee. In his career, he has taught accounting and finance, worked in the banking industry, and been the CEO of a building products company, a defense contractor, a hotel company, and now a public refrigerated warehousing company.*

> *Modern small-charge, leak-free ammonia refrigeration systems offer a low TGWI (Total Global Warming Impact).*

can be removed from the ceiling, while R1234yf must be collected from the floor and aggressive vapor exhaust is essential for safe operations.

R1234yf and other HFOs are odorless, but people can detect ammonia at less than 5 ppm. OSHA's permissible exposure limit (PEL) for ammonia, based on a normal 40-hour work week, is 50 ppm. People can tolerate exposures of up to 300 ppm of ammonia for short time intervals without any ill effects.

When R1234yf falls to the floor of a building, the oxygen can be displaced and people can suffocate without realizing that they are in danger. By contrast, the danger associated with ammonia is readily apparent at low exposure levels. Indeed, ammonia is aggressively self-alarming – people will not voluntarily stay in an area with an ammonia smell.

Although statistics are not easily verified, it has been stated that the number of deaths from refrigeration F-gases displacing the oxygen at breathing level are equal to those caused by ammonia.

Moreover, should a fire occur with R1234yf or other HFOs, the resulting compounds are poisonous, such as HF. This concerned German auto manufacturers – particularly Daimler, which has chosen to fit its automobiles with air conditioning that use CO_2 rather than R1234yf to meet the European MAC Directive's under-150 GWP requirement.

Even F-gases that are not classified as flammable can burn and produce poisonous compounds, whereas ammonia's products of combustion are nitrogen and water.

In other words, despite its toxicity potential, ammonia continues to be an excellent, environmentally friendly refrigerant. Packaged in low-charge units and secondary systems that remove the refrigerant from occupied spaces, ammonia can be a much safer and less-regulated option. It should be used instead of HFOs in industrial refrigeration. ■ GvD

Some characteristics of ammonia-based refrigeration:

- Excellent equipment and systems are available
- Trained mechanics, although not abundant, are available in most markets
- Users have developed good maintenance and safety procedures
- It's a mildly flammable refrigerant, but is relatively easily controlled
- It's a toxic refrigerant, but systems and procedures minimize the risks
- Exposure is readily apparent to even untrained people due to the odor
- It's cost effective
- The refrigerant is relatively inexpensive and environmentally friendly
- Secondary systems restricting the refrigerant to the compressor area are available as packaged systems, which reduce charge and exposure to people, product, and the public
- An excellent, respected professional organization (IIAR) is large and well-attended.

Fatal Ammonia Accident at Ice Rink Sparks Safety Concerns

But experts point to the rarity of such incidents, and the advent of safer technology like low-charge chillers

– By Elise Herron

On Tuesday, October 17, tragedy befell the small Canadian town of Fernie, B.C. Around noon, emergency crews were called to the Fernie Memorial Arena, an ice rink in the center of town.

There, first responders found that three men – Wayne Hornquist, 59; Lloyd Smith, 52; and Jason Podloski, 46 – had died as the result of an ammonia leak.

In the weeks following the incident, while the town of just over 5,000 mourned, local headlines ranged from alarmed ("Expert sounds alarm on ammonia at public rinks") to reassuring ("Rinks safe despite use of ammonia to chill ice, cities say"). One of B.C.'s elected officials, Wayne Stetski, even took to calling for a countrywide phase-out of ammonia in ice rinks, opting for CO_2 instead.

> *We are doing an awful lot to make [ammonia-based systems] safer.*

- Art Sutherland, Accent Refrigeration Systems


Art Sutherland

In any event, the incident left some people scared of the refrigerant that many Canadian ice rinks use.

But several industry experts on ammonia use and safety that spoke with *Accelerate America* said that vilifying ammonia is unnecessary and unwise.

What should happen, they agree, is further education on the nature and history of the refrigerant – which has been used for over a century, is readily available, energy-efficient, self-alarming, and environmentally friendly with a GWP and ODP of zero.

"If you arbitrarily jump to the conclusion that ammonia should just be banned, it's just not thinking through all the facts and understanding the situation," said Dave Rule, president of the International Institute of Ammonia Refrigeration (IIAR), an ammonia education and standards-writing body.

In the ice rink industry, ammonia has been extremely safe, said Art Sutherland, Canadian ice rink specialist and president of Accent Refrigeration Systems, Victoria, B.C. Sutherland, who entered into the ice rink industry in 1974, said there hasn't been a fatality in an ice rink due to ammonia in his or his predecessor's lifetime. "It's not something we hear about on a daily, weekly, yearly basis," he said. "It just hasn't happened in our working lifetime."

As a result, when a fatal accident does take place, "there's probably a tendency to overreact," Sutherland said. "For the families of those who lost lives, it's tragic. It's just terrible. But we are doing an awful lot to make [ammonia-based systems] safer."

The investigation into what caused the leak is still ongoing, but Sutherland speculated as to what may have happened. He said the refrigeration system being used at the Fernie Memorial Arena was a 60-year-old traditional ammonia-based system – meaning it would have had a charge of around 800 lbs.

Sutherland guesses that some sort of catastrophic leak at the chiller during facility maintenance may have led to the fatalities. But, he added, there's no way to be sure until the official investigation's conclusions are released.

While it's not uncommon for Canadian ice rink refrigeration systems to be so old – many of the country's rinks were built around 50 to 60 years ago, Sutherland said – upgrades usually take place sooner in the system's lifespan, as new innovations in technology emerge.

Low-charge: a safer solution

One of the innovations enabling safer ammonia use is the low-charge system.

Sutherland said that many of the new chillers Accent Refrigeration now installs use only one-fifth the ammonia charge of traditional systems.

"On newer systems, we're getting the ammonia charge down to less than 150 lbs," Sutherland said, "and in some cases less than 100 lbs."

On top of that, the ammonia is increasingly being installed outside of the rink in secondary chiller systems – where the ammonia is used to cool a secondary refrigerant like water or glycol and thus never actually enters the rink. The company has already installed around a dozen low-charge ammonia systems, including four low-charge ammonia packaged


low-charge ice rink chiller

Dave Rule, IIAR

systems, at ice rinks in Anchorage, Alaska; Saskatchewan province; Langford, B.C. ;and one in New Zealand.

"They've been operating very well," Sutherland said. "There's no difference between the packaged systems and an indoor unit other than we do them in outdoor machine houses that get them outside the rink."

In part, the very long fatality-free period of ammonia use has been due to the strict regulations in place wherever the refrigerant is used.

The Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) oversee regulations for ammonia use in the U.S., and Technical Safety BC does the same in British Columbia.

In addition, frequent meetings between end users, contractors, standards-writing bodies like IIAR and regulatory agencies occur in North America to ensure that best practices are being followed, said Rule and Sutherland.

IIAR even launched an Academy of Natural Refrigerants program last year to provide the industry with certificate courses on safe ammonia use and design.

"What IIAR does is address the deficiencies in the industry to make sure that workers on site have proper safety training," Rule said. "You just have to keep reminding everyone what the proper procedures and practices are and encourage them to follow those procedures."

IIAR has also become the go-to organization for ammonia safety standards, most recently encapsulated in its updated IIAR-2 standard.

Safety's not just for ammonia

The safety regulations on ammonia are stringent, and necessary, because of the refrigerant's toxicity, as the Fernie incident tragically exemplified.

However, Phil Libbert, application engineer for Calibration Technologies Inc., a manufacturer of gas detection systems, points out there are safety considerations for every type of refrigerant.

"For example, Freons – they are not as toxic, per se, but they can displace oxygen," he explained. "You may be working in a room with a Freon leak and you can't smell it. You don't know it's leaking until the oxygen level is so low that you may pass out and maybe not walk out."

On the other hand, "you can smell ammonia," he added. "I think that gives you an edge over some of these other ones. You know to get your personal protective equipment on or get out."

Ultimately, Libbert agreed, the key to avoiding fatalities in future situations with any type of refrigeration is proper training and education.

"I think ammonia is a really good, reliable refrigerant for everyone. It's just everybody needs to know the risk factors and necessary maintenance procedures to be sure ammonia systems run properly, and to prevent any type of disasters or leaks."

Looking ahead

In Canada, Sutherland said, ammonia is still a popular refrigerant, though CO_2 is starting to gain traction. And in the past few years he's seen the trend in ice rink refrigeration move towards low-charge ammonia systems.

Just weeks before the Fernie incident at a meeting Technical Safety B.C. held for major contractors and end users to discuss safety, Sutherland said, "One of the big things that got brought up was limited-charge chillers and getting the ammonia charge down. It was something that had a lot of interest among the arena operators that were there, and I think you're going to see more push towards [low-charge systems] in the future."

And, all things considered, Sutherland doesn't predict low-charge ammonia systems installations will stop at ice rinks. "At the last ATMOsphere America convention [in June, 2017] they were voting on what people felt was the best direction for industrial refrigeration and low-charge was the number one pick." ■ EH

Are Home Fridges in U.S. Turning Toward Hydrocarbons?

New AHAM servicing guidelines signal transition to hydrocarbon-based home appliances used elsewhere in the world

– By Elise Herron

Home refrigerators that use hydrocarbons such as propane or isobutane are commonplace in many parts of the world – but not in North America.

However, this could be changing, as demonstrated by newly published guidelines for the safe servicing of residential appliances with flammable refrigerants, created by the Washington, D.C.-based Association of Home Appliance Manufacturers (AHAM).

"The reason for the guidelines is that the industry is beginning to transition to a new category of refrigerants – non-HFC refrigerants and foams – that are more environmentally friendly and also widely used in Europe," said AHAM spokesperson Sydney Henderson. "However, the new refrigerants require changes to the way they are serviced, so our guidelines were developed to educate U.S.-based appliance servicers that may be dealing with the products for the first time."

The transition to hydrocarbons should be accelerated by the Environmental Protection Agency's newly proposed rule that would boost the charge limit of these refrigerants in home refrigerators to 150 g from 57 g. (See page 28.)

AHAM's new guidelines, outlined in a white paper titled "Safe Servicing of Household Appliances with Flammable Refrigerants: Recommended Practices," includes guidance on pre-service safety checks, leak detection and coolant-line repair, recharge and replacement of refrigerants, refrigerant removal and post-service procedures.

The home appliances impacted include refrigerators, freezers, ice makers, beverage coolers, room and portable air conditioners, and dehumidifiers. "The home appliance industry has already begun producing appliances that utilize these newer refrigerants," said AHAM in a statement.

The guidelines added that transitioning to hydrocarbon appliances is "part of [the home appliance industry's] continuing effort to manufacture the most energy efficient, environmentally friendly products."

But given the flammability of hydrocarbons, "it is critical that those who service and maintain appliances that incorporate these refrigerants are familiar with this new guidance as these new refrigerants are introduced to the market," AHAM said.

Global market for hydrocarbons

On a global basis, of the 100 million household refrigerators and freezers manufactured annually, about one-third or more use isobutane (R600a) or a similar refrigerant.

Growth in the U.S. market for hydrocarbon-based home refrigerators has heretofore been stunted by the EPA's charge limit of 57 g. In Europe, the charge limit for hydrocarbons in home refrigerators is 150 g.

Though the EPA has approved the use of hydrocarbons in air conditioners – with a charge limit that is based on room size and LFL (lower flammability limit) parameters – propane-based air conditioners have yet to make a strong entrance into the North American market. However, the increased production of R290-based air-conditioning units in other parts of the world demonstrates how popular they are becoming.

In China, according to the country's Ministry of Environmental Protection, manufacturers are expected to deliver 100,000 R290-based units this year. In India, manufacturer Godrej & Boyce has sold 350,000 R290-based split units since 2012.

Greenpeace, the environmental NGO, has long advocated for raising the hydrocarbon charge limit in the U.S. The group's "GreenFreeze" technology – which uses hydrocarbons in domestic refrigeration rather than HFCs – has caught on around the world.

"North American charge limits should be immediately harmonized with international standards," Janos Maté, a senior consultant in Greenpeace's political business unit told *Accelerate America* in a September interview on GreenFreeze. "With nearly 1 billion hydrocarbon fridges in the world operating perfectly safely, why are North American consumers denied the right to purchase climate-friendly refrigerators?" ■ EH

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EPA Proposes Rule to Boost HC Charge Limit ***for Household Fridges***

The SNAP rule would raise the cap for propane, isobutane and R441A to 150 g from 57 g, in line with new UL standard.

– By Michael Garry

The U.S. Environmental Protection Agency (EPA) is proposing to increase the charge limit for propane, isobutane and R441A to 150 g from 57 g in new household refrigerators and freezers under the Significant New Alternatives Policy (SNAP) program, a move that would greatly expand the U.S. domestic market for hydrocarbon-based refrigeration appliances.

The EPA's new use condition for flammable (A3) refrigerants is linked to UL 60335-2-24, Edition 2, which was revised in late April of this year to increase the hydrocarbon charge allowed in U.S. domestic refrigerators to 150 g from 57 g, the amount allowed under the previous standard, UL 250.

The previous 57 g limit was widely seen as an impediment to the adoption of energy-efficient hydrocarbon refrigeration in the U.S. domestic market. Elsewhere in the world, where 150 g has long been the charge limit for domestic refrigerators, hydrocarbon units have gained substantial market share.

The Environmental Investigation Agency (EIA) and the North American Sustainable Refrigeration Council (NASRC) submitted a petition in September asking the EPA to take this step.

"The U.S. market has lagged behind the rest of the world for many years in adopting climate-friendly fridges, due to an outdated, restrictive standard that had prevented hydrocarbon refrigerators used globally from entering the market," said Avipsa Mahapatra, Climate Campaign Lead for the Washington, D.C.-based EIA. "This rule will allow innovative American appliance manufacturers to catch up with the rest of the world."

Each year U.S. consumers purchase about 12 million new household refrigerators and freezers. Replacing the HFC commonly used as a refrigerant (R134a) in this sector with hydrocarbons could avoid emissions of up to 3.7 million metric tons of direct CO_2-e annually, according to EIA. Hydrocarbon fridges are also found to be more efficient than HFC units, EIA noted.

In a report called "Bringing the U.S. Fridge Market into the 21st Century," EIA pointed out that multinational companies like AB Electrolux of Sweden, Samsung Electronics and Haier, which are selling domestic refrigerators with R134a in the U.S., are already producing and selling models using hydrocarbons in other markets.

Efforts are also underway globally and in the U.S. to increase the allowable hydrocarbon charge in commercial refrigerators above 150 g. The IEC is considering raising the limit for flammable A3 refrigerants to 500 g.

Awaiting comments

The EPA said it's submitting the rule change – titled "Protection of the Stratospheric Ozone: Revision to References for Refrigeration and Air Conditioning Sector to Incorporate Latest Edition of Certain Industry, Consensus-based Standards" – for publication in the Federal Register. The change is considered "a direct final rule," barring "adverse comment" received within 45 days from the date of publication in the Federal Register. Comments (identified by Docket ID No. EPA-HQ-OAR-2017-0472) can be submitted to the Federal eRulemaking Portal, https://www.regulations.gov.

The EPA "is taking this action as a direct final rule without prior proposal because EPA views this as a noncontroversial revision and anticipates no adverse comments," the agency said. "The action does not place any significant burden on the regulated community and ensures consistency with industry standards."

If the EPA receives adverse comment, it will withdraw this direct final rule and address all public comments in any subsequent final rule. ■ MG

America's Pledge Includes HFC Reduction

The report unveiled at COP23 by California Governor Brown and former New York Mayor Bloomberg reaffirms U.S. commitment to the Paris Agreement on Climate Change.

– By Michael Garry

Among the ways that a growing number of U.S. states, cities and businesses will work to reduce climate change and meet the U.S. commitment to the Paris Accord will be to seek deep cuts in greenhouse gases in addition to CO_2, including HFCs, according to phase one of a new report.

The report, which describes an initiative called America's Pledge, was presented November 11 at the United Nations COP23 Climate Change Conference in Bonn, Germany. It was unveiled by California Governor Edmund G. (Jerry) Brown Jr., who is COP23 Special Advisor for States and Regions, and former New York City Mayor Michael R. Bloomberg, who is the United Nations Secretary-General's Special Envoy for Cities and Climate Change.

The report is the first communication to the international community specifically addressing the scope and scale of non-federal climate action, in contrast to the Trump administration's decision to withdraw from the Paris Agreement. Under the Obama administration, the U.S.'s Paris Agreement commitment was to reduce emissions by 26%-28% below 2005 levels by 2025.

The report points out that HFCs are a small but rapidly growing component of U.S. and global GHG emissions. Moreover, it notes that "successful transition from the HFCs specified by the Kigali Amendment [to the Montreal Protocol] will result in the avoidance of 80 billion metric tons of CO_2 equivalent by 2050 and some 0.5°C of warming by the end of the century."

The report also mentions that natural refrigerants like CO_2 and hydrocarbons represent alternatives to HFCs. "The shift away from HFCs is already underway with many businesses transitioning to less HFC-reliant systems," the reports says.

As an "opportunity to step up," the report suggests that "states, cities and businesses create public-private partnerships and/or incentive programs to accelerate the phase-down of HFC use and emissions." Such collaboration "can include R&D support to businesses developing these technologies, internal commitments to low-GWP

equipment procurement, and grant or rebate programs for low-GWP products for homes, businesses or plants."

In addtion, states "can adopt new legislation to ban sales on high-GWP refrigerants in new equipment where lower-GWP alternatives are available."

The America's Pledge report cites instances of U.S.-based initiatives that are already reducing HFC emissions through the use of low-GWP alternatives. For example, as part of the U.S. Environmental Protection Agency's GreenChill Partnership, 43 supermarket companies have committed to reducing their HFC emissions, with 533 stores becoming certified under the program since 2008; many of those stores employ natural refrigerants.

In addition, the report notes, Coca-Cola, PepsiCo, Red Bull and Unilever have installed more than 5.5 million refrigeration units using HFC-free refrigerants, with nearly 400,000 of those installed in the U.S. The Target chain is also cited for installing propane display cases in more than 1,000 stores.

Finally, the report refers to the pioneering efforts by California to reduce "super pollutants" known as short-lived climate pollutants (SLCPs), which include HFCs. Under its SLCP plan, California intends to cut HFC emissions by 40% by 2030, compared to 2013 levels.

"California is planning to outpace the HFC emissions reductions expected under the Kigali Amendment to the Montreal Protocol by adopting additional regulations and incentivizing available [low-GWP] refrigerants where available," says the report.

For its SLCP reduction program, the State of California was named the winner of the Climate & Clean Air Award in the Outstanding Policy category from the Climate & Clean Air Coalition (CCAC). CCAC announced the award at COP23. "California represents what fast action on climate change looks like and the enabling environment its policies have created is driving innovation in clean energy and green technology," said CCAC in a statement about the award.

The America's Pledge report identified 20 U.S. states, 110 U.S. cities, and over 1,400 businesses that have adopted quantified emissions reduction targets.

"The group of American cities, states, and businesses who remain committed to the Paris Agreement represents a bigger economy than any nation outside the U.S. and China," said Bloomberg. "Together they are helping deliver on the promise of the agreement and ensuring the U.S. remains a global leader in the fight against climate change. In Paris, the U.S. pledged to measure and report our progress reducing emissions alongside every other nation. Through America's Pledge, we're doing just that, and we're going to continue to uphold our end of the deal, with or without Washington." ■ MG

> *"The shift away from HFCs is already underway with many businesses transitioning to less HFC-reliant systems."*

California Senator Proposes Law to Cut HFCs

At the 23rd UN Climate Change Conference (COP23) in Bonn, Germany, last month, California Sen. Ricardo Lara (D-Bell Gardens) proposed legislation – the California Cooling Act – to reduce HFCs, considered to be the fastest growing source of greenhouse emissions in California and around the world.

Notably, the California Cooling Act includes incentives for businesses and residents to switch to low-polluting air conditioning and refrigeration. The legislation will be introduced in 2018.

"The super pollutants inside air conditioners and refrigeration are like a silent assassin that threatens our global climate, and California is sounding the alarm about the threat they pose," said Lara. "The California Cooling Act will help businesses and residents leave behind HFCs and support American manufacturers who are leading the way toward safer chemicals that do not contribute to global warming."

HFCs "disproportionately contribute to global warming and the type of extreme weather events that California has been experiencing in recent months," said an announcement issued by Lara. "Reducing these emissions will have a significant impact in the fight against climate change."

Lara's announcement follows a public workshop held by the California Air Resources Board (CARB) on October 24 as a first step towards adopting the Environmental Protection Agency (EPA) Significant New Alternatives Policy (SNAP) rules on HFC regulation, which are currently tied up in court proceedings. The workshop also addressed CARB's plans to reduce short-lived climate pollutants (SLCPs), including HFCs.

SLCP-Reduction ***Can Cut Warming 0.9°C by 2050***

UNEP's 2017 Emissions Gap report says reduction of short-lived climate pollutants, including HFCs, is an important part of mitigation efforts to meet Paris Agreement's 2°C target

– By Michael Garry

The 8th Emissions Gap Report, published last month by the United Nation Environment Programme (UN Environment), for the first time acknowledges the potential contribution short-lived climate pollutants (SLCPs) such as HFCs, methane, and black carbon (soot) can play in the global effort to keep the planet from warming more than 2°C above pre-industrialized levels.

An online post by the Climate & Clean Air Coalition (CCAC) Secretariat, citing the UNEP report, noted that over the period 2018-2050, "stringent SLCP reductions based on existing, demonstrated technical measures could reduce warming by between 0.3°C and 0.9°C relative to current emissions projections."

Roughly half of the mitigation potential is associated with methane, one-third with black carbon, and the remainder (about 17%) with HFCs.

Because they remain in the atmosphere for a shorter time than CO_2 emissions, "reductions in SLCPs have the potential to reduce the rate and degree of warming in the next few decades," the report says. "In contrast, reducing CO_2 … tends to reduce warming more slowly."

An example of the potential of SLCP-reduction is the Kigali Amendment to phase down hydrofluorocarbons (HFCs) under the Montreal Protocol, "Agreed to in October, 2016, the Amendment has the potential to decrease HFC emissions by 61% and prevent up to 0.09˚C of warming by 2050," noted the CCAC Secretariat. "Technology alternatives to HFC cooling and refrigeration systems are also often much more energy efficient than the systems they replace, which provides additional CO_2 and air quality benefits by reducing energy consumption."

By the turn of the century, the Kigali Amendment could avoid up to 0.5°C of warming, according to UN Environment.

The Emissions Gap report added that transitioning to available low-GWP alternatives faster and more thoroughly than contemplated by the Kigali Amendment represents a "major opportunity" to achieve even greater cuts in HFC emissions, with a maximum temperature drop of 0.13°C by 2050. In countries with high ambient air temperatures, almost 70% of sectors currently using HFCs "can leapfrog past [high-GWP HFCs] directly to low-[GWP] alternatives with equal or better energy efficiency."

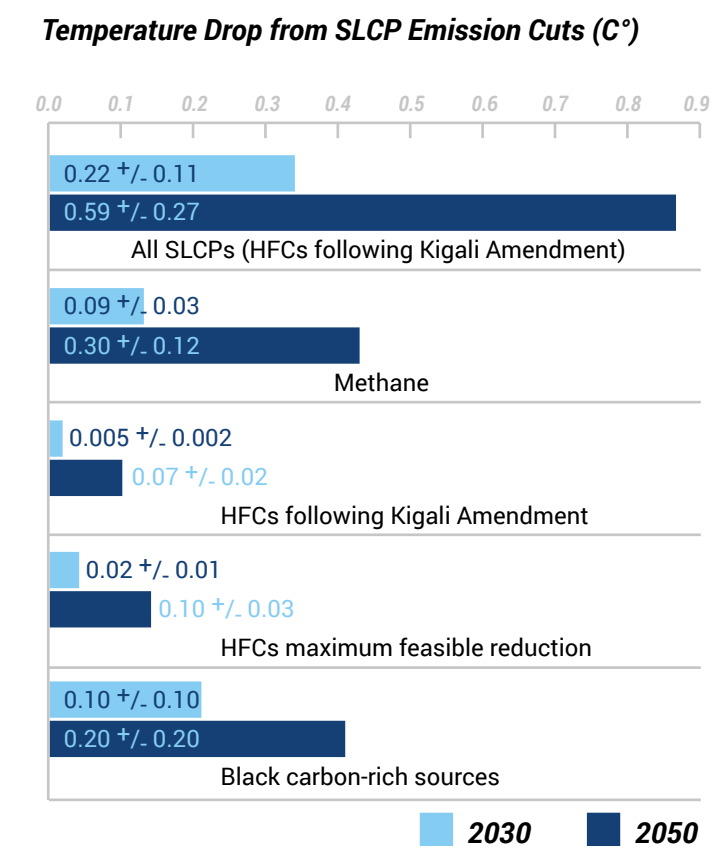
Urgent need for action

Overall, the report looks at the gap between emissions reductions needed to hold global warming to well below 2°C (preferably no more than 1.5°C) and the likely emissions reductions from full implementation of the Paris Agreement.

The report concludes that "there is an urgent need for accelerated short-term action and enhanced longer-term national ambition if the goals of the Paris Agreement are to remain achievable – and that practical and cost-effective options are available to make this possible."

Fast action to reduce SLCPs would also help "reduce climate change impacts caused by cumulative heat uptake (for example, sea-level rise, and glacier and ice-sheet melting) and reduce the likelihood of passing irreversible temperature thresholds and triggering large positive feedbacks," said the CCAC Secretariat.

The lead authors of the section of the report on SLCPs (chapter six, "Bridging the gap - The role of short-lived climate pollutants") are Zbigniew Kilmont, research scholar at the International Institute for Applied Systems Analysis (IIASA) and Drew Shindell, professor of climate science at Duke University and Chair of the Climate and Clean Air Coalition Scientific Advisory Panel. " ■ MG



Source: The Emissions Gap Report 2017, UN Environment

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Urging Energy Efficiency at COP23

The United Nations' Climate Technology Centre & Network (CTCN), which facilitates transfer of climate-friendly technologies to developing countries, urged the adoption of energy-efficient systems at the COP23 climate talks last month in Bonn, Germany.

Energy-efficient, climate-friendly technologies includes those that replace HFCs. This year, the CTCN developed a program to support the replacement of F-gases in a refrigeration system used in fruits and vegetables processing and exports in Chile, in collaboration with United Nations Development Organization (UNIDO).

CTCN, a body hosted by the United Nations Environment Programme (UN Environment) and UNIDO, operates under the "Technology Mechanism," created at COP16 in Cancún, Mexico, in 2010 to enhance the development and transfer of climate technologies to developing countries. The Technology Executive Committee (TEC) is the policy arm of the Technology Mechanism.

"Energy efficiency is critical to reach our target under the Paris Agreement," Claudia Octaviano Villasana, a member of TEC, said at COP23, which stands for the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC).

Villasana outlined the CTCN's key policy recommendations on industrial energy and material efficiency in emission-intensive sectors: promote policies and programs on industrial energy efficiency; and raise awareness about the potential costs and benefits of industrial energy efficiency. – *Marie Battesti*

U.S. to Consider Ratifying ***Kigali Amendment***

'We support the goals and approach of the Amendment," says State Department official at MOP29, despite U.S. retreat from Paris accord.

– By Michael Garry

In a Thanksgiving Day statement, an official of the U.S. State Department said the U.S. has "initiated the process to consider U.S. ratification of the [Kigali] Amendment" to the Montreal Protocol, which calls for a global phase-down of HFCs.

"The United States believes the Kigali Amendment represents a pragmatic and balanced approach to phasing down the production and consumption of HFCs, and therefore we support the goals and approach of the Amendment," said Judith G. Garber, principal deputy assistant secretary of the State Department's Bureau of Oceans and International Environmental and Scientific Affairs.

Garber made these comments at the 29th Meeting of the Parties to the Montreal Protocol (MOP29), held November 20-24 in Montreal, Canada.

The U.S. Senate is the body that would ratify the U.S. commitment to the Kigali Amendment, and is awaiting transmittal of the Amendment by the Trump Administration. The Senate approved the original 1987 Montreal Protocol and each subsequent amendment.

"There are a number of steps in our domestic process that we would need to complete before reaching a final decision on transmittal of the Kigali Amendment to the U.S. Senate for its advice and consent," said Garber, adding, "There is no timeline currently determined for these steps," before noting that the process for consideration of ratification has been initiated.

Garber ended on an optimistic note: "We have enjoyed working with all of you for the past 30 years and look forward to continuing our cooperation. We have much work ahead of us, but we can rely on a strong foundation built by decades of Ozone Heroes. We can, and will, continue that incredible legacy."

Garber's statement is one of the few made by the Trump Administration that address ways to reduce climate-warming greenhouse gas emissions. President Trump announced on June 1, 2017, that the U.S. would pull out of the Paris Accord on climate change, making it now the only country in the world not backing the agreement.


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"The Trump administration's support for Kigali, which is backed by American industry and environmentalists, is a welcome difference from its rejection of the Paris Climate Agreement, and a bright spot amid general climate darkness," wrote David Doniger, director, climate and clean air program for the National Resources Defense Council (NRDC), and Alex Hillbrand, energy efficiency and climate advocate, NRDC, in a blog.

Going into effect in 2019

The Kigali Agreement, established at MOP28 in October, 2016, will go into effect on January 1, 2019, having passed the 20-country ratification threshold on November 17, 2017. As of November 30, 22 out of 197 countries had ratified the Amendment.

Any country that ratifies it going forward will be legally bound by its HFC phase-down requirements, which differ for developed and developing countries. (By contrast, the Paris Accord is not legally binding.) Countries that don't ratify it will be subject to trade restrictions on HFCs that would block import or export of the gases while other countries are phasing down their use.

The Kigali Amendment requires developed countries to take the lead on phasing down HFCs, starting with a 10% reduction in 2019 and delivering an 85% cut in 2036 (compared to the 2011-2013 baseline). Developing countries are given until 2024 or 2026 (for those in high ambient climates) to freeze HFC consumption and begin the phase-down process.

In January, in a letter addressed to then Vice President-Elect Mike Pence, the HVACR Industry Alliance listed Senate ratification of the Kigali Amendment to the Montreal Protocol as one of its 2017 legislative/regulatory priorities for the Trump administration.

"The HVACR Alliance strongly supports Senate ratification of the Kigali Amendment to the Montreal Protocol and urges members of the Senate to align U.S. policy with the direction U.S. manufacturers are heading with regard to HFCs," said the letter, signed by Paul Stalknecht, chairman of the HVACR Industry Alliance, which includes 11 North American HVAC&R trade associations.

Support for Senate ratification also came from two executives at component manufacturer Danfoss – James Knudsen, North American segment leader for food retail, and Mark Menzer, director of public affairs. They expressed their support in an opinions piece published in the January 2017 issue of *Accelerate America*.

"This is a time for action for the U.S. Senate, which should ratify the Kigali Amendment to the Montreal Protocol so that the U.S. can remain a leader in employing new refrigerant technologies," wrote Knudsen and Menzer.

The U.S. announcement regarding the Kigali Amendment comes at a time when the Environmental Protection Agency's regulation of HFCs is in limbo, pending the appeal of a U.S. Court of Appeals ruling in August that restricted the EPA's authority under its Significant New Alternatives Policy (SNAP) to ban the use of high-GWP HFCs. Meanwhile the California Air Resources Board (CARB) is looking at adopting the SNAP rules on HFC regulation in California.

But ratification of the Kigali Amendment by the Senate would commit the U.S. to a federal HFC phase-down program, which could leverage available natural refrigerant technology as an alternative to HFCs. ■ MG

Environmental Questions about HFOs

At MOP 29, HFOs came up as a topic of some concern.

Philip Owen, from the European Commission, the EU's executive arm, cited the Ozone Research Managers' conclusion that the formation of toxic TFA (trifluoroacetic acid), as well as tropospheric ozone, results from the degradation of HFOs. This "is a concern which requires further research and evaluation."

Questions have long been raised about HFOs' impact on the environment, particularly their decomposition in the atmosphere into TFA, a long-lasting substance that descends to the earth as a form of "acid rain" and accumulates in freshwater bodies.

TFA's long-term toxicity has been the subject of ongoing scientific study. One 2014 study in *Chemosphere* – "A 17-fold increase of trifluoroacetic acid in landscape waters of Beijing, China during the last decade" – recommended that "measures are needed to control the increase of TFA in China."

In other activity at MOP29, Norway and Switzerland reintroduced a draft decision to adopt a "precautionary approach" to the development and promotion of low-GWP one-component HFCs that are not listed as controlled substances by the Kigali HFC phase-down scheme and have a GWP greater than 53.

And in a final decision, the Parties at MOP29 requested the Protocol Assessment Panels to provide a report evaluating the consumption and production of these low-GWP HFCs in time for the MOP in 2023 and every four years thereafter. – *Marie Battesti*

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MOP29, in Montreal, Canada

MOP29: *Making Progress on Kigali*

– By Marie Battesti

The primary goal of MOP29 – the 29th Meeting of the Parties to the Montreal Protocol, held November 20-24 in Montreal – was to make progress on adopting concrete measures for the implementation of the Kigali Amendent's phase-down of HFCs.

Energy-efficiency

One of those measures was energy efficiency. Integrating energy efficiency into the requirements of the Kigali Amendment is relatively new to the MOP agenda. But, according to experts at the meeting, improving energy efficiency while phasing down HFCs could double the climate change mitigation benefits of the HFC phase-down, reducing temperatures by 1.0°C by 2100.

Countries requested the Technology and Economic Assessment Panel (TEAP), an advisory body to the Montreal Protocol Parties, to assess technology options, requirements and related costs to maintain or enhance energy efficiency while phasing down HFCs under the Kigali Amendment. TEAP will make its recommendations in a report to be presented at the next Meeting of the Parties, in Ecuador in approximately a year.

Multilateral Fund

One key decision was to determine how much money will be allocated to replenishing the Multilateral Fund (MLF), which supports developing countries in achieving the HCFC phase-out and the HFC phase-down required under the Montreal Protocol and the Kigali Amendment.

The delegates' most pressing task was to successfully conclude the MLF replenishment negotiations for the triennium 2018-2020, adopting a budget of $540 million.

HC standards

The need to update safety standards impeding the uptake of flammable refrigerants such as hydrocarbons was addressed by a number of countries throughout the week.

The Parties requested the Ozone Secretariat to hold regular consultations with relevant standardization organizations to gain an overview of the relevant safety standards governing flammable low-GWP refrigerants.

The overview will include information on the scope of standards (activities, appliances or products covered), content (safety-relevant technical aspects) and information on the review process.

In a new report, "Smarter Standards: Vital for Kigali Amendment Success," the Environmental Investigation Agency (EIA) provides an update on the status of national and international safety standards for hydrocarbon refrigerants, and explains the role that revised standards will play in the implementation of the Kigali Amendment to the Montreal Protocol

"In their current state, many standards severely restrict the use of hydrocarbons, which are among the most energy efficient low-global warming potential (GWP) refrigerants," wrote Christina Starr, EIA climate policy analyst, in a blog post. ■ MB

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30 Leading End Users of *Natural Refrigerants*

A diverse array of end users – food retailers, foodservice operators and brands, and cold storage and food processing companies, as well as an ice rink operator, telecommunications company, aquarium and apartment-building owner – are pioneering the use of CO_2, hydrocarbons and ammonia in North America

– By Michael Garry and Elise Herron

North America has not been first to the party when it comes to adopting natural refrigerants – Europe and Japan are way ahead. However, over the past few years, the number of North American end users of HVAC&R equipment employing one or more natural refrigerants – CO_2, ammonia and hydrocarbons – has grown substantially, making this continent a force in the marketplace for climate-friendly systems.

The following list is an attempt to spotlight 30 end users in the U.S., Canada and Mexico that have been leading the way in natural refrigerant adoption. Every effort has been made to provide the latest information on their natref installations, but for companies that declined to comment or provide an update, a best-guess estimate of their activities is provided.

It is by no means a complete list – other companies making good use of this technology were omitted to limit the number to 30. Some companies have been pursuing natural refrigerants to great effect but under cover of darkness, so their efforts remain unknown. However, with growing concerns about climate change, many companies like to point out that they are using an environmentally friendly, energy-efficient technology that contributes to greenhouse gas reduction. Savvy operators understand that sharing information about their installations could lead other end users to adopt natural refrigerants, driving up volume and bringing down costs.

Most of the end users on this list are using natural refrigerants for refrigeration, but several are incorporating them in air conditioning and heat pumps – natref applications that are in their infancy in North America but have great potential for growth.

And while some end users have more natural refrigerant installations than others, they are not being ranked; each is considered to be making a significant contribution to the marketplace in its own way.

The food retailing sector, with its great dependence on refrigeration and its longtime susceptibility to the regulation of refrigerants, has the most entries (12) on the list of leading end users. This sector is particularly strong in the use of CO_2-based systems, including many transcritical units, but is also manifesting growing interest in self-contained hydrocarbon cases, and at a few stores, ammonia/CO_2 cascade systems.

The foodservice sector comprises a number of brand manufacturers, but also major retail outlets. Hydrocarbons – propane and isobutane – are the dominant natural refrigerant in this sector, though CO_2 figures into some companies' plans.

In the industrial sector, a mix of cold-storage and food processing operators are utilizing low-charge ammonia units, including ammonia/CO_2 cascade systems, with some companies beginning to deploy transcritical CO_2 technology.

One of the more exciting developments in the natural refrigerants marketplace is the rising number of new sectors adopting this technology, including data centers, ice rinks, public buildings and apartment buildings – each represented on this list.

We hope this list paints a clear picture of the diverse, developing and market-changing ways that natural refrigerants are being used in North America.

FOOD RETAIL SECTOR

★ Sobeys

Natural Refrigerant: CO_2

Since it began installing transcritical CO_2 refrigeration systems in 2009, Sobeys, Stellarton, Nova Scotia, has been the leading user of this technology in North America. At the end of 2016, Sobeys had 91 stores with transcritical CO_2. By the end of 2017, Sobeys was expected to have about 110 transcritical stores, mostly in Quebec, a mix of new-store and remodeled installations, from different suppliers (Carnot Refrigeration, Hillphoenix and Systemes LMP). Many are franchised stores. Every year, 15-20 more stores are equipped with transcritical CO_2, including new outlets and retrofits. Sobeys' transcritical systems have lowered energy costs by 8% to 10% compared to HFC systems, and first costs of the transcritical systems are the same or lower than those of traditional systems.

★ ALDI US

Natural Refrigerant: CO_2, propane and ammonia

As of August 11, 2017, ALDI, the fast-growing chain of nearly 1,700 value-oriented supermarkets in 35 U.S. states, had deployed a transcritical CO_2 system – the majority of them the AdvansorFlex from Hillphoenix – in 69 stores, with more installations coming. That makes ALDI is the No. 1 user of transcritical CO_2 refrigeration in the U.S. supermarket industry. Hillphoenix supplied 66 of these stores, with the other three using transcritical systems provided by a partnership between Hussmann and Canadian OEM Systemes LMP. More than 10 projects so far have been in remodeled stores, and the rest of the systems were installed in new locations. ALDI US also uses propane as a refrigerant in all spot merchandiser freezers purchased since 2015 in about 200 stores, and the chain employs an ammonia refrigeration system in each of its 24 distribution centers.

★ Whole Foods Market

Natural Refrigerants: CO_2, propane and ammonia

Whole Foods Market, Austin, Texas, has the most diverse portfolio of natural refrigerant equipment in the U.S. food retailing industry. With 474 total stores, Whole Foods now runs 24 using CO_2 in some form in a remote system, with 14 that employ only natural refrigerants, including 12 transcritical operations. The two most recent transcritical systems are in Concord and Santa Monica, Calif. Of the nine CO_2 cascade systems, one uses ammonia and another uses propane on the high side. Whole Foods' installations have earned it 10 Platinum certifications from the EPA's GreenChill Partnership. On top of that, more than 50 Whole Foods stores employ self-contained display cases incorporating propane (R290) refrigerant, mostly bunker units. Each year, natural refrigerants are considered in 15-30 additional stores.

★ Target

Natural Refrigerants: Propane and CO_2

Minneapolis-based Target Corp., which operates more than 1,800 stores, has self-contained air-cooled display cases using propane refrigerant in more than 1,000 of them, with more to come. In a study of propane vs. 134a cases, Target found that the former consumed 53% less energy than the latter. Target now only uses propane in new and replacement stand-alone display cases with a capacity of under 2,200 BTU/hr. The discounter has installed water-cooled cases using HFOs in a number of small, urban stores, but is prepared to switch to propane in those units when its charge limit is raised above 150 g. Since 2014, Target has installed its prototype CO_2 cascade system with R134a on the high side in 12 PFresh stores. Last year, the retailer installed a transcritical system in two stores, one in Marin City, Calif., and one in Minneapolis. By the end of 2017, Target will have converted more than 100 of its SuperTarget stores from R22 to an HFO blend.

★ Trader Joe's

Natural Refrigerant: CO_2

In June 2016, Trader Joe's, a national grocery chain based in Monrovia, Calif., agreed to reduce emissions of greenhouse gases from refrigeration equipment at 453 of its stores under a settlement with the Environmental Protection Agency (EPA). One of the provisions held that, at fifteen new stores or major remodels, the chain "will conduct a pilot research project using advanced, ultra-low-GWP refrigerant such as carbon dioxide (CO_2)," according to the EPA. Trader Joe's declined to provide any information about these stores. However, the California Air Resources Board, at a public meeting on October 24 discussing its HFC-reduction plans, gave Trader Joe's as an example of a "low-GWP grocer," with four transcritical CO_2 stores in Southern California.

★ Lidl

Natural Refrigerant: Propane

German discounter Lidl opened its first small-format U.S. stores in June 2017, and as of the end of November had 47 outlets, largely in Virginia, South Carolina and North Carolina. The company said it plans to open as many as 100 stores on the East Coast of the U.S., with the potential to eventually have up to 600 U.S. stores. Lidl's U.S. office did not respond to a request for comment on which refrigerant it is using. But in Europe, Lidl said last year that it has committed to using propane for all new plug-in refrigerated units throughout its German stores and plans to roll out R290 for all future installations across Europe. In some cases, Lidl is employing propane chillers with a secondary glycol loop for cooling inside the cases. European discount retailer ALDI is using transcritical CO_2 systems in its U.S. stores, in parallel to what it is doing in Europe, suggesting that Lidl may follow its European propane strategy in the U.S.

★ Piggly Wiggly

Natural Refrigerants: CO_2 and ammonia

In September 2015 a Piggly Wiggly in Columbus, Ga., operated by JTM Corp. became the fourth U.S. store to use an ammonia/CO_2 system. The ultra-low charge ammonia, which is confined to a rack on the roof, condenses CO_2, which circulates throughout the store. Because of superior energy efficiency, even in warm climates like Georgia's, the ammonia/CO_2 system is an appealing natural refrigerant technology. From October 2015 through July 2017, the NH_3/CO_2 store consumed an average of 27% less energy than another comparable store using an HFC, saving $124,800.

★ DeCicco & Sons

Natural Refrigerant: CO_2

Since late 2015, DeCicco & Sons, Pelham, N.Y., has opened two new stores with transcritical CO_2 systems, In Larchmont and Millwood, N.Y., just north of New York City. In addition, the seven-store chain has retrofitted a store in Pelham. N.Y., with a transcritical system and is waiting for approval from the town of Harrison, N.Y., to retrofit a store there. Finally, a store under construction in Somers, N.Y., will be fitted with a transcritical system. Chain president John DeCicco, Jr., said he might consider installing propane self-contained cases in future projects.

★ Hannaford Supermarkets

Natural Refrigerants: CO_2 and propane

Hannaford Supermarkets installed its first transcritical CO_2 system in July 2013 – at a store in Turner, Maine. Two years later, the 189-store New England chain, a division of Ahold Delhaize, installed a second transcritical system at a store in North Berwick, Maine. This year, it retrofitted its first existing store, in Raymond, N.H., with a transcritical CO_2 system. That retrofit was one of the first of its kind in the U.S. Hannaford's director of energy and facility services, Harrison Horning, says that the transcritical CO_2 systems are functioning so well – with increased energy savings and low GHG emissions – that they have become the chain's new standard for new stores. Hannaford has also been piloting propane cases.

★ Roundy's

Natural Refrigerants: CO_2

Roundy's, a 154-store subsidary of Kroger that operates under four banners in Wisconsin and Illinois, began using a transcritical CO_2 system at a store in Menomonee Falls, Wis., in January 2014. Since then, Roundy's has installed transcritical systems at 10 additional new stores, including four in 2017. Nine of the stores are Mariano's in the Chicago area, one is a Pick 'n Save in Wisconsin and one is a Metro Market in Wisconsin. Next year, the company plans to install another transcritical system at a Mariano's in the Chicago area. The transcritical system saves $13,000 in annual energy costs over a comparable HFC system and delivers an annual reduction of 33.6 metric tons of greenhouse gas.

★ Sprouts Farmers Market

Natural Refrigerants: CO_2

In July 2017, Phoenix-based Sprouts Farmers Market opened a store in Woodstock, Ga., one of the first in North America to use a transcritical CO_2 booster system with parallel compression (from Hillphoenix) and an ejector (from Danfoss). Lab testing by Hillphoenix showed that parallel compression alone boosts the peak energy efficiency of a transcritical system by 8% while adding the ejector brought peak savings to 11.3% (under non-optimized conditions). Sprouts also operates a transcritical system with a BAC adiabatic condenser in Dunwoody, Ga., and a CO_2 cascade system at a store in Thousand Oaks, Calif. In September, the chain, which operates more than 260 stores, won the Environmental Protection Agency's GreenChill award for Store Certification Excellence, with 69 certified stores over the past year.

★ Defense Commissary Agency (DeCA)

Natural Refrigerants: CO_2

The Defense Commissary Agency (DeCA) is the "supermarket to the military" with 240 stores worldwide. In 2014, DeCA began experimenting with natural refrigerant-based systems with an ammonia/CO_2 cascade system at a commissary in San Antonio, Texas. Since then, the agency has completed three U.S. transcritical CO_2 retrofits in existing commissaries – in Newport, R.I.; Mojave, Calif.; and Mountain Home, Idaho. All of the transcritical systems employ adiabatic condensers and parallel compression. Outside the U.S., DeCA has installed a transcritical CO_2 system at a new store in Spangdahlem, Germany, and it plans to deploy a transcritical system at an existing commissary in northern Italy that will be the first to include an ejector to help with efficiency in the warmer climate.

FOODSERVICE SECTOR

★ Red Bull

Natural Refrigerants: Hydrocarbons

The Austria-based company, with U.S. headquarters in Santa Monica, Calif., started deploying hydrocarbon-based ECO-Cooler beverage merchandisers in 2008. Red Bull has to date installed a total of 980,000 ECO-Coolers globally, amounting to more than 80% of its fleet of cooling equipment. Most of the coolers employ isobutane, though some use propane. In the U.S., to date, Red Bull has deployed over 270,000 isobutane ECO-Coolers. In 2013, the company helped to get approval from the Environmental Protection Agency for isobutane to be used in commercial stand-alone refrigeration. The hydrocarbon-based ECO-Cooler units, which include LED lighting and energy-efficient fans, use up to 45% less energy than standard coolers (23% less on average). The company has also established a hydrocarbon cooler servicing summit to train contractors and developed a hydrocarbon cooler handbook. Red Bull is a member of Refrigerants, Naturally! and the North American Sustainable Refrigeration Council (NASRC).

★ Coca-Cola

Natural Refrigerants: CO_2 and hydrocarbons

According to its 2016 Sustainability Report, released in August of this year, Atlanta-based Coca-Cola, the world's largest beverage company, added more than 623,000 HFC-free coolers, fountains and vending machines globally in 2016. This ramped up the total number introduced since 2009 to 2.5 million. As of October 2015 (when its global HFC-free installations were 1.5 million units) Coke had installed nearly 100,000 HFC-free units in North America. Between 2000 and 2015, the company improved the energy efficiency of its equipment by 40% (in part by using intelligent energy management devices) and had eliminated 75% of direct greenhouse gas emissions by transitioning to HFC-free insulation foam in new equipment. Up until last year, about half of Coca-Cola's HFC-free units used CO_2 as a refrigerant. However, the company then shifted course, opening the door to more hydrocarbon equipment. Coke's goal: As of 2020, all new cold-drink equipment will be HFC-free. Coca-Cola is a member of Refrigerants, Naturally! And the Consumer Goods Forum.

★ PepsiCo

Natural Refrigerant: Propane

In the U.S., PepsiCo plans to phase out HFCs from new vending machines and coolers by 2019, using propane instead where regulations allow, and is about halfway through its conversion plans. PepsiCo updated its specifications to meet the Department of Energy's 2017 efficiency requirements. In 2015, the food and beverage giant joined a private-sector initiative to reduce cumulative global consumption of HFCs by the equivalent of 700 million metric tons of CO_2e through 2025. PepsiCo is a member of Refrigerants, Naturally!.

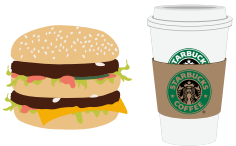
★ Nestlé

Natural Refrigerants: Hydrocarbons

Nestlé, the Swiss food and beverage manufacturer with U.S. headquarters in Rosslyn, Va., introduced its first hydrocarbon-based ice-cream chest freezer in 2011. Since 2014, all of the company's new ice-cream chest freezers in Europe have been HFC-free. This policy was extended worldwide in 2015. Since 2016, all of its new ice-cream chest, upright and island freezers have used hydrocarbons, either propane or isobutane, worldwide. By 2020, all new proprietary cold beverage dispensers made by Nestlé Professional will use hydrocarbons.

★ Starbucks

Natural Refrigerant: Propane



At ATMOsphere America 2015 in Atlanta, Paul Camera, senior director, Global Research & Development for Starbucks, outlined the coffee purveyor's plan to transition more than 150,000 front- and back-of-house refrigeration units to natural refrigerant systems, starting with propane for small equipment. Starbucks declined to comment on its progress, but over the past year a number of foodservice equipment suppliers have developed energy-efficient upright and under-counter commercial refrigeration equipment using propane that would meet Starbucks specifications. The units are more efficient than their HFC predecessors and meet the new Department of Energy efficiency requirements launched in March 2017. Energy efficiency is one of Starbucks' paramount concerns, said Camera. "When we talk about why we need to replace existing equipment, it's just costing us too much."

★ McDonald's

Natural Refrigerants: Propane, isobutane and CO_2

McDonald's natural refrigerants journey began in 2003, when it opened an HFC-free restaurant in Vejla, Denmark, that employed propane, isobutane and CO_2 in various equipment. By 2015, the number of HFC-free pieces of equipment at McDonald's European restaurants had unofficially grown to as high as 13,500 units using propane, isobutane of CO_2. The equipment proved to be 38% more energy efficient than conventional alternatives, meeting a key requirement for Oakbrook, Ill.-based McDonald's, which wants to achieve a 20% increase in energy efficiency in company-owned restaurants by 2020. (Eighty percent of its restaurants are franchised.) Typically, the company has focused on replacing end-of-life equipment and installing energy-efficient systems in new restaurants. McDonald's did not comment on its progress in the U.S. but is known to have begun using propane commercial equipment in the states, where the market for this equipment has developed substantially in the past few years.

★ Unilever

Natural Refrigerants: Hydrocarbons

Since 2004, Unilever, owner of Vermont-based Ben & Jerry's ice cream, has been replacing point-of-sale ice-cream freezer cabinets with equipment that uses hydrocarbons (propane or isobutane). Ben & Jerry's application to the Environmental Protection Agency in 2009 led to the agency's approval of hydrocarbons for commercial applications in 2011. Today, in the U.S., Unilever buys only hydrocarbon cabinets, which are 10% more energy efficient than traditional models. Globally, it has purchased more than 2 million hydrocarbon units. The company is a member of Refrigerants, Naturally!.

> *"Today, in the U.S., Unilever buys only hydrocarbon cabinets, which are 10% more energy efficient than traditional models"*

INDUSTRIAL SECTOR

★ Henningsen Cold Storage Co.

Natural Refrigerants: Ammonia and CO_2

Henningsen Cold Storage, an 11-plant operator based in Hillsboro, Ore., has carved out a reputation for reducing the ammonia charge at its warehouses by eliminating components and using evaporator coils with low overfeed ratios. Under the leadership of Pete Lepschat, is engineering services manager, Henningsen reduced its charge-to-capacity ratio from as much as 52 lbs/TR in 1993 to 12 lbs/TR at a plant in Salem, Ore., in 2014. Another Salem plant opened this year with a charge of 16 lbs/TR. Next summer, Henningsen plans to open a 110,000-sq-ft facility in Grandview, Wash., that will be its first to use a transcritical CO_2 system; it will be supplied by Carnot Refrigeration and installed by PermaCold Engineering. The system will comprise about 3,000 lbs of CO_2 with a refrigeration capacity of 210 TR for a 0°F to -5°F freezer with a refrigerated dock. Henningsen is looking at energy-saving options such as an adiabatic condenser and ejectors and is exploring a use for the waste heat.

★ Campbell Soup

Natural Refrigerants: Ammonia and CO_2

Campbell Soup, based in Camden N.J., was one of the pioneers of low-charge ammonia systems in the industrial refrigeration sector, starting in the late 1980s. Today, most of Campbell's thermal plants use less than 10,000 lbs of ammonia, having adopted low-charge ammonia skids in a machine room with glycol or chilled water as a secondary fluid. In addition, Campbell has converted four Pepperidge Farm bakeries (with another planned) from R22 and HFCs to low-charge ammonia skids. At its latest conversion, in Lakeland, Fla., the bakery is using Campbell's first NH_3/CO_2 system. At a plant in Napoleon, Ohio, Campbell installed a low-charge ammonia chiller package for air conditioning, one of the first of its kind in the U.S. Located outside the plant, it generates cold glycol piped to an air handler that cools a labeling and packaging area.

★ Prairie Farms

Natural Refrigerant: Ammonia

Turner Dairy, member of Prairie Farms, is installing five low-charge packaged ammonia units from Evapcold at its plant in Memphis, Tenn., as part of an expansion and remodeling project. The units include two 35°F penthouse coolers (200 TR total) for a milk storage area, and two process cooling chillers (260 TR total) located on the ground outside the plant; the chillers use secondary glycol to cool ingredient tanks and pasteurizers. The first penthouse unit has been running since July 2017, and the second penthouse is being installed next month. The two chillers will then be installed in a few months. In addition, Turner Dairy is ordering a third chiller for the final building phase. Altogether, the capacity will be 720 TR with a total ammonia charge for the plant of 1,226 lbs (1.7 lbs/TR).

★ Konoike-Pacific California (KPAC)

Natural Refrigerant: Ammonia

General Cold Storage, a division of Konoike-Pacific California (KPAC), this year opened a 100,000-sq-ft state-of-the-art facility in South Gate, Calif., that uses eight rooftop "ultra-low-charge" ammonia units from NXCOLD. The largest ammonia charge in the units is 30 lbs; the smallest, 15 lbs. The units are being used in five -10°F freezers and one 34°F dock. Their energy efficiency is being vetted by the California Energy Commission, the Electric Power Research Institute (EPRI) and Southern California Edison (SCE), which has calculated an energy incentive of $85,000. The facility is expected to save $1.4 million in energy costs over five years compared to a traditional system.

★ U.S. Cold Storage

Natural Refrigerants: Ammonia and CO_2

When U.S. Cold Storage (USCS) decided to install an ammonia/CO_2 cascade system at a plant in Bethlehem, Pa. in 2005, it was one of the first U.S. industrial refrigeration sites to do so. USCS, a division of U.K.-based Swire, has since installed ammonia/CO_2 cascade systems at 12 more cold-storage facilities. The system caught on in the industry, and now numerous other food processing and cold storage companies in North America deploy similar systems. At one warehouse in Laredo, Texas, the company has installed a low-charge DX system from Colmac Coil. Currently, USCS is planning three new systems, either ammonia/CO_2 cascade or low-charge DX.

★ Frialsa

Natural Refrigerants: Ammonia and CO_2

Mexico City-based Frialsa Frigorificos, Mexico's largest cold-storage operator, has made ammonia/CO_2 its standard refrigeration system. Starting in 2010, Frialsa uses this technology at five of its 24 facilities. Four of the plants employ an NH_3/CO_2 cascade system from M&M Refrigeration while at the fifth, an expansion of the facility has been equipped with a rooftop ammonia/glycol chiller (about 1 lb/TR) from Tewis (installed by Bohn); the chiller supplies glycol inside the building to condense a low-temperature CO_2 DX system and medium-temperature pumped CO_2. In addition, Frialsa is starting up new NH_3/CO_2 systems at two new plants.

★ Wholesome Harvest Baking

Natural Refrigerants: Ammonia and CO_2

In September 2016, Wholesome Harvest Baking, a division of Mexico-based Grupo Bimbo, became the first company in Canada to install the NewTon, Mayekawa's ammonia/CO_2 packaged refrigeration system. The project, which took place in an expansion of a Toronto bread-making plant, was also only the second of its kind in North America. The NewTon, which keeps the refrigerant charge well below 10,000 lbs, is well established outside of North America – with over 1,000 in Japan alone. Wholesome Harvest was ultimately drawn to the safety, environmental friendliness and energy efficiency of the system.

> *"Wholesome Harvest was ultimately drawn to the safety, environmental friendliness and energy efficiency of the system."*

OTHER SECTORS

★ Mercy Housing

Sector: Residential Buildings

Natural Refrigerant: CO_2

Sanden's SANCO$_2$ domestic hot-water heat pump can be used in multiple tank and heat pump combinations to provide hot water to apartment buildings. This year, Mercy Housing, a Denver-based affordable-housing nonprofit, installed them in six of its Northern California properties. One 93-unit apartment building in San Francisco deployed 11 of the heat pumps, replacing a 726,000 BTU/hr gas boiler system. The latest model of the 4.5 kW heat pump has a capacity of 15,400 BTU/hr and can produce hot water up to 175F with outdoor temperatures as low as -20F. In a comparison of Energy Factors, the Sanden SANCO$_2$ heat pump has a rating of 3.84, vs. 3.0 for an HFC heat pump, 0.95 for a tankless gas heater and an electric storage heater, and 0.67 for a gas storage heater.

★ Municipality of Anchorage, Alaska

Sector: Ice Rinks

Natural Refrigerants: CO_2

The Municipality of Anchorage, Alaska, has deployed four transcritical direct CO_2 systems at municipal rinks. The facilities – the Harry J. McDonald Center, Sullivan Arena, Ben Boek arena, and Dempsey Anderson arena – previously used aging R22 systems. Now, CO_2 circulates under the rink floors to keep the ice frozen. Hillphoenix was the designer and installer of the rinks, the first four in the U.S. to use CO_2 as a refrigerant. The U.S. EPA approved CO_2 for use in ice rinks in May 2016.

★ Bell Canada

Sector: Data Centers

Natural Refrigerant: CO_2

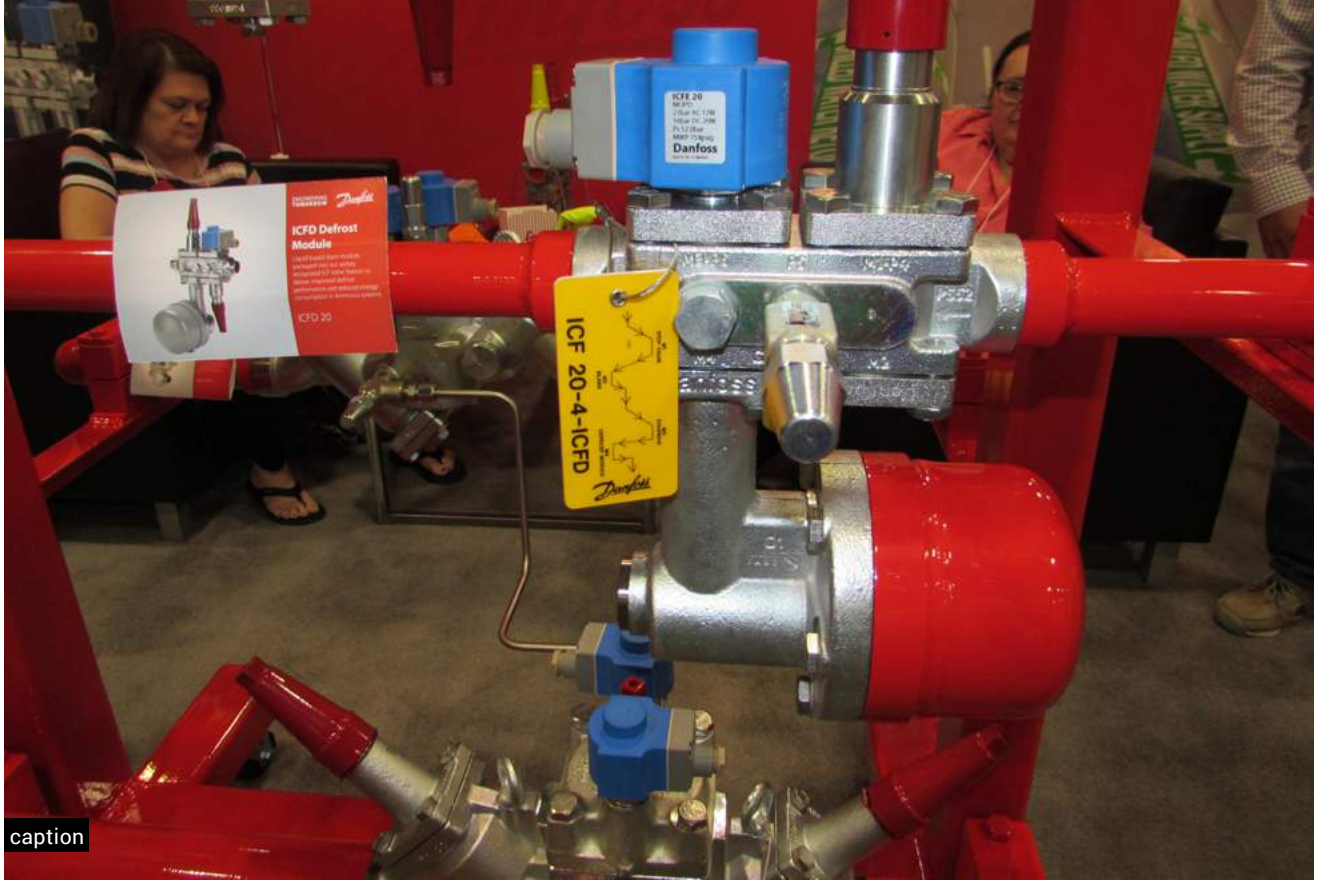
Montreal-based Bell Canada, which began installing Carnot Refrigeration's 105 kW Aquilon CO_2 transcritical CRAC (computer room air conditioning) systems in September 2014, now has about 45 CO_2 units, with more on the way, including CRAC systems, chillers and in-row units, said Marc-André Lesmerises, Carnot's CEO. The CO_2 units, which replaced R22 systems, take advantage of free cooling when outside air temperature drops below that needed by the computer room. The in-row units are located between rows of computers, allowing "direct control at the heat source," said Lesmerises, and the units don't use water or air in free cooling.

★ Alaska SeaLife Center

Sector:Public Buildings

Natural Refrigerant: CO_2

Located in Seward, Alaska, the Alaska SeaLife Center shifted 98% of its annual heating needs from fossil fuel to ocean water as a heat source, using heat pumps – including four 20-TR CO_2 units – in place of oil-burning and electric boilers. The Mayekawa CO_2 heat pumps, which were installed in January 2016, produce heat up to 194°F in a multi-loop hydronic system for multiple medium-temperature loads, including baseboards, an air handling unit and hot water. The COP of the system is approaching three, with more loads to be added. The project represents one of the first installations of CO_2 heat pumps to replace oil or electrical boilers in a conventional heating system in the U.S. ■ MG & EH



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Ammonia Advances Seen at RETA

The RETA National Conference featured low-charge ammonia systems and products designed to improve the efficiency and safety of the technology

– By Michael Garry

Here is a look at some of the developments in ammonia refrigeration observed at the RETA (Refrigerating Engineers and Technicians Association) National Conference, held in Hershey, Pa, September 25-29.

Danfoss's new Defrost Module

Danfoss displayed its new ICFD Defrost Module (type ICFD 20) for ammonia systems, packaged into its ICF Valve Station, at its RETA booth. Unlike most defrost devices for evaporators, which use pressure regulators, the Defrost module employs a mechanical float ball and a liquid drain method, noted Jim Hower, industrial refrigeration national sales manager for Danfoss.

"It keeps excess hot gas from bypassing the evaporator," only allowing liquid to pass through, he said. This up-to-90% reduction of blow-by gas results in less loading of compressors, which in turn saves energy. End users can cut energy costs by $1 per defrost per evaporator and achieve less than a two-year payback on the extra cost of the device. he added. The module serves evaporator capacity up to 58 TR (200 kW).

Terry Chapp, national business development manager for Danfoss, explained efficiency factor further. "When you are bringing hot gas to the coil to defrost it, and you let it out through a pressure regulator, what happens to the hot gas – it gets recompressed, which is wasted energy," he said. Moreover, he noted, excess hot gas creates more humidity, which creates more defrost to form. "With a float drainer, it only opens up when there's enough liquid in it to drain. You use all the hot gas for defrost.

The module's float drainer is not new technology but has been "historically difficult to install and size," said Terry Chapp, national business development manager for Danfoss. "This is a simplified, more effective solution than previous designs. We created a device that is self-regulating."

Hillphoenix's NXTCOLD development

Conyers, Ga.-based Hillphoenix, a leading manufacturer of CO_2 commercial refrigeration systems, announced in late September the addition of NXTCOLD ultra-low-charge ammonia systems to its industrial refrigeration portfolio. The patented technology will be available to customers in North America and Latin America for cooler, freezer and blast freezer applications.

Hillphoenix is now in the process of developing a standard platform for NTXCOLD comprising 36 models that will include low- and medium-temperature as well as convertible units, with capacities ranging from 10-120 TR, said David Neu, vice president, industrial refrigeration for Hillphoenix, at the RETA Conference. Hillphoenix is actively selling the system for light and heavy industrial applications, and plans to do a full launch of the line in 2018.

As it markets NXTCOLD, Hillphoenix will be educating the marketplace on the technology behind it, said Neu. End users may not "understand how low the charge is and that it's made of time-tested industrial components."

NXTCOLD's ammonia charge of 6 oz to 8 oz/TR is the lowest-charge ammonia refrigeration solution available for large refrigeration facilities, said Hillphoenix. Eight NXTCOLD units were installed this year at a new 100,000-sq-ft General Cold Storage plant in South Gate, Calif., and the equipment will be used at a US Growers Cold Storage facility under construction in Vernon, Calif.

Colmac's flourishing DX system

Colmac Coil Manufacturing, based in Colville, Wash., continues to market its low-charge Advanced DX (ADX) ammonia system, said Jerry Francis, senior refrigeration sales engineer for Colmac. "It's become a regular product for us. It's no longer a novelty – it's part of the industry. He estimated that "at least a dozen" facilities have installed the system, including Joliet Cold Storage, Joliet, Ill.; Preferred Freezer Services, Richland, Wash.; US Cold Storage, Laredo, Texas; Shepherd's Processed Egg, Spanish Fork, Utah; and J&D Refrigerated Services, Clackamas, Ore.

The Shepherd's Processed Egg facility uses 400 lbs of ammonia to deliver 150 TR of capacity, a ratio of only 2.7 lb/TR. In the Colmac ADX system, the ammonia in the evaporator is reduced by 30-50 times compared to a traditional ammonia overfeed system, said Bruce Nelson, president of Colmac Coil, speaking last June at the Global Cold Chain Expo. "That takes a lot of risk out of the occupied space and gets the overall charge well below 10,000 lbs."

CTI's sturdy gas detectors

Calibration Technologies Inc. (CTI) talked about what distinguishes its ammonia and CO_2 gas detectors. "Our sensors are coated in epoxy," protecting them from corrosion, said Debbie Koske, marketing assistant for CTI. "They're protected from wash downs, spray downs and chemical washes."

The detectors are also designed to withstand a wide temperature range, from -40°F to 140°F, she added.

CTI has just started making emergency stop switches required outside of engine rooms. ■ MG

CO_2 at RETA

The RETA National Conference displayed a myriad of ammonia technologies, but CO_2 systems were seen and discussed as well.

Heatcraft Worldwide Refrigeration displayed a commercial transcritical CO_2 booster system on the RETA exhibition floor, but the point was to stimulate a discussion "about CO_2 as a viable option for industrial applications," said Grady McAdams, director of cold storage sales for Stone Mountain, Ga.-based Heatcraft. "People did a double-take, seeing it was CO_2 not ammonia. But that led to a lot of great discussions."

Heatcraft is beginning to deliver the next transcritical platform that "will go larger" than commercial units, he said.

Adiabatic gas coolers are one of the specialized technologies that enable transcritical CO_2 refrigeration systems to operate efficiently in subcritical mode in high ambient temperatures.

As evidence of that, Baltimore Aircoil Company (BAC) has installed its TrilliumSeries Condenser, an adiabatic gas cooler, with transcritical CO_2 systems in a number of southern U.S. supermarket locations, including Miami, Ft. Lauderdale and Naples, Fla., as well as Southern California locations such as Cerritos, Palm Springs and Palm Desert, said Paul Noreen, BAC's director of sales for North America, at the RETA Conference.

"We have transcritical operating in subcritical mode year-round in the hottest climates in the country," he said.

The addition of an adiabatic gas cooler increases the cost of a transcritical system about 10%, said Noreen, though the improved efficiency lowers the total cost of ownership.

The stores do not use ejectors or parallel compression, though Noreen acknowledged that those features would further enhance the efficiency of the transcritical systems.


Rusty Walker, Hillphoenix

Rusty Explains CO_2

At the RETA Conference, Hillphoenix trainer Rusty Walker breaks down how transcritical CO_2 works for an audience of ammonia technicians

– By Michael Garry

As industrial refrigeration operators work on reducing the amount of ammonia in their systems, there is one option that eliminates ammonia altogether but is still a natural refrigerant – CO_2.

Of course, ammonia has long been and will continue to be the coin of the realm in industrial refrigeration. But slowly, some cold-storage and food-processing operators, mindful of regulatory pressures, are pursuing the CO_2 alternative. For some, such as United States Cold Storage and the Mexican operator Frialsa, the change has started with ammonia/CO_2 cascade systems.

But now some companies are starting to install transcritical CO_2 systems. One example is Henningsen Cold Storage, which is working with PermaCold Refrigeration to install a transcritical CO_2 system from Canadian CO_2 pioneer Carnot Refrigeration at a plant being built in Grandview, Washington. (See page 47.)

Conyers, Ga.-based Hillphoenix, one of the leading providers of transcritical CO_2 systems to supermarkets in North America, also markets these systems to industrial end users as well as ice rinks. In an effort to educate technicians who typically work in ammonia industrial plants on the finer points of transcritical CO_2, Hillphoenix sent its engaging senior corporate trainer, Rusty Walker, to the RETA

(Refrigerating Engineers and Technicians Association) National Conference, held in Hershey, Pa., September 25-29.

Walker's presentation mirrored a white paper called "CO_2 Booster System Technology Explained," by Bill Katz, senior technical writer for Hillphoenix. "CO_2 in transcritical industrial systems so far remains limited and many potential users only have a partial understanding of how the technology works," wrote Katz.

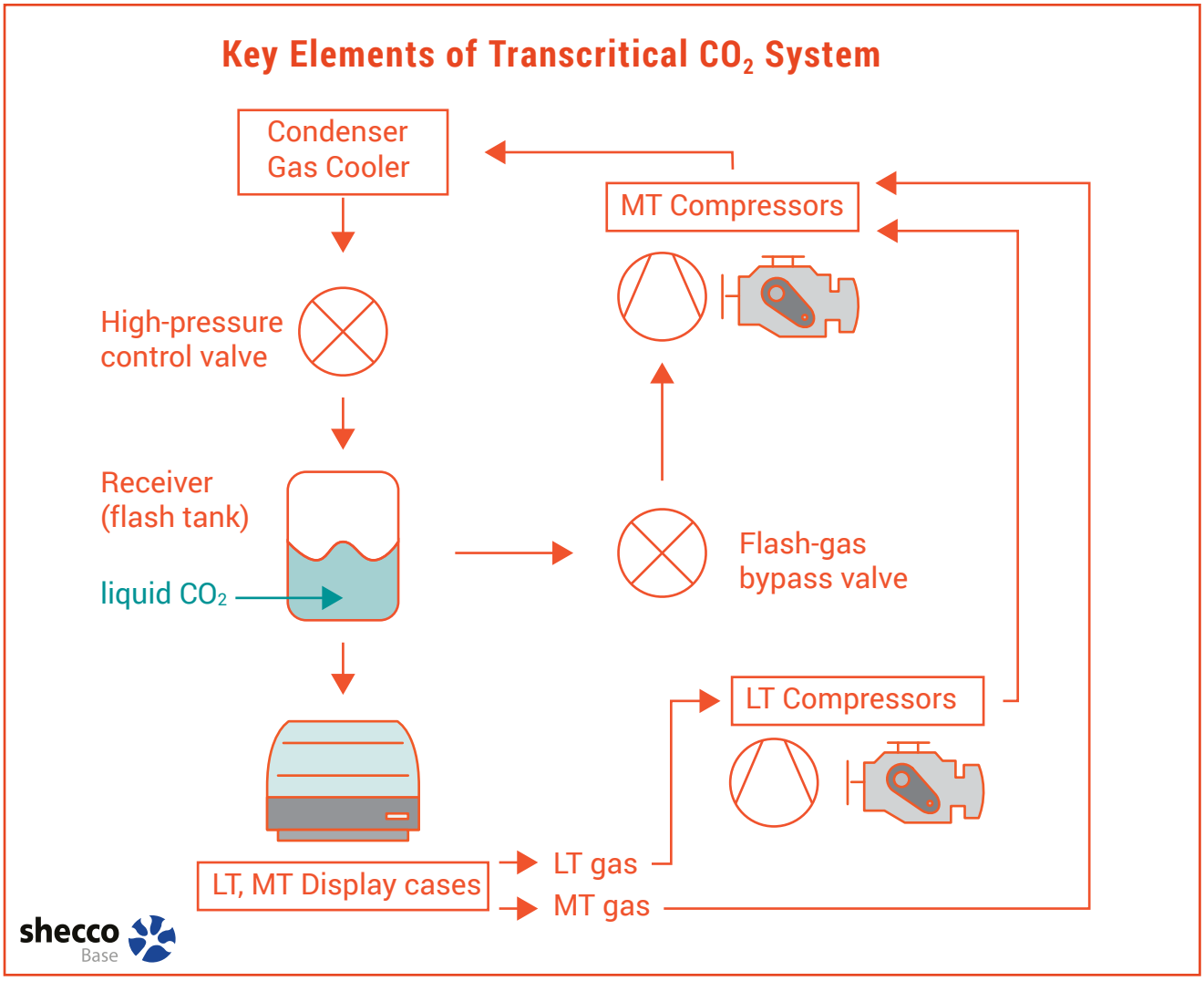
CO_2 transcritical systems are similar in many regards to traditional direct expansion systems, but Walker and Katz endeavored to explain the key differences.

CO_2 has particular thermodynamic properties that set it apart, including a high coefficient of heat transfer, making it highly efficient. "This quality, in particular, places CO_2 as the best alternative to traditional industrial systems," wrote Katz. In practical terms, CO_2's efficiency is reflected in the compressor displacement it requires compared to that of ammonia.

"Ammonia requires compressors to work at least eight times as much as needed for an equivalent volume of CO_2," he noted. CO_2 also produces much less heat of compression (wasted energy).

On the other hand, CO_2 operates at higher pressures than other refrigerants. And most significantly, it has a low critical point (87.7°F and 1055 psig), above which it can't be condensed to a liquid, creating special challenges. In fact, CO_2 above the critical point changes into a "supercritical fluid," which resembles a gas but is neither liquid nor gas. Because CO_2 switches between supercritical and subcritical (below the critical point), depending on the ambient temperature, the system became known as transcritical.

Transcritical systems have three key components not found in conventional systems – a condenser/gas cooler, a high-pressure control valve, and a flash-gas bypass valve – that make it possible to effectively employ CO_2 even in higher ambient temperatures.



> *[The expansion valves] are getting a nice, cool 34-degree liquid and they're totally digging it.*

Three scenarios

Walker described the operation of a transcritical system under three temperature conditions – moderate (41°F-80°F), high (above 88°F) and low below (41°F). (Above 80°F, the system begins operating in the supercritical range of CO_2.)

On a 70°F day, for example, the transcritical system works much like a traditional DX system, albeit at higher pressures (838 psig). Compressed CO_2 emerging from the medium-temperature compressors (which are fed by the discharge from the low-temperature compressors in the booster set-up) go through an oil separator and enter the condenser. The CO_2 "leaves my condenser as a liquid – it changes state," said Walker.

As the liquid CO_2 traverses the drop line on the way to the high-pressure control valve, sensors read its temperature and pressure. "If you give me pressure and temperature on a liquid line, what can it calculate?" he asked. "Subcooling," which is when the liquid is cooled to below its saturation temperature, reducing the amount of flash gas produced before the evaporator.

In his example, Walker said the amount of desired subcooling was five degrees, which is achieved by modulating the high-pressure control valve to raise the pressure in the condenser to what it would be at 75°F, or 895 psig.

The subcooled liquid goes through the high-pressure control valve and enters the receiver (flash tank) at 895 psig. That's too high for the evaporator coils, so "I simply tell the controller to open the flash-gas bypass valve" and reduce the pressure to 500 psig, for which the temperature is 34°F, he said. "How do you think my [electronic] expansion valves (leading to the evaporators] are feeling about that? They're getting a nice, cool 34-degree liquid and they're totally digging it."

From there, with pressures at acceptable levels, the cooling process in the evaporators proceeds as it would conventionally, with the expansion valves controlling the super heat inside the evaporator coils. The low-temperature suction gas gets compressed and the discharge mixes with the medium-temperature suction gas and any flash gas before entering the medium temperature compressors, starting the process anew.

"That's the typical, normal, 41-to-75 degree operating system," said Walker. "Pretty simple, easy to work on."

If the ambient temperature is above 87°F, the condenser is now a gas cooler that simply lowers the temperature of the supercritical CO_2 fluid. No subcooling is possible – there is no correlation between pressure and temperature.

The high-pressure control valve is now 75%-80% open, creating a pressure drop that finally condenses the supercritical fluid to a liquid in the receiver, with flash gas channeled to the medium-temperature compressor. The flash-gas bypass valve is almost 100% open to maintain 500 psig in the flash tank.

Meanwhile, the evaporators are oblivious to what the ambient temperature is. "They have no idea it's 90 degrees outside because I've managed that on the high side of the system," Walker said. Adiabatic condensing and other technologies (parallel compressor and ejectors) can be used in warmer regions to improve the efficiency of the system during transcritical operation.

If the ambient temperature is below 41°F, say 30°F, that becomes an issue because the temperature in the receiver is maintained at 34°F. In that case, the high-pressure control valve becomes a "holdback valve," Walker said. "He's going to try to stack liquid inside the condenser to make sure I don't crash the system, and make sure I have a proper pressure drop going from the condenser into the receiver." The flash-gas bypass valve also works to keep the receiver pressure high enough to maintain the 34°F temperature "that's going to feed my evaporators," said Walker.

Walker and Katz stressed that the two special valves – the high-pressure control valve and the flash gas bypass valve – along with the condenser/gas cooler represent the linchpin of a transcritical CO_2 booster system. They allow the system to work most of the time like a traditional DX system and make CO_2 "an alternative to traditional industrial refrigerants that places users on a path toward greater sustainability and higher levels of efficiency," wrote Katz. ■ MG

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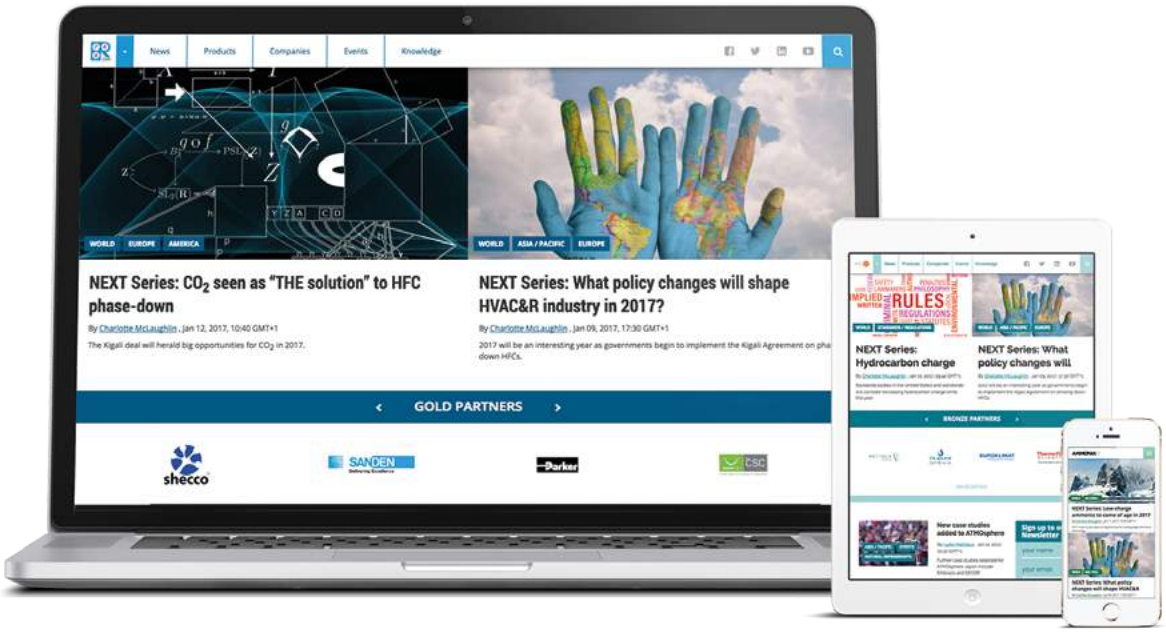

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Training session on low-charge systems at Turner Dairy, Memphis, Tenn.

Can Low-Charge Systems Ease Technician Crisis?

The safety and relative simplicity of low-charge ammonia packages could make them a better fit for an industry with a shrinking supply of qualified technicians

– By Elise Herron

It has been widely acknowledged that the number of technicians trained to handle natural refrigerant systems is dwindling.

But the advent of small and standardized low-charge ammonia packaged systems, which can be used instead of traditional massive ammonia plants or synthetic refrigerant systems, will make it easier to train and maintain enough qualified technicians.

This was the contention of Mike Chapman, director of process safety management (PSM) compliance for Stellar, and Kurt Liebendorfer, vice president of Evapco, in a presentation at the Refrigerating Engineers and Technicians Association (RETA) conference, held in Hershey, Pa. in September.

"There is a deficit of qualified technicians in our industry," Chapman said to begin the presentation, titled "Low-charge ammonia packages and safety." "It is a technician's market with regard to getting work."

Chapman and Liebendorfer pointed out that low-charge ammonia packaged units (coolers and chillers) are inherently safer than conventional ammonia-based refrigeration systems, which lessens the training requirement.

Low-charge ammonia penthouse unit at Turner Dairy, Memphis, Tenn.

"Ammonia refrigeration is still, always has been, and always will be ammonia refrigeration – we're taking the heat out of something and the result is making it cold," said Chapman. "But the technology by which we're doing that is what's changing, improving and becoming more effective and safer."

The retirement problem

The primary driver of the technician shortage is that seasoned technicians are retiring, and their replacements are not showing up in sufficient numbers.

A recent study cited by Chapman determined that there were around 745 qualified technicians for 4,500 jobs in the U.S.

Not only are people retiring, Chapman said, younger generations are increasingly pursuing four-year degrees over community college, trade, or technology school programs. Quite simply, there aren't as many young people seeking trades careers as there once were.

"The four-year degree and advanced degree are great," said Chapman, "but if we lose out on that trades skill development piece, then we truly have a deficit and a void in our industry."

Another consequence of the retirement boom is that the remaining workforce has significantly less on-the-job qualifying experience.

"Nobody's invincible after a single training course," Chapman said. "Through the educational process in your career you become qualified to do the job."

Facilities directors at many of the big companies Chapman has polled say that their refrigeration technicians have less than five years of servicing experience.

"That's not a lot of time to get a lot of expertise under your belt in regards to trouble shooting advance technology and being able to figure out things and problem solve," he said.

However, Chapman was confident that the evolution of factory-tested systems like low-charge ammonia packages would ultimately make training easier, and more appealing, for new technicians in the field.

"We can get back to where we need to be," he said. "The old conventional-style systems are much larger, much more complex, have much more ammonia and inherently can be more dangerous and make things more difficult."

The evolution of packaged units

Low-charge ammonia packaged units continue to make inroads in industrial refrigeration, and even in some commercial applications.

Less ammonia, flexibility in installation location, less piping, ease of maintenance and installation, and safer start-up help make low-charge ammonia packaged units appealing to end users and technicians.

For technicians, the installation process is dramatically streamlined, and for end users there are energy-efficiency

> *“We still have to train people – regardless of the type of system – but it’s easier to do when it’s a simplified system.”*


Kurt Liebendorfer, Evapco

and refrigerant savings, as well as decreased regulatory burdens, which contribute to lower total cost of ownership.

“The central machine room goes away,” said Liebendorfer, “because you’ve got these packaged units distributed throughout the building locally serving the cooling loads.

“They’re typically factory assembled and tested,” he added, “which can facilitate quick installation and start-up versus the field labor it takes to run all that piping.”

Following the presentation, Liebendorfer provided an example of a current low-charge installation – at a Turner Dairy plant in Memphis, Tenn., owned by Prairie Farms. “Since the Evapcold units are completely packaged and enclosed, this work is much easier than if the new system were all traditional stick-built equipment,” he said. “The low-charge packaged solution has really helped them in this complicated building remodel and expansion/construction project.”

Another boon to low-charge technology is that ammonia systems operating with a charge under the threshold quantity of 10,000 pounds are not typically subject to the Occupational Safety and Health Administration’s Process Safety Management (PSM) rules and the Environmental Protection Agency’s Risk Management Program (RMP). They still, however, must adhere to the agencies’ General Duty Clause.

Liebendorfer referred to a low-charge ammonia packaged chiller with a 3,800-lb charge. “It’s going to be self-evident, when facilities go from 18,000 pounds to 3,800 pounds, that they will be less susceptible to fines – if properly executed.”

While low-charge ammonia packaged units are beginning to change industrial refrigeration, Chapman made sure to point that proper training remains crucial.

”We still have to train people – regardless of the type of system – but it’s easier to do when it’s a simplified system,” Chapman said. With the repeatable design of a small-charge system, even in a facility with multiple units “you could do one training session for all of those together.”

Training, backed by standardized documentation, has also been easier at the Turner Dairy plant, said Liebendorfer. “Having all the documentation like operating procedures, maintenance procedures and hazard reviews all completed and part of the operator training is very powerful stuff.”

Currently, Chapman said, the low-charge ammonia packaged unit industry is ready and waiting for technicians and end users to safely implement the new technology. Chapman and Liebendorfer both predict that the uptake of low-charge systems is on the brink of ballooning, and that while the technician field is currently meager it will continue to grow.

“The compliance and regulatory paperwork is available, and the ability to train operators on mechanical integrity – it’s all right there,” Chapman said.

“Bottom line, [low-charge ammonia package units] are a powerful and safe solution to ease the challenges of our day-to-day compliance and safety burdens.” ■ EH

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ACCELERATE

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