

FEBRUARY 2019

ACCELERATE

ADVANCING HVAC&R NATURALLY

A M E R I C A



Campbell's

NEW REFRIGERATION FLAVORS



JUNE 17-18, 2019
ATLANTA

PROGRAM HIGHLIGHTS

Monday 17

Technology Trends

Market Trends

Industrial Refrigeration
Case Studies

Technomercials

Commercial End User Best Practice*

Commercial End User Panel

Technomercials

Technomercials

ATMO Business
Connect Afternoon

Dinner & Awards

PARALLEL

PARALLEL

Tuesday 18

Policy Session

Utilities Panel

Commercial Refrigeration
Case Studies

Technomercials

Industrial End User Best Practice*

Industrial End User Panel

Technomercials

Technomercials

ATMO Business
Connect Afternoon

Farewell Drinks Reception

PARALLEL

PARALLEL

*Private Meeting

Welcome drinks, Workshops & Site visits to take place around the main conference days

Learn more at www.ATMO.org/America2019

Keeping HFCs Out of the Atmosphere

– by Michael Garry

The Trump administration is well known for its efforts to dismantle programs created by the Obama-era Environmental Protection Agency (EPA) to curb greenhouse-gas emissions, such as the Clean Power Plan and upgraded car-fuel efficiency rules, among others.

Probably less known is the Trump EPA's proposal last September to rescind Obama's 2016 update to Section 608 of the Clean Air Act. Under the update, the EPA extended the refrigerant management rules (on leak repair, for example) for supermarkets and industrial facilities to HFCs and HFOs, along with ozone-depleting substances (ODS), the original target of the regulation.

The start date of the Obama update was January 1, 2019, so it is presumably in effect while the EPA tries to remove it.

Of course, the Trump EPA has already rolled back Obama-era rules that banned a series of high-GWP HFCs – the upshot of a 2017 U.S. Appeals Court ruling negating those rules in certain circumstances. The agency has started consideration of new HFC regulations last April.

Meanwhile, much of the world is moving ahead with HFC-reduction plans pursuant to the Kigali Amendment to the Montreal Protocol, which also went into effect January 1, 2019. As of February 25, 69 parties (mostly countries) had ratified the amendment, though not the U.S.

HFCs are part of a group of short-lived climate pollutants (SLCPs) – also known as “super pollutants” – that don't linger as long as CO₂ in the atmosphere but have GWPs thousands of times higher than the GWP of CO₂ (one). They represent low-hanging fruit in the GHG-reduction world.

Accelerate America supports replacing HFCs with natural refrigerants. However, there are

other steps that need to be taken while HFCs and HCFCs continue to be used in existing commercial, industrial and residential HVAC&R systems – notably reducing leak rates and executing proper end-of-life recovery, reclamation and destruction of these gases.

This, of course, is why it is so important to keep Section 608 refrigerant management rules on leak repair and maintenance of HFC equipment. Last November, 15 U.S. states and the District of Columbia sent a letter to the EPA strongly opposing its proposal to remove HFCs from the rules.

Further evidence of the importance of proper management of HFCs emerged recently in the form of a new report by the Environmental Investigation Agency, “Search, Reuse and Destroy: How States Can Take the Lead on a 100 Billion Ton Climate Problem.” ([Page 28.](#)) The EIA urges U.S. states to adopt California's refrigerant management program (RMP) and adopt other policy measures to prevent leaks and support refrigerant recovery.

In addition to its RMP, California has passed the California Cooling Act, which adopts the EPA's voided HFC regulations and lays the groundwork for incentives for natural refrigerant alternatives. Three other states – New York, Connecticut and Maryland – have pledged to follow California with respect to HFC regulations, and others are poised to follow suit. The EIA wants to make sure they include refrigerant management in their programs.

The power of leak prevention and recovery of HFCs is quite extraordinary – so much so that Project Drawdown made it No. 1 in its compendium of 80 current climate remediation techniques.

Managing and eventually getting rid of HFCs is well within the capability of the HVAC&R industry, and I expect many U.S. states, if not the EPA (right now), to lead the way. ■ MG



Michael Garry
Editor

In this issue

- 03** **Editor's Note**
Keeping HFCs Out of the Atmosphere
- 06** **About Us**
About *Accelerate America*
- 08** **Accelerate America Opens 2019 Awards Program**
- 10** **Letters to the Editor**
- 12** **Infographic**
Natural Refrigerant Trends for Industrial Refrigeration
- 14** **Events Guide**
Major industry events in March and April
- 16** **America in Brief**

// Opinion

// Trends

// Policy

// Event

18 **U.S. Committee Should Vote 'Yes' on 500-g HC Charge**

If the U.S. National Committee votes against the IEC's new hydrocarbon charge limit, it would put U.S. supermarkets at a disadvantage. By Danielle Wright

20 **Preventing False Alarms in Ammonia Detection**

Frequent false alarms can undermine the effectiveness of detection systems; here are some ways to avoid them. By Jason Mueske and Brian EuDaly.

24 **Saving the Planet with Foam**

True Manufacturing touts the use of a foam-blowing agent in its refrigeration insulation that has no GWP or ODP and cuts energy use.

26 **HC Charge Limit May Stop at 300 g in U.S.**

So said NAFEM Show exhibitors, who differed on whether 300 g would be better than the IEC's proposed 500 g limit.

28 **EIA Urges U.S. States to Address Refrigerant Leaks and End-of-Life Recovery**

New report recommends adopting California's programs and other measures to avoid tons of GHG emissions in the face of federal rollbacks.

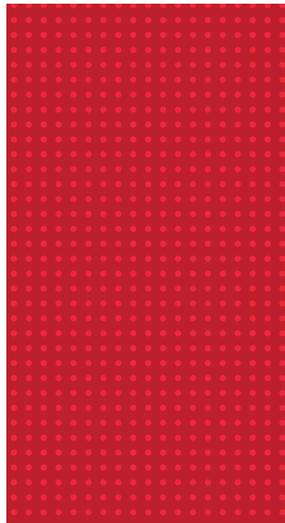
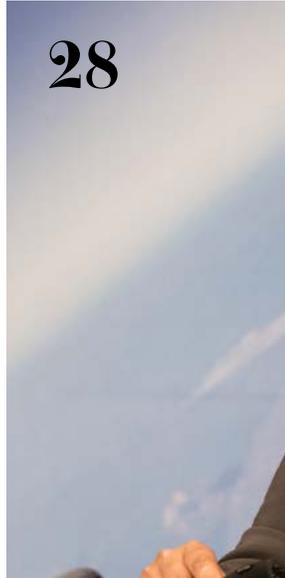
30 **AHR Expo Highlights, Part 2**

CO₂ components manufacturers KeepRite, Emerson, Dorin and Parker as well as R290 component makers Tecumseh and ebm-papst were among the companies showcasing products at the massive trade show in Atlanta.

32 **NAFEM Show Highlights: Part 1**

The foodservice equipment show continues to showcase the transition to propane (R290) refrigeration, though with some new enhancements.

28





// End User

// Cover Story

// Technology

36 No R290 Leaks Since 2013 at H-E-B Store
 The Texas grocery chain reports on the performance of its pioneering 83,000-sq-ft Austin outlet using only propane condensing units for all display cases.

40 CO₂ Thrives in the Desert
 The first transcritical CO₂ system used by a supermarket in the Middle East delivers energy savings of up to 30% compared to an HFC system.

42 Campbell's New Refrigeration Flavors
 The food and beverage giant, which pioneered low-charge ammonia systems, has added cascade and transcritical CO₂ systems to the mix.

50 Rivacold Bringing R290 Walk-In Unit to U.S.
 Two U.S. stores are using ceiling-mounted packaged system, which the Italian company will be manufacturing in the U.S.

52 Standing Up for Ammonia
 Scantec's Stefan Jensen defends his low-charge ammonia systems in a comparison with CO₂ technology.

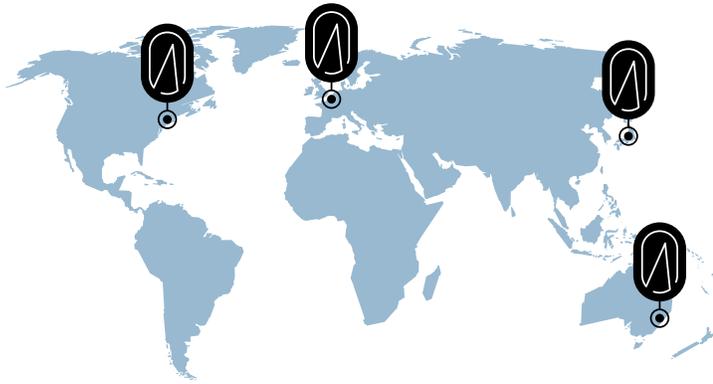
54 Editorial Corner

NEW REFRIGERATION FLAVORS

FEBRUARY 2019

ACCELERATE

ADVANCING HVAC&R NATURALLY A M E R I C A



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://acceleraten.com>

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

WANT TO ADVERTISE?

/ Ad Sales

Silvia Scaldaferr
silvia.scaldaferr@shecco.com
+39 331 961 3956

GOT A STORY IDEA?

/ Editor

Michael Garry
michael.garry@shecco.com
203-417-0767

Accelerate America
February 2019
// Volume 5, Issue #42

Publisher

Marc Chasserot
marc.chasserot@shecco.com

Editor

Michael Garry
michael.garry@shecco.com

Contributing Writers

Pilar Aleu
Marie Battesti
Dario Belluomini
Jan Dusek
Eda Isaksson
Charlotte McLaughlin
Klara Zolcer Skacanova
Andrew Williams
Devin Yoshimoto

Ad Coordinator

Silvia Scaldaferr

Art Director

Charlotte Georis

Photographers

Ben Beech
Scott Chasserot
Carla Tramullas

The views expressed by the contributors are not necessarily those of the Publisher. Every care is taken to ensure the content of the magazine is accurate but we assume no responsibility for any effect from errors or omissions.

Published by shecco SPRL. All rights reserved. Reproduction in whole or in part is prohibited without prior written permission of the copyright owner.



#GoNatRefs





ACCELERATE AMERICA OPENS 2019 AWARDS PROGRAM

The awards will be presented at ATMOsphere America 2019 in Atlanta; deadline for nominations is March 29

– By Michael Garry

Accelerate America is pleased to open the nominating process for its fourth annual awards program, which recognizes companies and individuals doing the most to drive adoption of natural refrigerants over the past year.

The awards are divided into four categories: Best in Sector, Best Contractor, Person of the Year and Innovation of the Year.

Winners will be selected by a panel of shecco and third-party experts. The awards will be presented at ATMOsphere America 2019 (organized by shecco, publisher of *Accelerate America*), to be held June 17-18 in Atlanta, Ga. The winning companies and the Person of the Year will be profiled in the June-July 2018 issue of *Accelerate America*.

The nominating process for the awards will remain open through March 29. Nominations may be submitted by end users, manufacturers, contractors, consultants, academics, policy makers and others involved with HVAC&R applications using natural refrigerants; companies and individuals may nominate themselves.

Nominations, which should cite a particular category of award and include details supporting the company or person nominated, can be submitted at: www.shecco.com/accelerateawards/

Among the awards going to companies, a Best in Sector award will go to an end-user company in two sectors – food retail and industrial. The Best Contractor award will go to the company that has done the most to facilitate the adoption of natural refrigerants in the past year.

The Innovation of the Year award will go to a company that developed a particular technology having a significant impact on the market.

Criteria for assessing nominated companies will include:

- ▶ Number of installations of natural refrigerant systems
- ▶ Energy efficiency of equipment
- ▶ Reduction in greenhouse gas emissions
- ▶ A business case encompassing capital, installation, operation, maintenance and training, and a return on investment
- ▶ Commitment to future natural refrigerant installations
- ▶ Industry leadership, innovation and perseverance

The Person of the Year Award will honor a single individual who has forged new pathways for natural refrigerants – someone without whom the natural refrigerants business in North America would be much less developed than it is. This award is open to any individual, including end users, manufacturers, policy makers, academics and researchers.

Criteria for assessing nominated individuals will include:

- ▶ Impact on development and/or implementation of natural refrigerant systems
- ▶ Leadership in organization as well as the industry
- ▶ Innovation and perseverance

The awards program was launched in 2016. The winners of the 2016 awards were: Marc-André Lesmerises of Carnot Refrigeration (Person of the Year), Sobey's (Food Retail), Red Bull (Foodservice), Campbell Soup (Industrial) and True Manufacturing (Innovation of the Year). See "[The Best & The Brightest](#)," *Accelerate America*, July-August 2016.

Winners of the 2017 awards were: Paul Anderson of Target (Person of the Year), Whole Foods Market (Food Retail), Nestlé (Foodservice), US Cold Storage (Industrial) and Hillphoenix (Innovation of the Year). See "[Celebrating the Disruptors](#)," *Accelerate America*, June-July 2017.

Winners of the 2018 awards were: California State Senator Ricardo Lara (Person of the Year); Henningsen Cold Storage (Industrial); ALDI US (Food Retail); Source Refrigeration & HVAC (Contractor); Southern California Edison (Utility); and Colmac Coil Manufacturing (Innovation of the Year). See "[Barrier Breakers](#)," *Accelerate America*, August 2018. ■ MG

Naturally...



...more efficient

HydroPad adiabatic pre-cooling
with intelligent control

...low water usage

In combination with GÜntner
Hydro Management Pad

...environmentally friendly

No water treatment, no aerosols, no
stagnant water, low refrigeration charge

How can we help you?

As a leading manufacturer of first-class heat exchange technologies for refrigeration engineering and air conditioning, GÜntner provides high-quality products for high operational safety and impresses with know-how and consulting expertise, especially also in the area of natural refrigerants like CO₂ and NH₃. For the V-SHAPE gas cooler with optional adiabatic *HydroPad* pre-cooling, energy- and cost-efficient operation of transcritical CO₂ booster systems in warm, dry climates is just one of the impressive advantages.

For further information on our **V-SHAPE**, please visit our website.



Güntner U.S. LLC
+1 847-781-0900
info@guentner.com

www.guentnerus.com

LETTERS TO THE EDITOR



COMMITTED TO R290

With regard to our propane (R290) self-contained equipment (“R290: The Future of Food Retail?”, *Accelerate America*, January 2019), all of our standard plug-in equipment for display cases and multi-temperature horizontal merchandisers can easily operate to the required capacities at less than 150 g of R290, the charge limit per circuit.

For our Vento multi-decks, we do use multiple circuits to achieve the desired capacity. But these circuits are not always running at 100%. Our design allows for the display case to operate on one circuit once the case gets to its desired temperature, or based on the temperature in the cabinet (during restocking, say). This also provides redundancy if there is an issue, as the case can still function until repair.

With regard to using a single circuit using HFC/HFO, the cost is really in the design and the components needed. It would be hard to compare with R290 circuits; there are many factors influencing the cost of components and the manufacturing process that are needed to determine which is ultimately more expensive.

I have not seen any large multi-deck cabinets/freezer cases operating with HFC/HFO in a self-contained design. I guess the assumption could be made that they are easier to design – but then why are manufacturers for these cases trending towards micro-distributed R290 systems or CO₂ systems?

Our point of view is that by leveraging R290 as our primary refrigerant, we can design cases that will meet and fulfill the needs of the entire market regardless of legislation. I think there could be added costs for manufacturers who are making a case design that leverages HFC/HFO for certain markets/states – and then making a different case design to support those markets/states looking to bring global warming potential (GWP) down below 150.

Drew Tombs

President
AHT Cooling Systems
USA Ladson, S.C.

OPPOSED TO MULTIPLE R290 CIRCUITS

I read “R290: The Future of Food Retail?” (*Accelerate America*, January 2019) and enjoyed it – it’s good to see progress being made.

My question would be why put so much value in the 150-g charge when so many people have worked so hard for higher charges – such as the 500-g limit under serious consideration by the International Electrotechnical Commission – these past 10 years?

The higher charges will make the solution much more viable and financially attractive. The multiple-circuit approach feels to me counterintuitive to the need for energy efficiency – and also perhaps too high a burden in capital expenditure for end-users.

Better to get energy efficiency right and ensure simplicity on single-circuit design – albeit with the “wrong” refrigerants – until we get those higher R290 charges for large grocery-store cases. Keep in mind that, regardless of refrigerant, it is a significantly smaller charge in comparison to that of remote direct-expansion systems; in addition, these are factory-sealed self-contained systems that do not leak refrigerant.

Geoff Amos

NRMS Global Ltd.
Birmingham, U.K.

LETTERS ARE WELCOMED!

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

The **FASTEST GROWING** Industrial Refrigeration Contractor in the USA

Now Hiring Throughout North America

- Refrigeration Technicians/Mechanics
- Senior Project Engineers
- Project Managers
- Construction Supervisors/Foremen
- Electrical Engineers
- Sales Engineers
- Account Managers

Apply at www.cimcorefrigeration.com/careers

TOROMONT

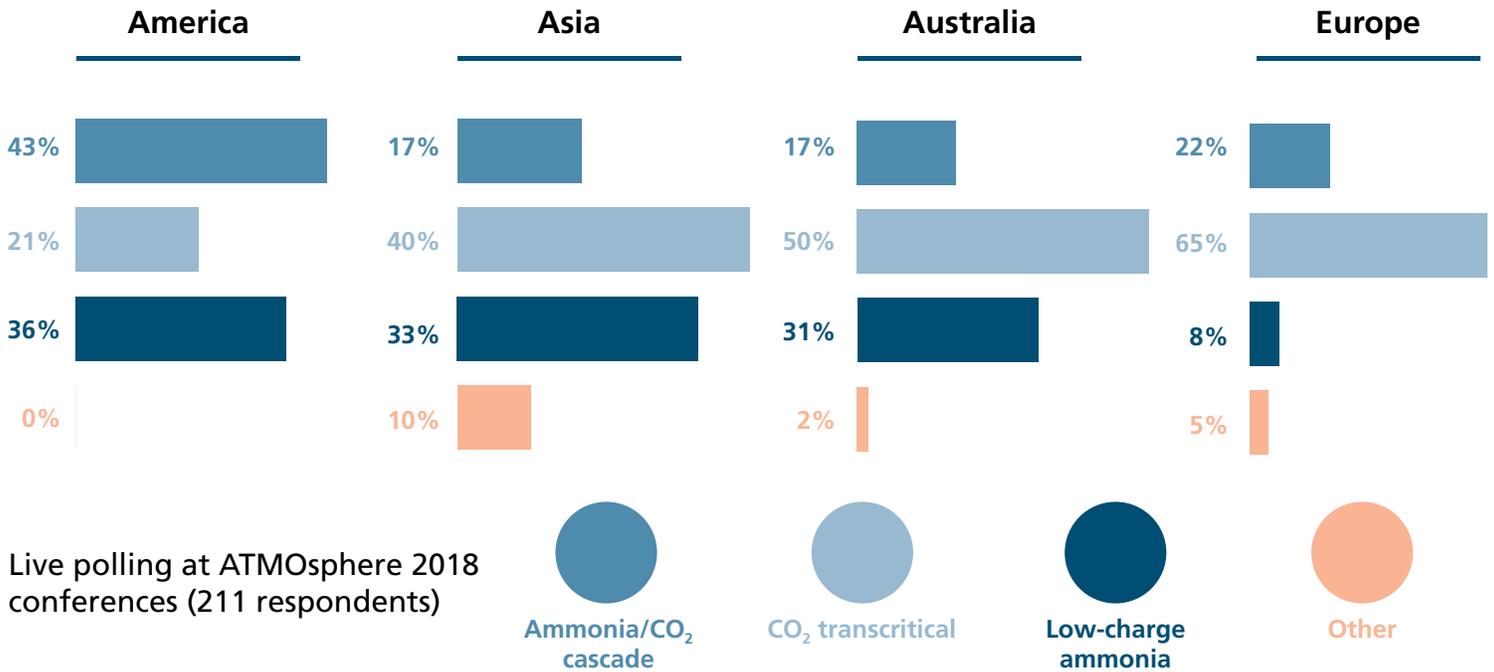
CIMCO

www.cimcorefrigeration.com

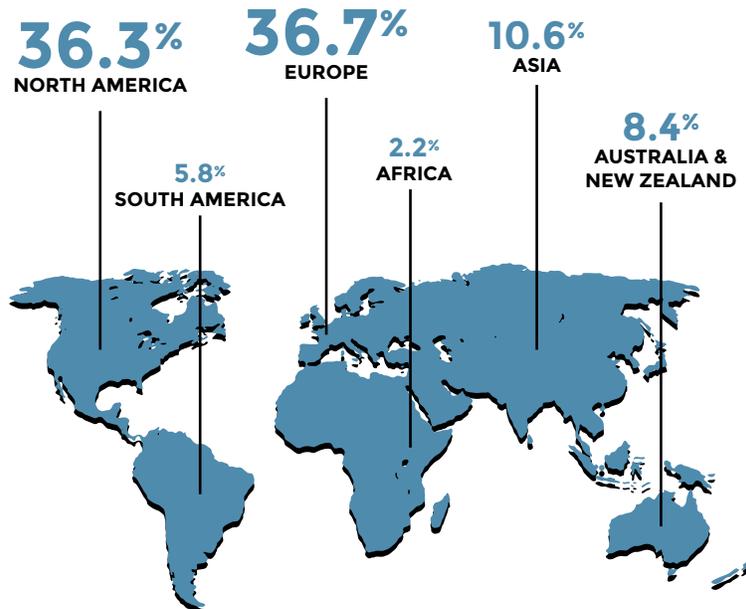
1.800.456.2653

Natural Refrigerant Trends for Industrial Refrigeration

POTENTIAL: Which natural refrigerant-based technology holds the biggest potential for industrial refrigeration over the next five years?



LOW-CHARGE GROWTH: Which world region do you expect to experience the fastest growth in low-charge ammonia installations in the next five years?*



*Based on global survey conducted under shecco's World Guide to Low-Charge Ammonia project.

Temprite Series 130 for CO₂ **Now 140 Bar!***



Designed for Transcritical Applications



Reservoirs



Drier Shells

Combination Connection Options: ODS, BW, MPT.

* Model 131 Rated 160 Bar * Model 139A Rated 140 Bar on Request

Oil Separators • Reservoirs • Liquid Receivers • Oil Management Products

920 & 920R Series for Subcritical CO₂, Ammonia, and Other Natural & Manmade Refrigerants



Series 920



Series 920R

Coalescent Oil Separators

Imperial and Metric Connections - Hermetic and Accessible

• Proven Energy Savings • Cleaner Systems

www.temprite.com

email: temprite@temprite.com

1.800.552.9300

1.630.293.5910

FAX: 1.630.293.9594



MAR

03-05

HVAC Excellence: National HVAC&R Educators and Trainers Conference, Las Vegas, Nev.

This conference, designed for HVAC&R instructors, trainers and administrators, covers physics, emerging technologies, new educational delivery methodologies and regulatory changes, among other topics.



<https://bit.ly/2sjeD6k>



@Esco_Group

03-06

2019 IIAR Natural Refrigeration Conference & Expo, Phoenix, Ariz.

Event includes an energy efficiency program, expo hall, technomercials, technical program, government and code update and NASRC commercial track.



<https://bit.ly/2Fqz7VD>



@IIARnews

03-07

MCAA 2019, Phoenix, Ariz.

The Mechanical Contractors Association of America (MCAA) serves the needs of approximately 2,600 firms involved in heating, air conditioning, refrigeration, plumbing, piping, and mechanical service.



<https://bit.ly/2HSPr11>



@MCAANews

13-14

Emerson CO₂ Learning Sessions, Cudahy, Wis.

Designed for service technicians, manufacturers and end users, this event covers terminology, mapping of cascade and transcritical systems, efficiency optimization in warm ambient climates, and more.



<https://bit.ly/2P0maQf>



@Emerson_News

17-18

Seafood Expo North America/ Seafood Processing North America, Boston, Mass.

This event is for seafood buyers in retail, restaurants, catering, food-service and processing. It features global suppliers of seafood, new products, equipment and services.



<https://bit.ly/2E8qZlt>



@bostonseafood



APR

01-04

HPC National Home Performance Conference & Trade Show, Chicago, Ill.

The HPC National Conference & Trade Show, organized by the Home Performance Coalition (HPC), is aimed at residential energy efficiency professionals involved in home performance and weatherization



<https://bit.ly/2L8lpT7>



@HPCTweets



02 2PM ET

GreenChill Webinar: Market Trends for Carbon Dioxide, Ammonia and Hydrocarbon Refrigerants in North America, Online

Environmental Protection Agency's GreenChill program hosts webinar featuring Klara Zolcer Skacanova, market development manager for shecco.



<https://bit.ly/2DIF77T>



@EPAGreenchill

16 2PM ET

GreenChill Webinar: California Cooling Act and Proposed High-Global Warming Potential Refrigerant Prohibitions, Online

Environmental Protection Agency's GreenChill program hosts webinar featuring Glenn Gallagher of the California Air Resources Board.



<https://bit.ly/2UKCNmk>



@EPAGreenchill

07-10

IARW-WFLO Convention, Santa Ana Pueblo, N.M.

The 128th IARW-WFLO Convention is for executives of temperature-controlled warehousing and logistics companies and industry suppliers.



<https://bit.ly/2HU0Eyq>



@gccaorg

23 2PM ET

GreenChill Webinar: Retrofit Doors, Online

Environmental Protection Agency's GreenChill program hosts webinar featuring Deanna Cooper of Marco, Energy Trust of Oregon and food retailers to be announced.



<https://bit.ly/2BopXTk>



@EPAGreenchill

AMERICA IN BRIEF

HFC Reduction Seen As Key Green Trend

U.S. online publication GreenBiz and the U.S. financial firm S&P Global on February 5 published the 12th annual “State of Green Business” report, which cited cutting super pollutants such as HFCs as one of the top sustainable business trends for 2019.

“Various actors are prioritizing accelerated replacement of HFCs, a refrigerant commonly used in air conditioners and commercial building chillers,” the report states in a chapter called “Super Pollutants Become Super Important.”

In addition to HFCs, super pollutants – also called short-lived climate pollutants (SLCPs) – include methane and black carbon.

A big reason for the action on HFCs, the report notes, is the global phase down of the high-GWP gases under the Kigali Amendment to the Montreal Protocol, which took effect this year on January 1. The amendment calls for a 10% reduction in 2019 from the baseline level (the consumption of HFCs and HCFCs from 2011 to 2013) for developed countries like Australia, Canada and European Union countries.

The U.S. has not ratified the Kigali Amendment. But at the state level, “Maryland, Connecticut and New York vowed last fall to phase out HFCs, and California previously declared its intention to do so – its rule took effect in January,” the reports says.

The report also notes that the U.S. Climate Alliance (a coalition of 21 governors) aims to reduce emissions from super pollutants like HFCs by up to 50% by 2030.

■ CM

Lennox Plans Sale Of Kysor/Warren

In a February report of its fourth-quarter and full year 2018 results, Lennox International, a Dallas-based global manufacturer of HVAC&R equipment, announced that it plans to sell its Kysor/Warren business, and is aiming to close the sale in the first quarter.

Kysor/Warren, a Columbus, Ga.-based division of Lennox subsidiary Heatcraft Worldwide Refrigeration, manufactures refrigerated merchandisers and systems – including transcritical CO₂ and ammonia/CO₂ cascade systems – for food retail and foodservice outlets.

Lennox purchased Kysor/Warren from the Manitowoc Company in 2011.

In 2015, Kysor/Warren installed an ammonia/CO₂ cascade refrigeration system at a Piggly Wiggly outlet in Columbus, Ga., which has reported energy savings compared to an HFC system running in the same store.

In 2018, Kysor/Warren installed a transcritical CO₂ system at a Casa Ley store that it called the first supermarket installation of transcritical CO₂ in Mexico.

The announcement of the impending sale of Kysor/Warren follows the sale last year of Lennox’s refrigeration businesses in Australia, Asia and South America.

“We plan another divestiture in 2019 with the sale of the Kysor Warren business within our Refrigeration segment to focus on our businesses that have strong market positions and fit our growth profile,” said Todd Bluedorn, Lennox’s chairman and CEO, in a statement.

■ MG

BSRIA: Home AC Energy Use To Increase in U.S.

As the planet continues to warm over the next three decades, air conditioning will be one of the few home applications in the U.S. that will increase its consumption of energy in 2050 compared to 2017, but this will be mitigated by the growth of green HVAC technology.

So observed Raphael Chalogany, general manager of U.K. market research firm BSRIA, in a presentation in January at the AHR Expo in Atlanta.

Chalogany referred to a U.S. Energy Information Administration chart showing that annual air conditioning energy use would increase from about 1,700 kWh per household in 2017 to about 1,900 kWh/household. By contrast, energy use by lighting, space and water heating, refrigeration, clothing and dishwashing, and TV/PCs would decrease over that period. The only other application showing an increase (a small one) is cooking.

But countering the rise in energy consumption of ACs, market forces are promoting “green HVAC,” he said. “Industry believes in efficiency and promoting new low-GWP refrigerants and smart controls.”

■ MG

California Funds Green HVAC Project

California-based Electric Power Research Institute (EPRI) announced in January that it received \$4.7 million in cap-and-trade funding to develop advanced residential heating, ventilation, and air conditioning (HVAC) systems using low-GWP refrigerants – in particular heat pumps – with an additional focus on bringing the technology to low-income Californians.

The California Strategic Growth Council provided the grant. Its Climate Change Research Program is part of California Climate Investments, a state-wide program that funnels billions of cap-and-trade dollars toward reducing greenhouse gas emissions.

“Our work will advance the development of a window unit to heat and cool homes [using heat pump technology] at a lower cost for the consumer and the environment,” said Mukesh Khattar, EPRI technical executive and co-principal investigator. “We’re focusing on this efficient appliance because it provides households the opportunity to realize energy savings and contribute to greenhouse gas emission reductions without major capital investment.”

EPRI will collaborate with California-based energy and finance companies Treau, WattzOn, and Otherlab. ■ CM

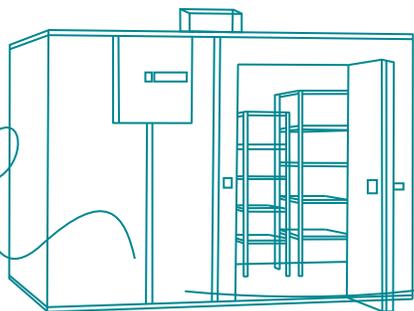
embraco

Leaders in Natural Refrigeration



Embraco has been conducting research for many years and believes that the use of natural refrigerants is the future for refrigeration.

We've been applying natural refrigerants, such as r290 and r600a, and found that these alternative solutions reduce the negative effects on the ozone layer and improve equipment energy efficiency. Embraco will attend IIAR Natural Refrigeration Conference and Expo on **March 3-6th, 2019**, in support of the industry-wide shift toward natural refrigerants. **Stop by booth 322** to meet our brand experts and discuss the latest innovations and natural refrigerant solutions.



To learn more about natural refrigerant solutions,
[visit naturalrefrigerants.info](http://naturalrefrigerants.info).

U.S. Committee Should Vote 'Yes' on 500-g HC Charge

If the U.S. National Committee votes against the IEC's new hydrocarbon charge limit, it would put U.S. supermarkets at a disadvantage

– By Danielle Wright

As an organization that champions all natural refrigerant solutions, the North American Sustainable Refrigeration Council (NASRC) doesn't pick favorites. But our supermarket members do. For many retailers, especially national chain supermarkets, self-contained cases using propane (R290) are the ideal solution and quickest path to regulatory compliance for new and existing stores.

The list of benefits is long: energy savings, reduced capital costs, virtually zero leak rates, merchandizing flexibility, and simplified service and maintenance. But the maximum propane charge of 150 g prevents these benefits from being fully realized, ultimately putting U.S. supermarkets at a disadvantage in the face of increasing regulatory pressures.

Since 2014, the International Electrotechnical Commission (IEC) SC61C subcommittee has worked to update global standard 60335-2-89, which sets the charge limit of A3 (flammable) refrigerants, such as propane, in self-contained commercial refrigeration equipment.

The IEC's National Committee members are scheduled to vote this spring on the new standard that would raise the limit to 500 g from 150 g. After multiple revisions and a thorough examination of safety research and data, all signs are pointing to a majority "Yes" vote.

Despite the pending international approval, the U.S. National Committee is expected to vote "No," triggering a process that will ultimately result in a much lower limit of propane in the U.S. The limit could be as low as 300 g or less of propane per circuit. ([See page 26.](#))

A lower charge limit means that commonly used cases would still need to use multiple circuits per case, making them less cost effective and energy efficient. These cases include low-temperature reach-in cases with four or more doors, and 12-foot medium-temperature open multi-deck cases. Without these case types, it will be difficult for supermarkets to consider propane self-contained cases a viable solution that complies with refrigerant regulations.

The U.S. supermarket industry is heading toward an HFC refrigerant phase down, driven by the global Kigali Amendment to the Montreal Protocol (though the U.S. Senate has not yet ratified the amendment). Meanwhile, individual U.S. states like California and New York are leading the HFC phase down on a much more stringent timeline. Now, more than ever, supermarket retailers need options to deal with pending regulations.

Self-contained cases using higher charges of propane have the potential to be an excellent solution, both for regulatory compliance and the bottom line. But if the U.S. National Committee votes against the new propane limit, it risks putting U.S. supermarkets at a disadvantage by leaving them with one fewer viable alternative. ■ DW



Danielle Wright is the executive director of the North American Sustainable Refrigeration Council (NASRC). She has over ten years of experience in the sustainability and energy efficiency industry, with a specific focus in supermarket refrigeration. Previously, she managed a wide range of energy-efficiency programs on behalf of one of the largest utilities in the U.S., saving grocers millions in energy costs through efficiency retrofit projects.

Recalibrate the way you look at **gas detection** for industrial refrigeration



Visit Danfoss Booth

529

at the IAR Natural
Refrigeration Expo

Experience the next generation of gas detection for industrial refrigeration.

Danfoss digital gas detectors range from basic to heavy duty models that utilize pre-calibrated digital sensors, on-board diagnostics, and digital life meters for improved safety, accuracy, and efficiency.

See how tomorrow's solutions are ready today
visit www.GDIR.danfoss.com

ENGINEERING
TOMORROW

Danfoss

Preventing False Alarms in Ammonia Detection

Frequent false alarms can undermine the effectiveness of detection systems; here are some ways to avoid them

– By Jason Mueske and Brian EuDaly.

At 4:00 a.m. on January 14, 2015, three astronauts on the U.S. segment of the International Space Station were abruptly awakened by a piercing alarm announcing an ammonia leak. Because ammonia is a dangerous gas that can cause injury, death, and even explosions, the two Americans and one European were quickly evacuated to the Russian side of the station and kept safe while the alarm was investigated.

Ammonia is used by the International Space Station in a loop system to help control temperature and keep the station's solar panels from overheating. The alarm was triggered by an increase in pressure in the water loop for one of the cooling systems, signaling a possible ammonia leak. All scheduled research activities were cancelled while the potentially life-threatening and explosive situation was evaluated.

By the end of the day, the ammonia alarm was determined to be false, and the astronauts were returned safely to the U.S. side of the station. Although no one was hurt, the false alarm caused a full day of work to be lost, unnecessary stress, and significant media attention.

A SMART INVESTMENT

It is not surprising that ammonia was chosen as the refrigerant for the International Space Station.

Ammonia is still a popular refrigerant for industrial refrigeration applications worldwide due to its incredible efficiency (a small amount of ammonia can cool a very large space), its abundant supply (it occurs naturally in the environment and is easy to produce commercially), its low price compared to synthetic refrigerants, and its predictable behavior.

While CFC, HCFC, and HFC refrigerants are being banned and phased out around the world due to environmental concerns, ammonia is seen as a good natural alternative because it has a global warming potential and an ozone depletion potential of zero.

But detection systems are required in all industrial settings that use ammonia as a refrigerant due to its toxicity and potential to become explosive or flammable in certain situations. These systems are a smart investment that can save lives and reduce product loss.

Levels of ammonia in the air are measured in parts per million (ppm). Unlike smoke detectors, which only announce the presence of smoke in the air, ammonia detectors must not only detect the presence of ammonia, but also measure the amount so that an appropriate response can be taken. Knowing the amount of ammonia in the air enables you to catch leaks early and avoid damage to people and property. ([See chart, page 22.](#))

Even though ammonia is “self-alarmed” – the distinctive, unpleasant smell is noticeable well before a dangerous level is reached – you should not rely solely on your nose as a detection system. For one thing, a person may not always be present in the facility. Furthermore, the human nose may be able to detect the presence of ammonia, but it cannot measure the exact amount.

A mechanical detection system also has the advantage of taking automatic, almost instant action, such as turning on fans, opening vents, and shutting down equipment without any human delay.

However, the effectiveness of detection systems is greatly reduced by frequent false alarms. Most importantly, safety will be compromised. False alarms are also a problem when they stop production, require unnecessary evacuations, or call in managers at all hours of the night. As workers experience the inconvenience, frustration, and loss of productivity from alarms that turn out to be inaccurate, they will begin to ignore them, stop responding to them, and sometimes even turn off the detection system completely. This increases the chance of a real leak being missed and severe damage being done.

False alarms are also a problem when they stop production, require unnecessary evacuations, or call in managers at all hours of the night.

CAUSES AND SOLUTIONS

What causes false alarms? How can they be prevented?

Mismatch of sensor technology

Sensor technology comes in a variety of types, including electrochemical, catalytic bead, solid state, infrared and photoionization. Careful consideration should be given to the choice as well as the installation and maintenance of a detection system that has been designed specifically to detect ammonia leaks while minimizing false alarms.

Choose the sensor technology that is best suited for the application, and make sure it can reliably detect at the required alarm set points. Sometimes choosing multiple sensor types for a particular room is necessary to achieve a wide range of alarm set points. Talk to your sensor manufacturer's application engineers to select the best sensor type for your specific situation. They have seen it all and can be the difference between extreme success and years of pain.

When installing the detectors, mount them at a height and location recommended by the manufacturer. You should maintain the system by calibrating the sensors on a regular schedule and replacing sensor elements as needed, according to the manufacturer's recommendation. Also keep a detailed log of all calibrations.

The sensor reacts to a gas that is not ammonia

Not all sensor technologies are ammonia-specific. There are many gases that can cause false readings on an ammonia sensor, and some sensor technologies are better than others. Cross sensitivities to carbon monoxide and hydrogen sulfide are common, as well as sensitivities to cleaning chemicals. If "off-gassing" is causing issues, consider switching sensor technologies. Check with the sensor manufacturer on cross-sensitivities and consider testing before purchasing.

The sensor reacts to moisture and condensation

Refrigerated spaces in the food industry can be very challenging to ammonia detectors because of humidity changes, and how fast the changes occur. An area with a large amount of refrigeration can very quickly remove all moisture from the air, causing a spike in the signal, which results in a false alarm. High humidity or wet areas can also be the cause of false alarms for some detectors.

Detectors should be designed to perform in the presence of high moisture and extreme humidity fluctuations. Features such as potted circuitry and a built-in heater will keep the units dry, protected and performing properly.

The sensor reacts to extreme temperature fluctuations

Going from -40°F directly into defrost mode can cause an alarm due to the temperature and humidity change. Extreme temperature fluctuations are common in industries such as cold storage and food processing. When choosing a detector, make sure it meets the temperature requirements and has the software/hardware to sustain a consistent reading.

► **Damage to the sensor by cleanup crews**

Sensor elements can give a false reading or be damaged permanently if they are hit directly with water. If water or chemicals are likely to be sprayed onto the sensor element, consider a model that limits exposure from such an incident. The sensor element may need to be housed inside an enclosure, or protected by a splash shield.

Incorrect alarm set points

When choosing alarm set points, it is important to consider the range of the sensor. Keeping set points at or above 10% of the full scale of the detector is a good rule of thumb. For instance, if your goal is to detect 25 ppm of ammonia, choose a detector with a range no wider than 0-250 ppm. Trying to detect 25 ppm with a 0-20,000 ppm detector will tend to cause a false alarm. The lowest alarm set point for a 0-20,000 ppm detector would be 2,000 ppm (10% of full scale). Planning out alarm set points and choosing the correct range of detector before purchasing can resolve this issue.

The sensor reacts to electrical interference

To avoid electrical interference, use proper cables with shielding and drain wire. Avoid running sensor cables in the same conduit as AC cables. In addition, keep sensor and wire runs away from mercury vapor lights, variable speed drives, and radio repeaters. Applying a short time-delay to an alarm relay can also eliminate reactions to sudden signal spikes.

Not all false alarms cause the level of difficulty that was experienced by the International Space Station, but they should all be avoided whenever possible. When choosing, installing, and maintaining your gas detection equipment, use the guidelines mentioned above to avoid the danger, cost and inconvenience associated with frequent false alarms.

By taking steps to minimize false alarms, your detection system will become your valuable and trustworthy ally. ■ JM & BE

Refrigerated spaces in the food industry can be very challenging to ammonia detectors.



Jason Mueske is director of sales and marketing for Calibration Technologies, Inc. (CTI).



Brian Eudaly is chief operating officer at Calibration Technologies, Inc. (CTI).

SOME CONSEQUENCES OF AMMONIA EXPOSURE	
Level of Ammonia	Symptoms
5-10 ppm	Unpleasant, sharp odor, but no adverse health effects
50 ppm	Irritation to the eyes, nose and throat after two hours of exposure*
300 ppm	Immediately dangerous to life and health. A person can survive for 30 minutes without a respirator and without escape-impairing or irreversible health effects, but it is irritating**
2,500-4,500 ppm	Fatal within 30 minutes of exposure*

* Public Health England, Ammonia Toxicological Overview
 ** National Institute of Occupational Safety and Health

Sphere.

WHY NATURALS?

An environmentally-friendly alternative, carbon dioxide (CO2) is the world's number one choice of refrigerant. Global legislation, as well as the Kyoto and Montreal Protocols, which reviewed substances linked to ozone depletion and climate change, encourage its use.

Sphere has built up solid experience and a proven track-record in applying CO2. We use it in all our ranges, bringing its advantages to you, as well as your customers and suppliers.

Our systems are designed from first principle engineering methods with energy efficiency as the main driver.

Our portfolio covers the full range of heating, ventilation and refrigeration (HVAC&R) requirements and includes the following:

- Energy efficient CO2 refrigeration systems
- CO2 Chillers
- CO2 Condensing units
- Engineering

OUR CLIENTS



SAVING THE PLANET WITH FOAM

True Manufacturing touts the use of a foam-blowing agent in its refrigeration insulation that has no GWP or ODP and cuts energy use

– By Michael Garry

In talking about its sustainability efforts on its website, True Manufacturing, a major producer of propane (R290)-based self-contained commercial refrigeration, refers to its use of a climate-friendly polyurethane foam insulation in its production process.

True has long touted the positive environmental impact of R290 refrigerant, pointing to its global warming potential (GWP) of three, ozone-depletion potential (ODP) of zero, and energy efficiency.

But on its website (<https://bit.ly/2U1q0Mb>) the company also states that the polyurethane foam insulation in its display cases incorporates a blowing agent, Ecomate (methyl formate), that has a zero ODP and zero GWP. By contrast, HFCs used as blowing agents have very high GWPs.

Used to expand foam and create its cellular structure, blowing agents also function as the insulating component of the foam. According to Ecomate's producer, St. Louis-based Foam Supplies, Inc. (FSI), it offers high R-values (insulating power); this "helps manufacturers meet [U.S. Department of Energy] energy-efficiency standards, while also meeting environmental goals," said George Snyder, president of Direct Impact, a marketing agency representing Foam Supplies.

True is one of the few commercial display case manufacturers that incorporates climate-friendly foam insulation along with a natural refrigerant in its public sustainability story.

But natural refrigerants and Ecomate go hand-in-hand, according to Snyder. "Changing to natural refrigerants is obviously a great first step, but a product isn't truly sustainable if there are HFCs in the insulation," he said.

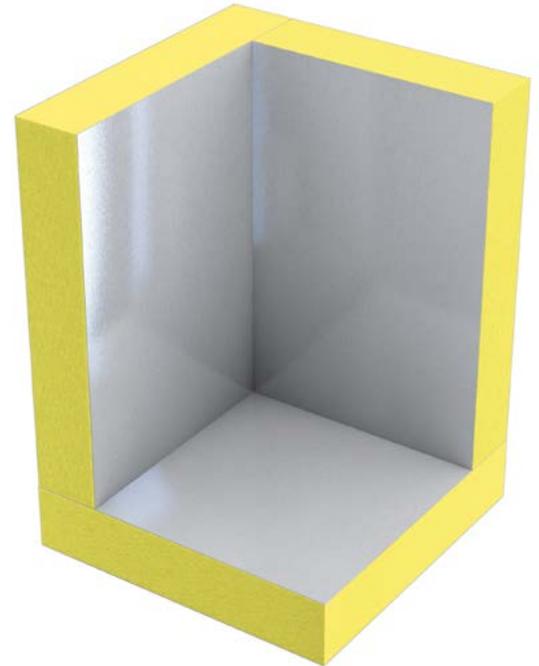
Methyl formate, the chemical component of Ecomate, is flammable; however, it is downgraded to "combustible" when blended into the polyol component of a polyurethane foam system. Also, no flammability is transferred to the foam.

SNAP approval

Approved in 2003 by the U.S. Environmental Protection Agency's SNAP (Significant New Alternatives Policy) program, Ecomate is a replacement for HFCs and HCFCs. "Ecomate offers a proven alternative to the HFCs commonly used today, as well as to the new HFOs and HCFOs, which have unknown long-term environmental impacts," said Snyder.

High-GWP blowing agents contained in foam insulation are emitted into the atmosphere during landfilling of refrigeration equipment, according to the EPA. There are no EPA requirements for foam recovery, but the agency advises removing insulating foam from all parts of refrigerators and freezers at end of life.

In 2013, the California Air Resources Board found that 8% of the state's HFC emissions derive from foams. Last year, foams were among the applications for which the state banned the use of high-GWP HFCs like R404A and R507. The



Polyurethane foam inside an air handler

law took effect for certain polyurethane uses on January 1, 2019.

At least three other states – New York, Connecticut and Maryland – have pledged to follow California's HFC regulatory path.

Meanwhile, HFC-based foams made by companies like Dow Chemical and BASF are still in widespread use, though "more and more companies are turning to Ecomate-based foams as they transition away from HFCs," said Snyder.

Certain hydrocarbons, including cyclopentane, n-pentane, isobutane and isopentane, are also low-GWP gases that can be used as blowing agents. These cost less than other blowing agents and typically are used in foams for residential refrigerators and other large-volume appliances. Foam Supplies, noted Snyder, has traditionally focused its marketing of Ecomate more on commercial and industrial HVAC&R products rather than on residential appliances.

■ MG

The high cost...

of Failure

On February 14, 2019 the coldest place in the lower 48 states was -37 degrees farenheit. During this polar vortex, the Kysor Warren transcritical system at that location never failed. As this epic cold swept across the nothern states, competitor products were failing one after another.

When you choose your supplier for transcritical refrigeration systems, select the supplier that doesn't cut corners on product designs and sleep well knowing your store will keep running.

Contact us today, to learn more.
kysorwarren.com/contact



HC CHARGE LIMIT MAY STOP AT 300 G IN U.S.

So said NAFEM Show exhibitors, who differed on whether 300 g would be better than the IEC's proposed 500 g limit

– By Michael Garry

The International Electrotechnical Commission (IEC) is expected in mid-March to start its final vote on whether to increase the charge limit per circuit to 500 g from 150 g for A3 (flammable) refrigerants, and conclude in mid-May, according to Marek Zgliczynski, Embraco's director of research and development, who chairs the IEC SC61C subcommittee.

If passed, the standard would be published in August. Then countries and regions could use it as a reference to enact binding standards. ([See "HC Charge Limit Nears Final IEC Vote," *Accelerate America*, November-December 2018.](#))

However, in the U.S., it is widely rumored that the standards bodies that would approve a charge limit increase for hydrocarbons – ASHRAE and UL – may want to limit the increase to 300 g, not 500 g. (The U.S. IEC National Committee is expected to vote against the 500-g standard; [see page 18.](#))

That was certainly the understanding of numerous exhibitors at the NAFEM foodservice equipment show, held in Orlando, Fla., February 7-9. But not everyone agreed that 300 g was a sufficient level for the standard.

"We're hearing it may only be 300 for propane, but that's not enough," said Jason Paquette, director of engineering for Structural Concepts, a Muskegon, Mich.-based display case manufacturer. "We need it to go up to 500 g, which would cover 90% of our cases." The current 150 g limit could handle only 20% of the company's cases, which include 12-ft-wide open-air refrigerated cases. The company is currently collaborating with another manufacturer on some R290 equipment, he said.



Marek Zgliczynski, chair, IEC SC61C subcommittee

The cost associated with R290 charging equipment is considerable, Paquette noted. "That doesn't scare us, but it doesn't make sense for only 20% of our equipment."

On the other hand, Nick Shriner, director of engineering for Winston Salem, N.C.-based OEMs Beverage-Air and Victory, observed that, while a higher charge is needed to use R290 to its fullest capacity, "300 grams would be good enough for our small systems."

Brandon Marshall, application manager refrigeration for component maker CAREL's U.S. division, located in Manheim, Pa., said he believes 300 g – double the current charge limit – "is a good first step." Ultimately, though, a 500-g charge limit "would allow us to expand our compressors to several other applications."

Robert Bittner, a consulting engineer based in Palm Coast, Fla., who spent 35 years with Ahold/Delhaize subsidiary Giant Food of Maryland, thinks the standard will only go up to 300 g in the U.S. because 500 g would be "too radical."

He also cautioned that any increase in the U.S., after being approved by ASHRAE, UL and the Environmental Protection Agency, would still need to be adopted by building and mechanical codes, which could take some time.

"Everybody's dreaming that the building codes are going to change quickly – keep dreaming," he said. "This involves life safety in buildings, and they're not going to change quickly."

■ MG

We didn't just tackle ammonia safety. We changed the game.



Discover the power of the Evapcold family of products—the next evolution in ammonia refrigeration systems. It's just one of the many innovations from EVAPCO that's designed to make life easier, more reliable, and more sustainable for you. We are EVAPCO—the team you can count on for life.

Inherently safer technology. Only 1 to 6 pounds of ammonia per ton of refrigeration.

Lower regulatory burden. Stay below OSHA's PSM 10,000 pound threshold and guarantee a lower EPA off-site consequence analysis.

Lower energy consumption. Suction temperatures precisely matched to your specific room loads and individual room temperature.

Smarter use of space. Reduce the size of—or completely eliminate—your Central Machine Room, enabling you to dedicate more square footage to revenue-generating operations.

Faster installation. A plug-and-play design that's factory tested and assembled for quick startup.

Competitive cost. Versus "stick built" systems, and reduces the costs associated with machine room construction and field electrical wiring.

Reduced tax burden for owners. The packaged system makes accounting for accelerated depreciation easier than itemizing "stick built" systems.

Lower life-cycle costs. Including lower regulatory and code compliance costs, lower training costs, lower electric bills and lower refrigerant costs.

100% EVAPCO manufactured and featuring the latest technology. From the company you already know and trust. Financially strong and employee owned, we are committed to product innovation through extensive R&D.

And that's only the beginning. Talk to your local EVAPCO representative or visit evapco.com to learn about ALL the game-changing benefits of the Evapcold Packaged Refrigeration System and new chiller packages.

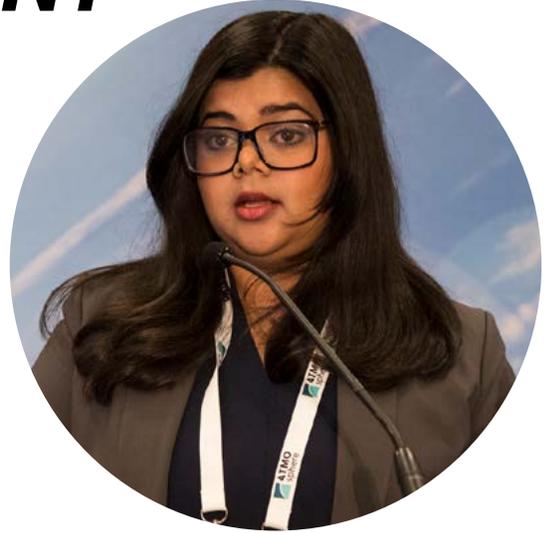


Since 1976 | An Employee-Owned Company
Commercial HVAC | Process Cooling | Industrial Refrigeration | Power

EIA URGES U.S. STATES TO ADDRESS REFRIGERANT LEAKS AND END-OF-LIFE RECOVERY

New report recommends adopting California's programs and other measures to avoid tons of GHG emissions in the face of federal rollbacks

— By Michael Garry



Avipsa Mahapatra, EIA

The Washington, D.C.-based Environmental Investigation Agency released a report in February urging U.S. states to follow California's refrigerant management plan (RMP) and adopt other policy measures to reduce the rate of emissions of HFCs and HCFCs.

The report focuses on emission reduction through leak prevention and end-of-life recovery, reclamation and destruction, which on a global basis would avoid up to 96.7 gigatons of CO₂e.

The report, called "[Search, Reuse, and Destroy: How States Can Take the Lead on a 100 Billion Ton Climate Problem](#)," targets emissions of fluorinated refrigerants from "F-gas banks," calling this "the single biggest near-term strategy to reduce greenhouse gases." EIA concentrates mainly on commercial refrigeration and AC, but also covers transport refrigeration, mobile AC and household appliances.

Avoidable end-of-life emissions of synthetic refrigerants from retired equipment in the U.S. are estimated to be 75-80 million metric tons of CO₂e annually, equivalent to emissions from 16 million cars, the report said.

The report calls the recovery and destruction of refrigerant banks "a cost-effective mitigation strategy, costing less per ton than conservative measures of the U.S. social cost of carbon."

SECTION 608 EXPANSION?

In 2016 The Obama administration expanded federal Section 608 refrigerant management regulations, including rules on leak repair, to include HFCs as well as ozone-depleting gases. However, last September the current Environmental Protection Agency proposed rescinding the Section 608 rules as they apply to HFCs.

Given federal uncertainty, the EIA report is asking U.S. states to "act quickly and decisively to address refrigerant emissions through policies aimed at scaling up refrigerant management, recovery, reclamation, and destruction — a near-term, cost-effective approach that would have immediate and significant climate benefits."

In particular, replicating and expanding on California's RMP regulation "would provide a consistent approach across states and counteract reversal of federal refrigerant management regulations," the report noted.

California's RMP requirements cover registry and reporting requirements, leak detection and repair practices, and technician certification and training for handling HFC refrigerants. EIA is advocating that California's RMP be expanded to cover large stationary air conditioning systems, which represent "a rapidly growing portion of the HFC bank."

The U.S. Climate Alliance, a group of 21 state governors who support the goals of the Paris climate change accord, has identified refrigerant management and end-of-life strategies as key elements of an approach to cutting HFC emissions. In addition to California, New York, Maryland and Connecticut are among the alliance members that have committed to reducing HFC emissions.

EIA'S RECOMMENDATION FOR ALL U.S. STATES INCLUDE:

- ▶ Conducting state-level inventories to determine quantities and sectoral breakdowns of ODS (ozone-depleting substances) and HFC refrigerant banks.
- ▶ Additional measures to increase recovery, reclamation and destruction, including mandating reclamation or destruction, banning sale of virgin high-GWP refrigerants for servicing, and incentivizing recovery through an "extended producer responsibility" scheme.
- ▶ Banning non-refillable cylinders.
- ▶ Piloting recovery and destruction projects in subsectors.

Policies that incentivize destruction of refrigerants at end of life have the added benefit of "encouraging retirement of old energy-inefficient equipment containing ODS or HFCs, and therefore a more rapid transition to alternative refrigerants and more energy-efficient systems," the report said. ■ MG

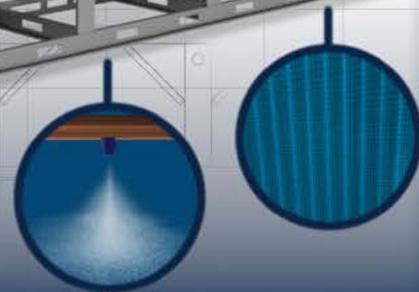
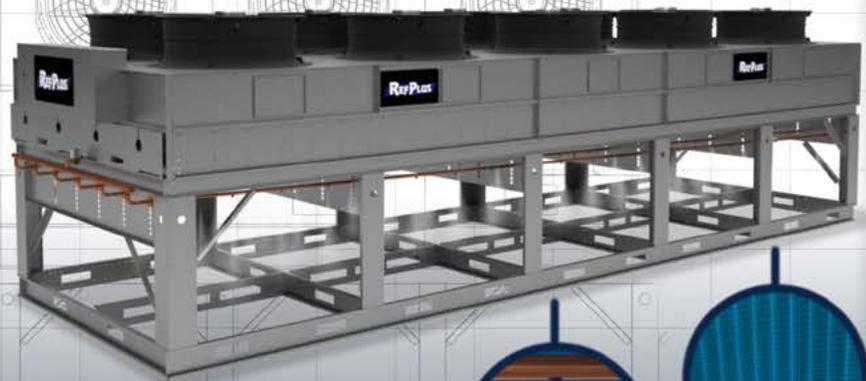
REFPLUS

CO₂



- Adiabatic pre-cooling system for longer period in sub-critical operation
- Blue Epoxy aluminum (hydrophobic) fins for maximal corrosion protection
- Gas cooler operating in transcritical system
- Design Pressure : 1741 Psig (120 Bar)

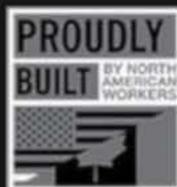
- Evaporators available in direct expansion mode and recirculated CO₂
- Standard 2 year warranty on motor & fan assembly
- Reliable T.E.A.O., high efficiency, heavy duty, two-speed motor with cast aluminum fan blade
- ECM motors available across the full product range
- Ultra quiet line available (8 pole motors)



ecoefficient+



888.816.2665
www.refplus.com



AHR EXPO HIGHLIGHTS, PART 2

CO₂ components manufacturers KeepRite, Emerson, Dorin and Parker as well as R290 component makers Tecumseh and ebm-papst were among the companies showcasing products at the massive trade show in Atlanta

– By Michael Garry



The AHR Expo continued to prove it is one of the largest exhibitions of HVAC&R equipment in the world in its latest iteration at the Georgia World Congress Center in Atlanta, January 14-16, held concurrently with ASHRAE's Winter Conference.

With a decided focus on HVAC, the expo did not have a substantial number of natural refrigerant exhibits. Still, many component makers supporting CO₂ and hydrocarbon applications were on hand. The following is a second sampling. (For the first installment, see "AHR Expo Highlights, Part 1," [Accelerate America, January 2019](#).)

KeepRite's robust Canadian CO₂ business

Most new supermarkets in Canada opt for transcritical CO₂ refrigeration, according to KeepRite, a major supplier of CO₂ evaporators for walk-in coolers and freezers, headquartered in Brantford, Ontario.

"The focus is on transcritical where it makes sense," said Georg Tusiuk, Canadian sales manager for KeepRite, in an interview at AHR Expo.

KeepRite's retail customers for CO₂ evaporators include Loblaw, Sobeys, Longo's, Metro and others; for new stores it partners with OEMs Carnot Refrigeration, Systemes LMP and Hillphoenix and contractor Neelands Group; for existing stores it uses wholesalers.

"We sell [walk-in] evaporators every day for CO₂, transcritical and secondary hybrid" said John Murray, executive vice president, national sales manager for KeepRite.

However, the U.S. market for transcritical CO₂ walk-in evaporators has been "the opposite" of Canada for KeepRite, said Murray. "We've probably had one U.S. customer in 11 years ask us to go down that path."

But KeepRite is "keenly interested" in HFC regulatory steps being taken by the California Air Resources Board (CARB), which could lead to more CO₂ installations, said Murray. "And more states may end up following this."

If the market expands in the U.S., "we're ready to go," he added.

According to sheccoBase, as of October 2018, there were 245+ transcritical CO₂ systems in Canada and 370+ in the U.S., the latter driven by ALDI US. Unlike Canada, the U.S. has not ratified the Kigali Amendment's global HFC phase-down plan and has rolled back federal HFC regulations.

KeepRite's CO₂ evaporators come with built-in electronic expansion valves. Its low-profile evaporators, with up to six fans, produces room temperatures down to -40°F, with capacities ranging from 4,300 BTU to 39,000 BTU at 10°F temperature differential.

At the AHR Expo, the company introduced an evaporator that also comprises a built-in controller to control super heat, though it is not yet available for CO₂.

Emerson's CO₂-specific rack controller

Emerson has recently introduced to the North American market the iProRACK rack controller, which is specifically designed for CO₂ systems.

Already marketed in Europe, South Africa and Australia, the CO₂ controller is "available now" in North America, though not installed in stores yet, said Stephanie Stine, OEM sales account manager, food retail, for Emerson Commercial & Residential Solutions, Kennesaw, Ga.

The unit was successfully tested by an OEM in North America, she added.

The controller manages a wide range of CO₂ functions, including parallel compression, two heat-reclaim circuits, high-pressure and bypass valves, suction and condenser controls, and oil management.

The rack controller communicates with Emerson's E2 store management system as well as its Supervisory store-management platform and its ConnectPlus Enterprise Services platform, which manages all stores in a chain.

Emerson continues to work on a single-screw transcritical CO₂ compressor for industrial heat pumps, said André Patenaude, director food retail growth strategy for Emerson Commercial & Residential Solutions. At 300 TR, it would be the largest-capacity CO₂ compressor on the market. "One or two screw compressors could replace 10 reciprocating compressors," he said. He expects the screw compressor to be ready in a year.

Emerson also offers CO₂ reciprocating compressors up to 40 hp. "We have one displacement left to get to 50 hp," Patenaude said.

For propane, Emerson hopes to introduce in North America this year a line of fixed-speed Copeland scroll R290 compressors for self-contained commercial cases, said Patenaude. The 3,000-13,000 BTU compressors (models ZB03-ZB11) are fixed-speed scroll units.

In 2018, at the AHR Expo in Chicago, Emerson debuted its first line of propane Copeland M-Line condensing units, including Copeland reciprocating hermetic compressors.

Emerson has sold about 12,000 R290 condensing units in Europe, said Patenaude. "We will leverage the design work Emerson has done in Europe and apply it to North America." The European R290 compressors use variable speed, a feature Emerson plans to bring to North America, he added.

Dorin's large CO₂ reciprocating compressor

Italian manufacturer Dorin displayed an example of its CD 500 range of reciprocating semi-hermetic CO₂ compressors, which the company says is the largest six-piston compressor for transcritical CO₂ on the market.

Designed for commercial and industrial applications, the CD 500 range has nine models, which feature 50 hp-80 hp motor power and displacements from 47.82 m³/h to 71.44 m³/h.

Parker Hannifin's new case controller

Parker Hannifin, Washington, Mo., displayed at AHR Expo a new S3C case controller and a 90-bar (1,350 psi) SPW pulse electronic expansion valve (EEV) that can be used with CO₂ systems. (Parker also offers a 90-bar stepper EEV.)

The company also has a new smartphone app that allows technicians to "see case trends and make better decisions about maintenance," said Dustin Searcy, applications engineering manager for Parker Hannifin.

"Certain chains, like ALDI, are driving the direction of CO₂ in the U.S. market," he said.

Tecumseh charging service

The biggest challenge for some OEMs in making the transition from HFCs to R290 in self-contained commercial refrigeration equipment has been charging the systems, according to Kit Fransen, director of North America Product Management for Tecumseh Compressor Company, Ann Arbor, Mich., in an interview at AHR Expo.

"A lot of manufacturers of commercial refrigeration equipment are small, and it takes a lot of capital investment to charge a system," he said.

Addressing that challenge, Tecumseh offers to charge an R290 system in its facility in Tupelo, Miss. "We'll work with [OEM] customers who don't want that investment," Fransen said.

Tecumseh will design the system with the evaporator and condenser, produce it and charge it. "It's shipped fully assembled and they drop it into their cabinet," he said.

At the AHR Expo, Tecumseh featured its IntelliCool complete refrigeration system for self-contained cases, pre-charged with R290 at the factory. It includes a variable-speed compressor and case controller.

ebm-papst R290 fan line

ebm-papst, based in Farmington, Conn., showcased a line of R290-ready ESM (energy-saving motor) fans at the AHR Expo, including blade diameters 250 mm, 200 mm, 172 mm and 154 mm.

"They can be used with evaporators or condensers in self-contained hydrocarbon equipment," said Lou Moffa, market manager for ebm-papst.

The fans use two-speed EC motors that are programmable in 10-rpm increments. "They can be dialed into where performance is needed without wasting any energy," said Moffa. ■ MG

NAFEM SHOW HIGHLIGHTS: PART 1

The foodservice equipment show continues to showcase the transition to propane (R290) refrigeration, though with some new enhancements

– By Michael Garry and Charlotte McLaughlin

The NAFEM (North American Association of Food Equipment Manufacturers) Show, held every other year, has served as a platform for a number of stand-alone refrigeration manufacturers to highlight their transition from HFC refrigerants to the hydrocarbons propane (R290) and, in some instances, isobutane.

Led by True Manufacturing, which has offered R290 display cases for retail and foodservice outlets in North America since 2015, a slew of OEMs showcased their hydrocarbon equipment at the NAFEM Show in 2015 and 2017, including Beverage-Air, Delfield (Welbilt), Minus Forty Technologies, Liebherr, Imbera, SandenVendo America, Turbo Air, and others. (See, “OEMs Flock to

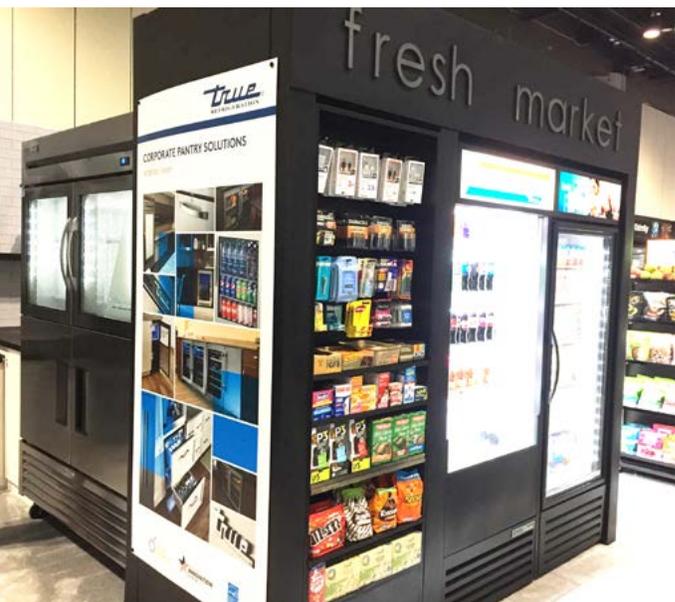
[Hydrocarbons”, *Accelerate America*, March 2017.](#)) And other manufacturers acknowledged being in the process of moving to R290, or at least considering it.

The trend continued at the 2019 NAFEM Show, held February 7-9 in Orlando, Fla., at the Orange County Convention Center. However, with the greater maturation of R290 technology, some OEMs this year debuted R290 products with new features, including True (an air-curtain display), Beverage-Air (a variable-speed condensing unit) and Delfield (a combination R290 fridge/hot food wells).

This first installment of NAFEM Show coverage will focus on those three companies.

Photo by:
NAFEM for The NAFEM Show,
February 7-9, Orlando, Fla., USA.





True's new air-curtain R290 beverage case (center), flanked by a doored case and an open display, at the NAFEM Show

TRUE'S FIRST R290 AIR-CURTAIN DISPLAY

True Manufacturing debuted its first propane (R290) vertical beverage case using an air curtain rather than a glass door at the NAFEM Show.

Starting four years ago, True was one of the first OEMs to market R290 cases for the foodservice and food retail segment in North America, paving a road that numerous other manufacturers have since traveled or are planning to travel. All of its glass-door cases have transitioned to R290, and air-curtain cases are next, beginning with the 30-in-wide TOAM30 unit on display at NAFEM.

"We left air-curtain [models] for last," said Todd Washburn, director of sales and marketing, Retail and Display Division, True Manufacturing, based in St. Louis, Mo.

The TOAM30 case uses one condensing unit, though larger air-curtain equipment might use multiple condensing units at the 150-g charge limit for hydrocarbons, Washburn said. However, if the charge limit goes up in North America, single units would be possible in larger equipment. (See page 26.) Meanwhile, "we can do everything with 150g," he said. Other potential changes True would consider: variable-speed compressors and glycol-loop cooling.

The new air-cooled unit features above-shelf LED lighting and a reduced height to match glass-door units. The display case is aimed at the "grab-and-go" retail market, including airports and convenience stores, as well as other retail outlets, said Washburn.

Also at the NAFEM Show – the biggest trade show of the year for True – the OEM displayed a year-old line of glass-door R290 merchandisers previously shown at the NACS (National Association of Convenience Stores) Show last October. He noted that glass-door cases are seven times more efficient than air-curtain units. "When you take a door off, some of your efficiency goes out the window," he said, though the air curtain "keeps some of the ambient air out."

An advantage for R290 systems is they can be used for both low and medium temperatures; HFC units require different refrigerants (R134a for medium temperature and R404A for low temperature).

He also lauded the R290 units' "great reliability numbers" and efficiency, and pointed out that the "service network has been built up." For better maintenance, True includes in all R290 models a "reverse condensing fan motor" that blows dust and dirt out of the unit over short intervals, improving energy efficiency.

"In our eyes, it's done," summed up Washburn. "Everything we do is R290."

In turn, more of True's customers – like Target – are asking for R290, he said. "They're saying, 'This is what I buy now.'"

Since introducing R290 cases globally in 2006, True has installed more than one million units, with a climate impact that equates to each of the following: preserving 2,480,000 acres of U.S. forest; removing 450,000 cars from the road; providing electricity for 320,000 U.S. homes, the company said.

BEVERAGE-AIR'S FIRST VARIABLE-SPEED-COMPRESSOR FRIDGES

OEM Beverage-Air, a division of Ali Group, introduced its first propane (R290) refrigerators to use variable-speed compressors at the NAFEM Show.

The vertical single-door refrigerators may be the first in the foodservice industry to feature variable-speed compressors, said Nick Schriener, director of engineering for Beverage-Air and Ali's Victory brand, based in Winston-Salem, N.C.

Beverage-Air and Victory are "100% committed to transferring to R290," Schriener said. About 80% of what the companies manufacture now use R290, the exception being smaller products that are in the process of being converted, he added.

The variable-speed refrigerators, called the Cross-Temp Series, include a dual-zone model on display at the NAFEM

Beverage-Air variable-speed-compressor refrigerator at the NAFEM Show



Show with two separate food-storage compartments and two condensing units. Another model uses one condensing unit for one chamber. Temperatures for both can range from -15°F to 40°F.

The variable-speed fridges employ a “drop-in solution” including a smart compressor that can “sense the load by how long it takes to achieve a set point,” said Schriener. “It then decides how much lower rpm it can step down to.”

The variable-speed technology enables efficiency gains of 30%-35% compared to standard units, said Schriener, adding, “The pull-down is awesome because it has extra capacity it really doesn’t use.” The units meet the latest ENERGY STAR efficiency standards for commercial refrigerators.

The extra capacity means that a refrigerator that formerly used two R134a condensing units would need only one R290 unit, said Mayank Patel, refrigeration engineer for Beverage-Air and Victory.

Schriener said Beverage-Air was seeing a lot of interest in the variable-speed units at the NAFEM Show, and plans to increase its product offering with variable-speed technology.

Despite the higher prices on variable-speed condensing units, John Prall, application engineer for compressor manufacturer Embraco, sees the demand for variable-speed R290 units “taking off” in North America.

As for the flammability of R290, Schriener acknowledged that a few school districts had qualms and “had to be properly educated” on the safety and environmental benefits of R290 refrigerant before accepting it. “We said it has gone through extensive UL tests and all components are protected – none can be a flame source.” They also point out the very small charge (150 g or less) of propane used.

But most customers don’t think about the flammability of R290, Schriener noted. “As long as the unit is quiet, it never comes up.”

With its commitment to R290, Beverage-Air will not offer condensing units with HFO blends. “We want to build our units and leave them alone,” said Schriener. “If we go with [HFO blends], we’ll be there again in five or six or seven years. That’s not where we want to be.”

DELFIELD COMBINES R290 FRIDGE WITH HOT FOOD WELLS

Delfield, a division of Mount Pleasant, Mich.-based Welbilt, showcased its first custom combined heating/refrigeration unit that includes propane (R290) refrigerant at the NAFEM Show.

Rebranded as the EcoMark counter with prep, the unit is “the most environmentally friendly version we have ever manufactured,” said Marcy Mathews, director, product management-global Delfield, which supplies foodservice operators.

The base of the EcoMark unit incorporates Delfield’s GreenGenius R290 refrigeration technology, which the company now uses throughout its line of foodservice refrigeration and freezer equipment.

The R290 equipment is able to coexist with a hot food wells because “any areas that could result in a spark are completely sealed,” said Mathews.

The previous version of the heating/refrigeration unit, the Mark 7, used R404A. “We see a 10%-15% efficiency increase with R290,” which the company attributes to just the refrigerant change, Mathews said.

The EcoMark unit also cuts energy consumption by 77% by using 500-watt heating elements for the hot food wells rather than the conventional 1,000-1,200 watts, Mathews said.

The R290 unit is “cost neutral” compared to the R404A unit, and the latter may be going up in price because of “supply and demand,” she said. “We know R290 is the right thing going forward.”

Sara Sunderman-Kirby, Delfield’s product manager, noted that Delfield’s food-service customer base has “gotten over” any initial concerns about hydrocarbons they may have had when Delfield converted its product base to R290 in 2016. In addition, “we haven’t heard anything bad” from service technicians whom the company trains to handle R290.

Mathews noted that mullion-style evaporator coils are located in the middle of the refrigeration space, which allows “even distribution” of air flow and increases space for products.

■ CM & MG

R290 refrigeration segment of Delfield’s combined fridge/heating unit



..... **HUSSMANN®**

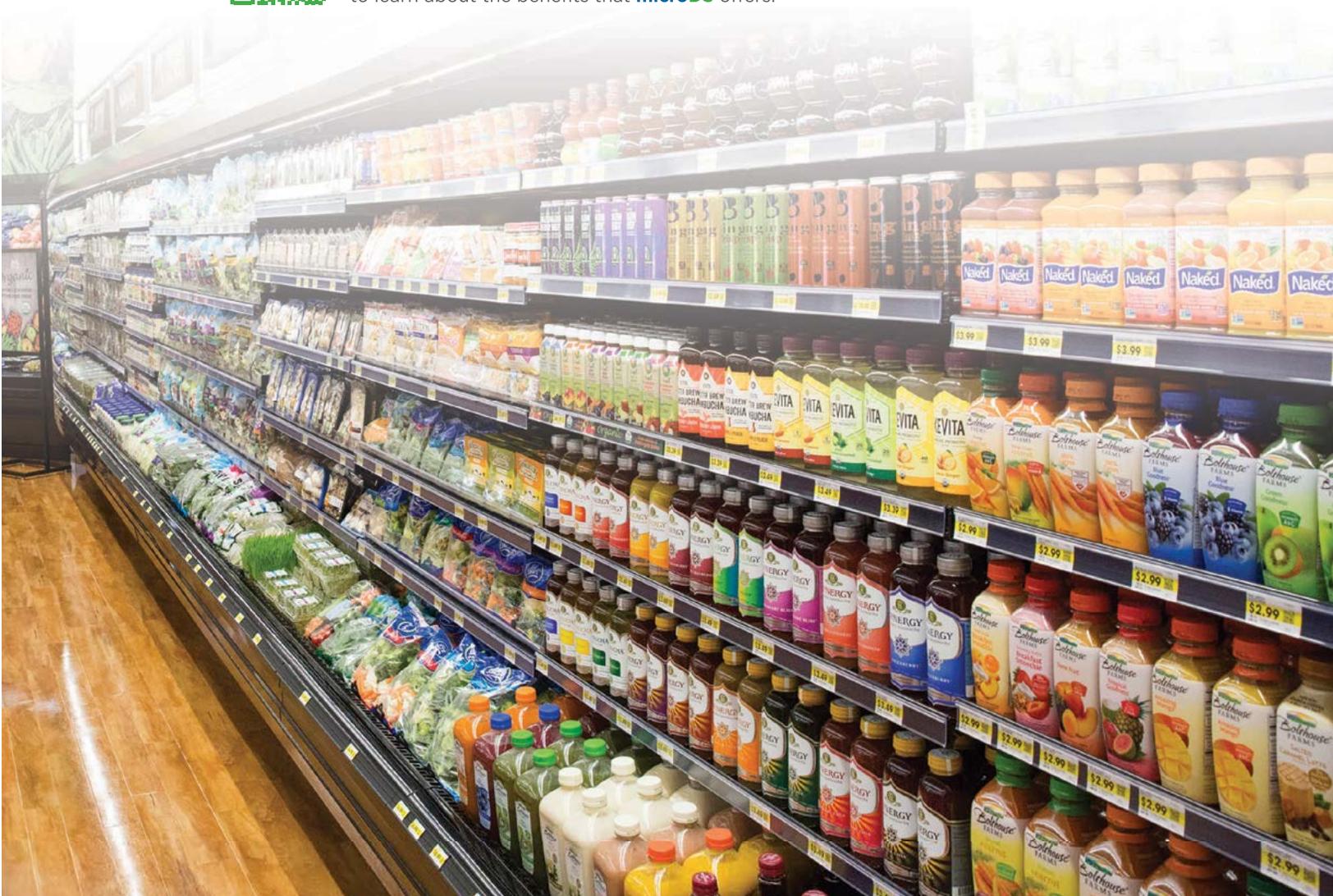
Your natural solution.

microDS™



Discover your green.

Scan the QR code or go to www.hussmann.com/propane to learn about the benefits that **microDS** offers.



NO R290 LEAKS SINCE 2013 AT H-E-B STORE

The Texas grocery chain reports on the performance of its pioneering 83,000-sq-ft Austin outlet, which uses only propane condensing units for all display cases

– By Charlotte McLaughlin and Michael Garry



In July 2013, San Antonio, Texas-based grocery powerhouse H.E. Butt Grocery Company (H-E-B) opened a store in Austin, Texas, that is regarded as the first U.S. supermarket to employ propane (R290)-refrigerated display cases throughout the store.

As R290 increasingly becomes a viable refrigeration option for new and existing stores in North America, many retailers and their suppliers have become understandably curious about how this initial R290 supermarket has fared over the past six years. (See “R290: The Future of Food Retailing?” [Accelerate America, January 2019.](#))

To shed light on that subject, the U.S. Environmental Protection Agency’s GreenChill program hosted a webinar on February 12 featuring Charlie Wernette, principal engineer at H-E-B, and Richard Gilles, senior product leader, distributed solutions for Hussmann, the supplier of H-E-B’s R290 cases.

The R290 pilot was an opportunity for H-E-B, which runs 400 stores in Texas and Mexico, to test a natural refrigerant in the warm temperatures where it operates, Wernette said.

“We were really going after as much from the sustainability standpoint as we could,” he said. Meanwhile, in 2019, the system continues “kicking right along.”

One of H-E-B’s biggest takeaways from the R290 store is that it has experienced zero leaks to date – practically unheard of for stores of this size. That’s even with 346 R290 condensing units in the store (each containing no more than the 150-g of propane charge, the maximum allowed) as well as packaged condensing units (with an evaporator) in the walk-in rooms; each of the packaged units has 350 g of R290, based on permission from the EPA. Keeping to the 150-g limit in the walk-ins would have required too many condensing units, Wernette noted.

Supermarkets in the recent past have typically leaked around 25% of their large-charge (3,000 lbs and over) DX systems containing high-GWP refrigerant, though the GreenChill program has helped bring that average down.

CTI

Gas Sensors

Built for harsh conditions.
Our sensors thrive where others fail.



- ✓ Designed to handle -50°F to +130°F operating temperatures.
- ✓ Encapsulated circuitry prevents corrosion and withstands high-pressure washdowns.
- ✓ Every sensor passes rigorous testing and includes a 2-year warranty.
- ✓ Same day shipping on all products



CALL 866-394-5861

VISIT ONLINE ctiengineering.com

EMAIL sales@ctiengineering.com

Industrial gas detection systems for natural refrigerants including:
Ammonia | CO₂ | Hydrocarbons

“In my mind it is a huge success that we can put in commercial refrigeration system in a supermarket and not have it leak,” Wernette said. H-E-B actually predicted a zero leak rate going into the project,” he added.

Hussmann’s new R290 MicroDS line consists of factory-made, pre-charged, hermetically sealed plug-in systems that have a leak rate of under 1% and a refrigerant charge that is 95%-98% lower than a conventional DX system, Gilles said.

But another prediction – that the system would save 40%-50% in energy consumption – did not prove true. “The energy savings are really on par with other stores,” Wernette said, adding that he had been “chasing energy in a big big way here.”

Wernette pointed to energy usage by pumps in the three glycol loops that remove heat from the condensing units as the reason for missing the energy targets. “It was a lot more than we assumed,” he said.

On the other hand, the store saved energy by putting doors or lids on about 95% all of the display cases,” he said. The doors were not found to cause any loss of sales. “Fresh meat has doors and people still shop it.”

Overall maintenance costs at the store were higher than expected due to compressor failures. “We haven’t been able to put our finger on why, but keep in mind there’s over 360 compressors just for refrigeration in this store,” Wernette said. “That’s one thing you have to get over when you’re talking about this.” Parts availability has also been a challenge.

Hussmann and H-E-B have worked to determine the cause of the compressor failures. In its new line of microDS R290 equipment, Hussmann has included a number of changes aimed at correcting this issue and improving efficiency, including phase monitoring, a high-pressure cut-out switch, and a high-temperature cut-out for the discharge line, said Gilles.

The capital cost of the H-E-B system was comparable to that of a transcritical CO₂ system, said Gilles. (A transcritical system typically costs more than a conventional system.) However, the simplicity of the R290 system reduces installation costs, he noted.

Also for HVAC

Located above the reach-in cases and inside the coffin cases, the H-E-B store’s condensing units consist of not only a compressor and condenser but also an evaporator.

The store leverages the heat of rejection (1,319,806 BTUs) captured by the glycol loop to also deliver cooling for air conditioning and heating for the store via a “temperature stairway,” said Wernette.

Initially, the 400-TR HFC chiller (with a cooling tower) brings down the temperature of the glycol to 45°F and sends it to the cases. (The new MicroDS line uses HFC-free fluid coolers; [see “Hussmann Debuts Self-Contained Propane Cases,” *Accelerate America*, November-December 2018.](#)) The glycol emerges from the cases at 55°F, and is used in the packaged HVAC equipment on the roof. Its temperature now 65°F, the glycol goes through a radiant slab for cooling and heating in the store.

Combining the air-conditioning and heating with the refrigeration system and also using LED lights helped earn the store Gold LEED (Leadership in Energy and Environmental Design) certification.

Wernette acknowledged that the 150-g charge limitation drives up the number of condensing units and the cost of the overall system. Assuming the International Electrotechnical Commission votes this spring to increase the charge limit to 500 g for A3 (flammable) refrigerants in commercial refrigeration ([see page 26](#)), the standard would still need to be adopted in the U.S. by bodies such as UL and ASHRAE, and by the EPA. “If we could ever do [this] one thing as a country, it would really help a lot to get the number of compressors down,” he noted.

According to Gilles, a 500 g charge would reduce the number of compressors by “one-half, if not two-thirds.”

Wernette also offered caveats for dealing with an R290 line-up, such as checking the equipment regularly. “You need to ensure that the glycol supply is really really clean,” he said. “Small particles will plug up the braze plate heat exchangers.”

He also advised other R290 users to make sure that the controls shut down the condensing units upon the loss of the chiller. Early on, when the H-E-B store lost its chiller in a thunderstorm, the condensing units didn’t shut down, a glycol line blew out, and water was dispersed throughout the store.

In addition, he recommended checking the water chemistry of the closed glycol loops, which changes when new water is added.

Despite some of the challenges he faced, Wernette left the webinar audience with number of positive statements about R290. “R290 is a safe and reliable refrigerant when installed properly,” he said. “I can’t say enough good things about that. It’s amazing that 150 g of it can do what it does from the refrigeration standpoint.”

Will H-E-B use R290 in future stores? “We think it it’s a viable technology, as well as other technologies,” he said. “We’re looking at everything.” ■ CM & MG

Natural Alternatives to HFCs are the Smart Choice in Refrigerants...

...and in Foam Insulation.

Environmentally responsible Ecofoam® polyurethane insulation offers the high R-values manufacturers need – without HFCs.



As the world transitions away from HFC refrigerants, leading HVAC/R manufacturers are also eliminating HFCs from their foam insulation by specifying Ecofoam®. Formulated with Ecomate®, our patented, HFC-free blowing agent technology, Ecofoam has NO global warming potential (GWP) and NO ozone depletion potential (ODP). Plus, by providing higher R-values, Ecofoam improves energy efficiency, further contributing to a more sustainable future.



www.foamsupplies.com

**Better products.
Better for the environment.**



Amman, Jordan

CO₂ THRIVES IN THE DESERT

The first transcritical CO₂ system used by a supermarket in the Middle East delivers energy savings of up to 30% compared to an HFC system

— By Charlotte McLaughlin

The Hashemite Kingdom of Jordan, much of it residing in the North Arab Desert, is listed as a high-ambient temperature (HAT) country by the Montreal Protocol, the global treaty on phasing out ozone-depleting substances and phasing down HFCs (under the Kigali Amendment).

Natural refrigerant CO₂ has not traditionally been noted for operating efficiently in hot ambient temperatures due to the relatively low critical temperature (88°F) of CO₂, above which it does not condense. This gave rise to the term "CO₂ equator," which describes the geographical limit for cost-effective and efficient performance of transcritical CO₂ systems.

However, CO₂ has been able to overcome its efficiency challenge in high temperatures with the use of technologies like ejectors and parallel compression. Those technologies — Dorin parallel compressors and a Danfoss multi-ejector — are featured in a transcritical CO₂ refrigeration system employed by the Al-Salam military supermarket in Amman, Jordan. Alfa Laval, LU-VE and Temprite also supplied components.

The store, which opened in February 2018, is the first in the Middle East to deploy transcritical CO₂ system. Since then, the system has been found to cope well with temperatures of up to 96.8°F (36°C) between June and September.

In fact, after measuring the CO₂ system's performance against an HFC-system in a similar supermarket in the same area, contractor Abdin Industrial determined that the CO₂ system performed 20%-30% more efficiently last year than the HFC equipment. "We installed energy meters in both projects," said Nasser Abdin, deputy plant manager for Abdin.

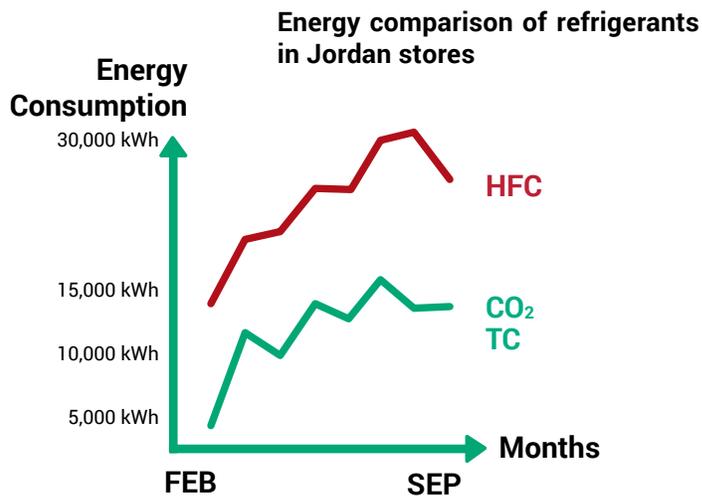
The transcritical system has succeeded even though this was the first time Abdin Industrial had worked with CO₂. Abdin is also responsible for maintenance of the system.

Enex, the Italian manufacturer of the CO₂ system, initially doubted that an HVAC&R contractor with limited knowledge of transcritical CO₂ would succeed — and was pleasantly surprised when it did.

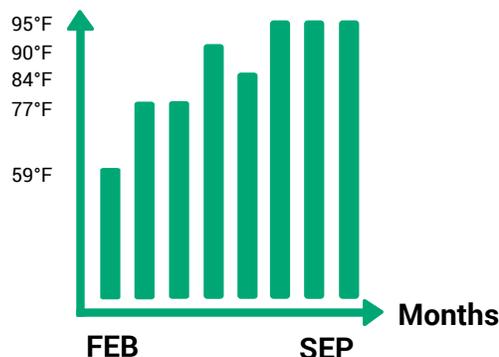
"In the beginning we were skeptical about the feasibility with a company that had never done



CO₂ transcritical system, Al-Salam military supermarket, Amman, Jordan



Average Ambient Temperature in Jordan in 2018



Source: Abdin Industrial

CO₂ – not even cascade – but then we had to rethink our ideas,” said Sergio Girotto, president of Enex “They learned very quickly [about] CO₂ systems.”

“The fruitful cooperation of Abdin and Enex shows that local manufacturers and suppliers of commercial refrigeration equipment are able to leapfrog towards the latest CO₂ refrigeration technology,” said Armin Hafner of SINTEF (Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology in Trondheim, Norway). Hafner served as technical adviser on the Amman project.

The transcritical system also features non-superheated evaporator technology, for both chilled and frozen food cabinets and storage rooms. The waste heat from the system is recovered for hot sanitary water supply, which increases the energy efficiency of the system.

The system is able to maintain chilled food with an evaporation temperature of 28.4°F (-2°C), while frozen foods are cooled by evaporating carbon dioxide at -13°F (-25°C), Hafner said.

With a total surface area of 21,528 sq ft., this supermarket represents a test for CO₂ in challenging weather conditions and could open the door to the expansion of CO₂ across the region.

“Recently I heard about the result – it seems [the military] is extremely satisfied [with] the energy saving,” said Girotto.

Abdin also reported favorable feedback from the military. The store has not experienced any maintenance or food wastage issues, and the military is exploring CO₂ installations in other locations in Jordan, he said.

“After installing the first CO₂ project in Jordan, we as Abdin feel that we now have the responsibility and duty to inform [others in the industry] about the benefits of CO₂ systems,” Abdin said. “I also think our government can do something to help, for example by [awarding] projects [to installers] that manage to reduce their energy bills.”

A UN PROJECT

The Al-Salam supermarket used R22, a refrigerant that depletes the ozone layer and has a high GWP (1,810), before the transcritical system was installed with support from Jordan’s Ministry of Environment. The demonstration project was funded by the Climate and Clean Air Coalition (CCAC) and implemented

by the United Nations Industrial Development Organization (UNIDO).

There are currently around 20,000 CO₂ transcritical supermarkets in the world, according to October 2018 estimates from sheccoBase (the market development arm of *Accelerate America* publisher shecco).

In addition to Europe, Japan and the U.S., CO₂ has been successfully used in supermarkets in such diverse locations as Brazil, China, Russia, Indonesia, Peru and Australia, thanks to the commitment of local and multinational retailers, as well as similar international funding on occasion.

“CO₂ technology is spreading very fast in the world as it is considered one of the most energy-efficient and climate-friendly refrigeration technologies for the retail sector,” said “Sulafa Mdanat, UNIDO’s country representative in Jordan. ■ CM



Campbell's

NEW REFRIGERATION FLAVORS

The food and beverage giant, which pioneered low-charge ammonia systems, has added cascade and transcritical CO₂ technology to the mix

– By Michael Garry

Like many consumer packaged goods companies, Campbell Soup Company offers numerous versions of its products, including dozens of soups and countless cookie options.

That penchant for diversity has now extended into natural refrigeration. A pioneer of low-charge industrial ammonia systems, Campbell over the past year has added two new refrigeration flavors – CO₂ cascade and transcritical CO₂.

In doing so, Campbell has joined a small but growing group of industrial end users who are installing transcritical and cascade CO₂ systems to improve safety and avoid regulations in what has for decades been an ammonia-centric industry.

The CO₂ cascade installations, incorporating ammonia (NH₃) and glycol, have taken place at two of Campbell Pepperidge Farm bakeries – a replacement system in Lakeland, Fla., and a new system in Downingtown, Pa. (incorporating an unusual spiral freezer). Another replacement system is planned this year at a bakery in Denver, Pa.

The CO₂ cascade solutions have so far “worked out well for us,” said Bing Cheng, Campbell’s senior manager of utilities, environmental and sustainability programs, who also serves on the IIR’s CO₂ standard committee.

In addition, at its headquarters in Camden, N.J., Campbell has deployed its first CO₂-only transcritical system for a new ingredient cooler/freezer.



▶ The CO₂ cascade systems use ammonia as the primary refrigerant, which in turn chills a glycol solution; the glycol, serving as an intermediary, chills CO₂. The CO₂ is then delivered to the evaporators serving freezer loads.

By incorporating glycol in its CO₂ cascade freezer systems, Campbell is leveraging the glycol already being used as a result of an earlier decision to replace ozone-layer-depleting R22 systems at five of its Pepperidge Farm plants (Downingtown, Lakeland and Denver, as well as plants in Richmond, Utah, and Willard, Ohio) with low-charge ammonia systems. (See [“Campbell Low-Charge Recipe,” Accelerate America, April 2016.](#))

The bakeries – which produce such iconic brands as Milano Cookies and Goldfish crackers – are now more than 90% R22-free, said Cheng, who has overseen the transition from R22 to natural refrigerants at Pepperidge Farm.

Campbell has deviated from using a direct ammonia/CO₂ cascade system (with no intermediary), an option increasingly utilized by industrial companies such as US Cold Storage and Mexican storage provider Frialsa. But in so doing, the soup company avoids having to deal with the possibility that ammonia and CO₂ would accidentally mix in the heat exchanger, producing system-clogging ammonium carbamate.

With its new CO₂ ventures, Campbell is adding another chapter to its pioneering career as a natural refrigerant innovator. That started in the early 1990s, when former longtime head of refrigeration Bob Czarnecki introduced one of the industry’s first low-charge ammonia designs, followed in the late 1990s with low-charge packaged ammonia units. Most of Campbell thermal plants (which make soup, sauces, beverages and other products) emphasize low-charge ammonia chiller packages circulating glycol.

Starting in Lakeland

Campbell first CO₂ cascade project took place in 2017 at the Lakeland, Fla., Pepperidge Farm facility as it underwent its conversion from R22, which was replaced by ammonia/glycol for HVAC and chilled water applications.

“We included enough capacity in that new system for a CO₂ skid,” which serves a small formerly R22 ingredient freezer, said Cheng. “CO₂ is better for low-temperature applications” than glycol, he added. The cascade system was provided by engineering firm CRT Design, Jacksonville, Fla.

The same approach will be followed in the early spring of 2019 at the Denver plant, though the CO₂ rack (from Zero Zone) will be located on the roof rather than in an engine room. “The load at Denver was remote enough [from the engine room] to put the CO₂ skid out there,” said Cheng.

The cascade systems at both Lakeland and Denver serve small ingredient freezers (7.2 TR and 6 TR, respectively), with CO₂ evaporators in the rooms.

Because of ammonia’s greater efficiency, Campbell normally uses it for freezers, but “it would not make economic sense to put in a low-temperature ammonia compressor and penthouse ammonia evaporator for that small a load,” said Steve Parra, a senior engineer for Campbell based, like Cheng, at its Camden, N.J., headquarters.

Campbell does employ a direct ammonia system with a penthouse evaporator in freezers at its thermal plants and at a Pepperidge Farm facility in Richmond, Utah. “We use a slight overfeed on the coil because we’re trying to reduce the amount of ammonia,” explained Parra. “We build them in a penthouse and elevate the coils enough to drain freely to the engine room.” ▶

- 1 / HVAC NH₃/glycol chiller package, Richmond, Utah
- 2 / Campbell Soup headquarters, Camden, N.J.
- 3 / Freezer, Camden, N.J.
- 4 / Transcritical CO₂ rack, Camden, N.J.
- 5 / Transcritical CO₂ rack, Downingtown, Pa.
- 6 / Spiral CO₂ freezer, Downingtown, Pa.





2 /



3 /



4 /



6 /



5 /



Photo by Carla Tramullas

LEFT

Bing Cheng, Campbell Soup

RIGHT

Steve Parra, Campbell Soup

bread freezer; see "A Canadian First," *Accelerate America*, February 2017.)

The CO₂ spiral freezer is connected to a CO₂ rack (from Hillphoenix), which is in turn linked to an existing ammonia/glycol system to create the cascade system. "There was extra glycol capacity that we tapped into for the CO₂," said Cheng.

Utilizing already existing ammonia/glycol equipment at the Downingtown plant again made the cascade system "a very low-cost option" compared to adding an penthouse ammonia evaporator, Cheng noted. For its Pepperidge Farm freezers, "we could have used penthouse ammonia or HFCs, but we thought [cascade CO₂] was the best balance between natural refrigerants and cost."

Campbell may install another CO₂ cascade system at a Pepperidge Farm facility in Downers Grove, Ill., that was converted in 2004 from R22 to mostly R507. "It sits in the middle of a residential neighborhood, so we can't have ammonia there," said Parra. The cascade system using secondary glycol would replace the remaining few R22 compressors.

Parra said he was pleased thus far with the performance of the CO₂ cascade systems. "We would use it again," he said. "It's a perfect fit for smaller loads where we don't have low-temperature ammonia systems."

After start-up, Campbell has not experienced CO₂ leaks in the cascade system, noted Parra. The efficiency of the cascade system takes a "little hit" compared to a direct ammonia system, noted Parra, but he did not consider it significant for "relatively small loads."

At its Pepperidge Farm facilities in Richmond, Utah, and Willard, Ohio, Campbell has transitioned to ammonia/glycol but has not yet installed CO₂.

▶ For safety reasons, he added, "we don't like flooded coils in the plant." This is also one of the advantages of using CO₂ in a freezer application rather than ammonia. "If you blow [a CO₂] evaporator unit in the freezer, there's not the potential for a dangerous situation," he said.

A lesson learned from the initial Lakeland cascade installation, which was delayed due to contractor issues, was the importance of hiring a contractor who is "familiar and comfortable with CO₂ systems," said Cheng. For its succeeding CO₂ projects, Campbell has employed Jax Refrigeration, Jacksonville, Fla.

For maintenance, Campbell uses its own technicians (such as in Downingtown) or a third party (Capital Refrigeration and Sodexo in Camden). Hillphoenix did initial training on its CO₂ technology at Downingtown and Camden.

For CO₂ racks in both transcritical and cascade systems, it's important to train the maintenance staff to remove all moisture from the system if the system is recharged with CO₂ and to use only "Coleman grade" CO₂ gas, noted Parra.

Spiral CO₂ freezer

At its Downingtown, Pa., Pepperidge Farm frozen-food plant, Campbell installed a new 110-TR spiral production freezer (including evaporator coils) for bread products in January 2018. Cheng believes this is one of the first freezers in the U.S. bakery industry to use CO₂ in the freezing unit, said Cheng. (In Canada, Wholesome Harvest Baking has installed a Mayekawa NewTon NH₃/CO₂ packaged system that serves a spiral



First transcritical

In Camden, N.J., at its world headquarters, Campbell installed its first transcritical CO₂ system (from Hillphoenix) in the first quarter of 2018 for a new 30-TR soup-ingredient cooler/freezer.

Camden is largely a research-and-development facility that occasionally does small manufacturing runs for test markets. In 2017, Campbell installed a 4.4-megawatt solar array at its headquarters, the largest in Camden, N.J. It was designed to generate the equivalent of 20% of the headquarters' electricity demand.

Campbell does not use ammonia in New Jersey due to the onerous regulations the state places on industrial users of the gas, said Parra, adding that the company does not want to use ammonia in any event at its headquarters. An R410A glycol chiller in Camden was too small to serve the new freezer, he said.

In terms of efficiency, the transcritical system offers the advantage of using a single refrigerant and not having to pump secondary glycol or use heat exchangers between refrigerants, as in the cascade systems. On the other hand, transcritical loses efficiency while operating in warmer ambient temperatures. Campbell did not choose to use an adiabatic condenser or other add-ons to improve efficiency. ▶

CGF'S REFRIGERATION GOALS

Campbell Soup Company is a member of the Consumer Goods Forum (CGF), a consortium of consumer foods manufacturers and retailers that has pledged to meet environmental goals, including one related to refrigeration.

Its initial refrigeration "resolution and commitment," published in December 2010, declared that the group would mobilize its businesses to "begin phasing out HFC refrigerants as of 2015 and replace them with non-HFC refrigerants (natural refrigerant alternatives) where these are legally allowed and available for new purchases of point-of-sale unit and large refrigeration installations."

That statement was replaced with another in October 2016, which reads in part as follows.

"We ... as individual companies, commit to the following in all commercial and industrial refrigeration equipment under our control along the food & beverage supply chain:

- ▶ In markets where viable, to install new equipment that utilizes only natural refrigerants or alternative ultra-low (under 150) GWP refrigerants, effective immediately.
- ▶ In markets where barriers to deployment exist, to engage with our suppliers, civil society, business partners and governments to overcome remaining technical, regulatory and other barriers in certain geographies and sectors, to enable the purchase of new equipment that utilize only natural refrigerants or alternative ultra-low GWP refrigerants as soon as possible but no later than 2025.
- ▶ Work to reduce the total equivalent environmental warming impact of our existing and new refrigeration systems, including (but not limited to) improving energy efficiency, optimizing refrigerant charge sizes and minimizing refrigerant leaks."

Overall, though, Cheng has been satisfied with the energy performance of the transcritical system over its first year of operation. “We definitely didn’t see a large spike in energy use” after adding the system, he said. For the capacity being served, the energy penalty for the transcritical system was small, added Parra. “It did not make a big difference in our decision.”

As a company, Campbell said in its 2018 Corporate Responsibility Report that it believes the use of natural refrigerants “significantly improves energy efficiency, lowers energy costs and reduces GHG emissions.”

For Parra, transcritical was “the best way from an economic standpoint, both capital and installation. And it runs nice.”

Cheng concurs that the transcritical system is reliable and “maintenance- and operations-wise, it functions pretty well.” After some initial tweaking in the first month, the system has not experienced a leak, he said.

Challenge of remote units

While most of the R22 HVAC units at Pepperidge Farm plants have been replaced by ammonia/glycol chillers, there were some small remote units, roughly 20-30 TR in capacity, for which “it did not make economic sense to run glycol across the roof from a central system,” said Parra. They have so far been replaced with R410A units.

“Eventually the R410A units will get replaced,” said Cheng. “We’re trying to figure out if it’s worth expanding the existing [ammonia/glycol] system to cover it.”

However, for a much larger (300-TR) load at a thermal plant in Napoleon, Ohio, Campbell installed a air-cooled ammonia chiller from Azane that produces cold glycol used by an air handler to generate air conditioning. “There was nothing else on that side of the plant,” said Parra. “So we put the Azane unit there.” (See “NatRefs for AC,” *Accelerate America*, October 2017.)

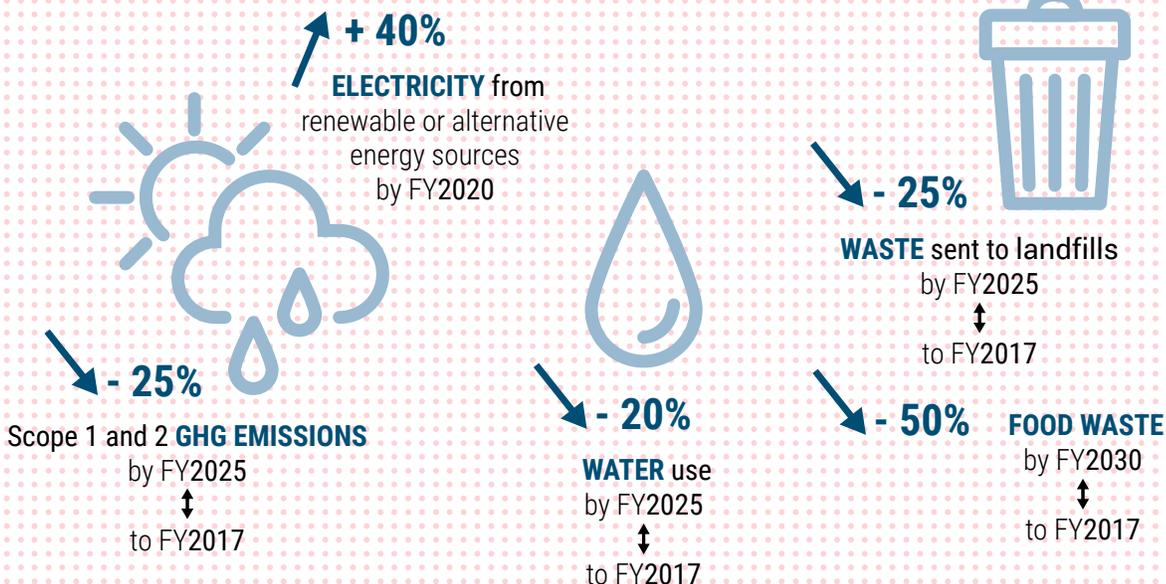
“It made more sense to drop [the Azane unit] in,” said Cheng. “It’s working fine.”

In general, Campbell’s operating guidance is “to remove HFC whenever possible,” said Parra. (Campbell has to date not used HFO blends.) That guidance stems from Campbell participation in the Consumer Goods Forum, which has pledged as a group to phase out HFCs and transition to climate-friendly refrigerants. (See page 47.)

“We’re still committed to our Consumer Goods Forum’s commitments,” said Cheng.

And Cheng, who last year added management of environmental and sustainability programs to his title, is committed to achieving sustainability goals established by Campbell, not only in refrigeration but also water usage, overall greenhouse gas emissions and waste reduction. “It’s a passion of mine,” he said. ■ MG

Campbell Soup’s Commitments



Source: Campbell Soup 2018 Corporate Responsibility Report



CAMPBELL CO₂ SYSTEM SPECS

LAKELAND, FLA. CASCADE INGREDIENT FREEZER (2017)

- ▶ Capacity: 7.2 TR
- ▶ Size of freezer area (sq ft): 647
- ▶ Temperature of freezer : -10°F
- ▶ Charge of CO₂: 200 lbs
- ▶ Supplier CO₂ rack: CRT Engineering
- ▶ Supplier of glycol/CO₂ heat exchanger: Vahterus
- ▶ Supplier of CO₂ evaporator: Bohn
- ▶ Supplier of two CO₂ compressors: Copeland
- ▶ Supplier of CO₂ detection system: Calibration Technologies, Inc.
- ▶ Supplier of CO₂ rack controller: Allen Bradley
- ▶ Supplier of CO₂ valves: Danfoss
- ▶ Type of CO₂ piping: Copper

DOWNINGTOWN, PA. CASCADE SPIRAL PRODUCTION FREEZER (2018)

- ▶ Capacity: 110 TR
- ▶ Temperature of freezer : -30°F
- ▶ Supplier CO₂ rack: Hillphoenix
- ▶ Supplier of CO₂ evaporator: Evapco
- ▶ Supplier of CO₂ detection system: Calibration Technologies, Inc.
- ▶ Supplier of CO₂ rack controller: Micro Thermo
- ▶ Supplier of CO₂ valves: Sporlan
- ▶ Type of CO₂ piping: XHP Copper

DENVER, PA. CASCADE FREEZER (2019)

- ▶ Capacity: 6 TR
- ▶ Size of freezer area (sq ft): 800
- ▶ Temperature of freezer: -10°F
- ▶ Charge of CO₂: 40 lbs
- ▶ Supplier rooftop CO₂ rack: Zero Zone
- ▶ Supplier of glycol/CO₂ heat exchanger: SWEP
- ▶ Supplier of two CO₂ compressors: Bitzer
- ▶ Supplier of CO₂ detection system: Calibration Technologies Inc.
- ▶ Supplier of CO₂ rack controller: Allen Bradley
- ▶ Type of CO₂ piping: XHP Copper

CAMDEN, N.J. TRANSCRITICAL INGREDIENT COOLER & FREEZER (2018)

- ▶ Capacity: 30 TR
- ▶ Size of freezer room (sq ft): 3,025
- ▶ Size of cooler room (sq ft): 1,144
- ▶ Temperature of freezer: 0°F
- ▶ Temperature of cooler: 35°F
- ▶ Supplier of CO₂ rack: Hillphoenix
- ▶ Supplier of gas cooler/condenser: Luvata
- ▶ Supplier of CO₂ evaporator: Bohn
- ▶ Supplier of CO₂ detection system: Calibration Technologies, Inc.
- ▶ Supplier of CO₂ rack controller: Allen Bradley
- ▶ Supplier of CO₂ valves: Danfoss
- ▶ Type of CO₂ piping: Copper

RIVACOLD BRINGING R290 WALK-IN UNIT TO U.S.

Two U.S. stores are using ceiling-mounted packaged system, which the Italian company will be manufacturing in the U.S.

– By Michael Garry



Rivacold's R290 walk-in unit

As more retail stores in the U.S. move toward installing propane (R290) display cases, Italian manufacturer Rivacold has begun selling its R290 ceiling-mounted packaged system for walk-in coolers and freezers in the U.S. market.

Rivacold has sold the R290 packaged units to more than 100 stores in Europe, and so far to two new stores operated by a single retailer in the U.S., said Doug Schmidt, president of Rivacold's U.S. division, based near Atlanta, Ga. (He could not name the retailer without their permission.)

"We expect to manufacture them in the U.S. later this year," he said, adding, "Almost everything we quote in the U.S. now is R290."

The sealed packaged system encompasses three parallel circuits – each consisting of a small hermetic compressor using under 150 g of propane – that work with one condenser and one evaporator. It is typically cooled via a glycol-loop system fed by an outside

chiller, and is installed on the top of a walk-in cooler or freezer. The system uses thermostatic expansion valves and hot-gas defrost.

One Rivacold unit can cool a room that is 10 ft by 10 ft by 8 ft, and multiple units are used for larger rooms. "It's very scalable," said Schmidt. In rooms with multiple units, one serves as a "master" and the rest as "slaves" linked to the master unit. "They all communicate to maintain a uniform cooling effect in a large room," he explained.

The two U.S. stores where the Rivacold units have been installed also use R290 for all of their display cases, most of which share a glycol-cooling loop with the Rivacold equipment (some are unitary coolers at the point-of-sale), Schmidt noted. One of the stores has six Rivacold units in the walk-in cooler, and four in the freezer; the ratio in the other store is eight/four.

The walk-in units are designed for supermarkets, convenience stores and fast-food outlets. The two U.S. stores are

smaller, urban stores, but the unit is not limited to smaller stores, said Schmidt.

Energy savings

The Rivacold unit is generally used instead of a split HFC system with a condensing unit on the roof and an evaporator in the room.

In a presentation last year at the ATMOsphere America conference in Long Beach, Calif. (organized by shecco, publisher of *Accelerate America*), Schmidt presented an energy comparison between the Rivacold R290 unit and an air-cooled split HFC system. The Rivacold unit was shown to use 26.1% less energy.

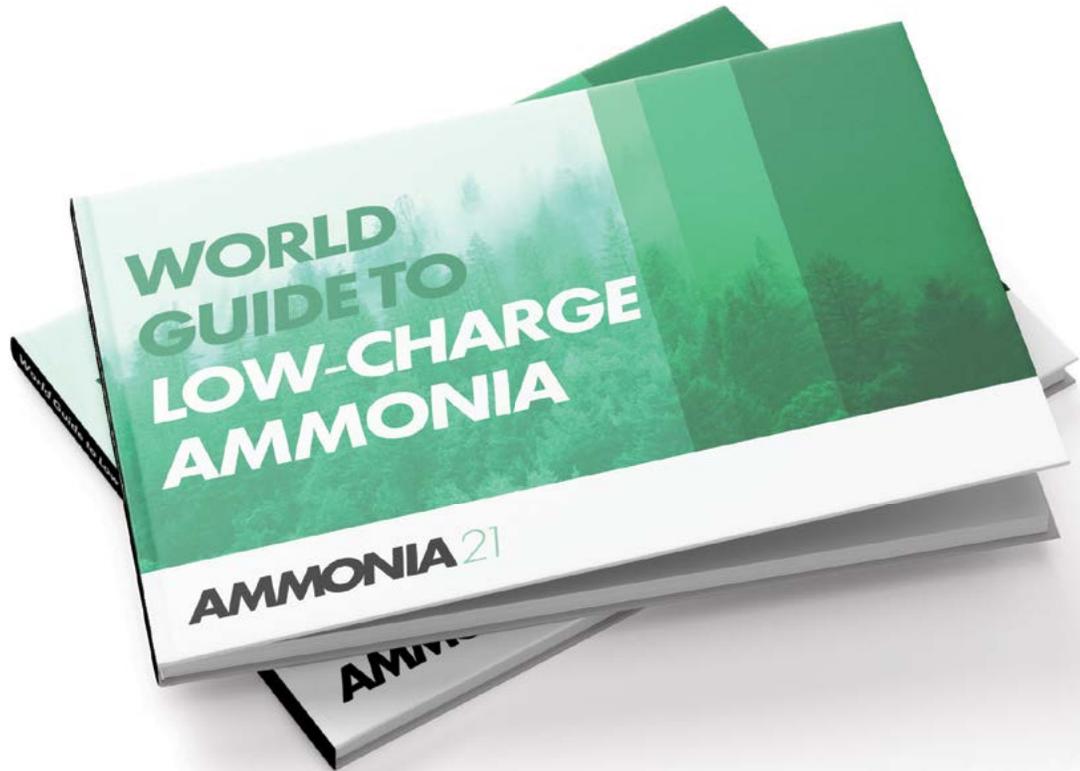
On a capital cost basis, the Rivacold system is about the same as an HFC split system, but the former has a lower installation cost, said Schmidt. "In a new construction or retrofit, you only need a hookup for power and the glycol loop."

Maintenance costs are about the same, though the Rivacold unit can be removed from a store for servicing. ■ MG

A21

World Guide to Low-Charge Ammonia

- Market analysis • Technology trends
- Case studies • Policy updates • New applications



The first comprehensive guide to the global low-charge ammonia industry!

Join the Supporters!



VAHTERUS



Temprite



|SSP|KÄLTEPLANER.CH|



info@sheccobase.com

+32 2 230 3700

brought to you by

sheccoBase

STANDING UP FOR AMMONIA

Scantec's Stefan Jensen defends his low-charge ammonia systems in a comparison with CO₂ technology

— By Devin Yoshimoto

Since developing the modern version of its central-style low-charge ammonia systems in 2013, Australia-based Scantec Refrigeration Technologies has consistently led development and discussion of the technology worldwide.

The company currently has 17 installations, with three more under construction. Most of these are located in Australia, with a few in China.

Having returned from speaking about low-charge ammonia systems in Germany, Scantec Managing Director Stefan Jensen spoke to *Accelerate Australia & NZ* (a sister publication to *Accelerate America*) in January about defending ammonia in a comparison with CO₂ technology, the potential for a global low-charge ammonia retrofit market, a recently completed installation in Brisbane, Australia, and more.

Accelerate Australia & NZ: You have recently returned from a refrigeration and air-conditioning technology conference in Germany, where you shared your knowledge about low-charge ammonia systems and energy performance. What kind of response did you receive?

Stefan Jensen: Yes, on the suggestion of one of our suppliers based in Germany, I attended the German Refrigeration

and Climate 2018 conference in Aachen last November.

The event was organized by the German Society of Refrigeration and Air Conditioning, which is a technical research organization for refrigeration, air conditioning, and heat pump technology.

I received two major responses. The first was that several companies showed interest in our low-charge ammonia installations.

One was from a German company, Kreuzträger, which has done 10 so-called low-charge ammonia systems. However they are not real central-style, low-charge ammonia systems. Because on the low side, they still use ammonia circulation pumps and conventional distributors. They are still developing, but the interest was clearly there.

The other response was that I was being challenged on data I was showing about the poor energy performance of transcritical CO₂ systems in Melbourne.

Now, we have been given energy performance records for a transcritical CO₂ system for a small warehouse that has already been operating in Australia for over a year.

If you work out the specific energy consumption in kilowatt hours per cubic meter per year, it uses twice as much as an equivalent low-charge ammonia system located in the same neighborhood.

I had to explain that refrigerant choice only has a minor impact on annualized system energy efficiency and that superior energy performance is all about system design. Everybody in the room liked that a lot, because there was a lot of applause.

I believe the refrigerated warehouse industry is ill-advised investing in something that has no chance of ever being as good as ammonia can be when it is done well.

I also believe that a huge ammonia retrofit market is emerging globally. Millions of existing ammonia plants are currently likely to be a long way away from the best energy performance they could deliver if modified appropriately.

AAUNZ: What can you tell us about your most recent low-charge ammonia system installation in Brisbane?

SJ: We've recently installed a low-charge [300 kg], two-stage, central-style ammonia plant for a transport depot in Brisbane. The refrigerated volume is around 45,000 cubic meters, and the system is in commissioning right now.

That one is quite good because it is DX (direct expansion), both on the low-temperature side and on the medium-temperature side. It's DX all the way through, and there are no ammonia pumps. The low and medium-temperature capacities are 194/192 kW respectively with future expansion to 284/241 kW.

AAUNZ: We have also heard that you implemented a number of firsts at another installation in Australia. Could you tell us about that?

Jensen: That's right. It's not a low-charge system. However, it is the first system in Australia with insulated coolers. It is also the first plant in Australia, to my knowledge, that uses cold lake air distribution.

The system was installed at a cold storage facility and has been in operation since August last year.

AAUNZ: What is cold lake air distribution?

SJ: What happens is that, inside the cold store, instead of blowing the cold air horizontally out from the evaporator and then expecting it to come back at low level, we do the opposite here.

We blow the air vertically down towards the floor. The cold air then crawls along the floor. As it heats up in the warehouse, it becomes lighter than the surrounding air. Then the warmer air in the cold store rises to the ceiling and then returns to the evaporator at high level without the use of ducts.

AAUNZ: Why was cold lake air distribution implemented here?

SJ: The builder didn't want any ducting inside the room. Normally when you use insulated coolers, you have long ducts inside the refrigerated warehouses.

We proposed cold lake air distribution, which avoids having air supply ducts inside the refrigerated warehouse.

AAUNZ: What are you looking forward to in 2019?

Jensen: We may be getting close to being awarded a central, low-charge NH_3 refrigeration plant for a high-rise cold [storage plant] in Asia.

The existing central liquid overfeed plant with screw compressors in two-stage configuration has an energy consumption of 59 kWh/cu m per year to service 37,000 cu m of refrigerated volume.

The predicted energy consumption of the new low-charge NH_3 system servicing the additional 110,000 cu m is 11 kWh/cu m per year.

This has the capacity to be a game-changer.

■ DY



Scantec's central low-charge NH_3 (300 kg) plant room, in Brisbane, Australia



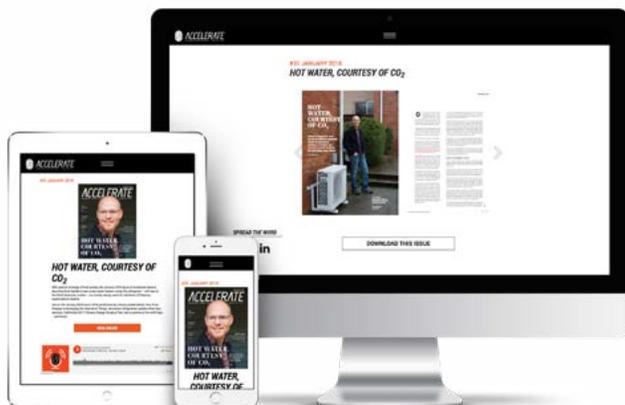
A cold lake air distribution system installed at a cold storage facility last August.

Photography: Marty Pouwelse Photography



Visit the homepage!

www.accelerateNA.com



Be first to get it & never miss an issue

Sign up to our email alert and receive an exclusive selection of the most exciting stories from each issue of *Accelerate America*.

SIGN UP NOW!



Follow us!



shecco



@GoNatRefs



@AccelerateNA



@sheccomedia

Want more natural refrigerants news?



www.R744.com



youtube.com/user/r744com



www.ammonia21.com



youtube.com/user/ammonia21com



www.hydrocarbons21.com



youtube.com/user/hydrocarbons21com



Follow the news highlights from all shecco Media platforms on Medium.

www.medium.com/naturalrefrigerants



The NatRefs Show provides a fortnightly round-up of the most important natural refrigerants news.

www.soundcloud.com/the_natrefs_show

brought to you by



Natural refr|



sheccoBase

The world's largest database
on natural refrigerants

shecco
Base



For more information on sheccoBase contact us at info@sheccobase.com