

FEBRUARY 2018

ACCELERATE

ADVANCING HVAC

A M E R I C A

Reaction to HFCs
Court Decision

p. 24

ALDI US Surpasses
100 CO₂ Stores

p. 30

AHR Expo
NatRefs Coverage

p. 40

PEGA HRNJAK

President, Creative Thermal Solutions
and Research Professor, University
of Illinois at Urbana-Champaign

PEGA'S QUEST TO REINVENT HVAC&R

P. 32



ATMO sphere

Business Case for
Natural Refrigerants

06/12-14/2018 – Long Beach, CA



Highlights:

End-user travel fund for first-timers | Technomercials
Private end-user meetings | ATMO Connect afternoon
2 new *Accelerate America* Awards categories
Expo-only tickets | Site visits



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ATMO Connect

STEPPING INTO THE BREACH

— by Michael Garry

On February 6, Elon Musk's SpaceX company successfully launched its Falcon Heavy rocket into space, carrying one of his electric Tesla cars on a voyage past Mars.

It's the sort of thing that NASA used to do. In fact, Musk borrowed the Florida launchpad previously used by NASA to go to the moon. But these days, as *New York Times* columnist Frank Bruni [recently pointed out](#), private companies are stepping into roles that the dysfunctional U.S. government no longer plays, or plays well.

That dynamic can be seen in the HVAC&R industry's transition from HFCs to natural refrigerants. While the Environmental Protection Agency ponders what to do next about HFCs in the wake of the most recent Appeals Court decision on its Significant New Alternatives Program (SNAP) program ([page 24](#)), and the Trump Administration wonders whether the HFC phase-down under the Kigali Amendment to the Montreal Protocol will be good for U.S. businesses ([page 28](#)), manufacturers and end users of natural refrigerants continue to innovate, and implement the technology. (Note to Trump Administration, the HVAC&R industry unequivocally supports Kigali!)

At the AHR Expo in Chicago last month, my colleagues at shecco America and I saw numerous natural refrigerant innovations on the exhibit floor, some of which are described in the show

roundup starting on [page 40](#). And the cover story on Pega Hrnjak ([page 32](#)) describes his long history at the cutting edge of natural refrigerant application development.

End user companies that have started transitioning from HFCs and R22 to natural refrigerants are continuing to do so, regardless of the uncertainty surrounding the EPA SNAP program. For example, ALDI US, the leading end user of transcritical CO₂ refrigeration in the U.S., has now surpassed 100 store installations, with more on the way ([page 30](#)).

Still, companies, governed by the profit motive, can't be expected to drive the growth of natural refrigerants alone. The government needs to help, and perhaps the U.S. Senate will ratify Kigali and the EPA will start phasing out HFCs, like the EU and many other governments around the world.

But if not, there's always California, and a growing number of other states, to step into the breach. The Golden State is pursuing its goal of reducing HFC emissions 40% by 2030 on several fronts: the Short-Lived Climate Pollutant (SLCP) Strategy, which sets GWP caps on refrigerants in various applications; regulations that would preserve the EPA's framework for controlling HFCs in California; and most recently, State Senator Ricardo Lara's introduction of the California Cooling Act, which restricts the use of HFC refrigerants in air conditioners and refrigeration

while offering incentives for low-GWP replacements like natural refrigerants. ([See page 26.](#))

The incentive piece in Lara's bill is particularly promising, since it would allow end users to overcome whatever premium they would otherwise pay for installing a natural refrigerant system.

With the nation's largest state economy, California has been able to influence other states and even the federal government to adopt its environmental programs. Manufacturers will undoubtedly be guided by the HFC phase-down and natural refrigerant incentive programs that California adopts.

As the U.S. continues to navigate through a time of high uncertainty at the federal level, we can be thankful that the private sector and local governments keep moving forward towards innovative, sustainable solutions. ■ MG



Michael Garry
Editor

In this issue

03 **Editor's Note**
Stepping into the breach.

07 **Editorial Calendar**

08 **Letters to the Editor**
Many uses for IoT; community of interested parties.

10 **Infographic**
Environmental impact of transcritical refrigeration.

12 **Events Guide**
Major industry events in February and March.

14 **Accelerate America Opens Awards Program**
The awards will recognize excellence in advancing natural refrigerant technologies..

16 **America In Brief**
AMCA unveils metric for fan efficiency; Canadian city practices after ammonia accident; EPA weighs comments on HC charge proposal; EIA, Greenpeace launch green HVAC&R database.

// Opinion

18 **What Took So Long?**
The industrial refrigeration industry is finally taking low-charge ammonia technology seriously, following decades of coasting on tried-and-true traditional systems.

20 **Training, the European Way**
The Real Alternatives 4 Life program is helping Europeans to transition from HFCs to natural refrigerants, and its online resources can help North Americans as well.

// Trends

22 **Millennials Drive Smart HVAC Market**
They want connected devices offering efficiency, optimization of conditions, and predictive maintenance.





26



32



40

// Policy

// End User

// Cover Story

// Event

// Techno

24 U.S. Court Denies Request to Rehear HFCs Case

Court of Appeals turns down petition by NRDC, Chemours and Honeywell to rehear ruling that blocks EPA from regulating HFCs – but Honeywell is appealing to the Supreme Court.

26 California Reacts to Court Ruling on HFCs

CARB looks at adopting EPA rules on HFCs, and Senator Lara introduces incentives bill.

28 Trump Administration Focuses on Economic Impact of Kigali

Before submitting the Kigali Amendment for Senate ratification, the administration wants assurance that U.S. business interests won't be hampered.

30 ALDI US Continues Transcritical CO₂ Rollout

The retailer has installed the technology in more than 100 stores – with more on the way.

32 Pega's Quest

An award-winning professor, researcher and entrepreneur, Pega Hrnjak continues to search for ways to optimize the use of natural refrigerants in myriad HVAC&R applications.

40 AHR Expo Roundup

Amid the 2,155 exhibits at the Chicago trade show were a plethora of natural refrigerant innovations.

46 Revisiting Hydrocarbon Safety

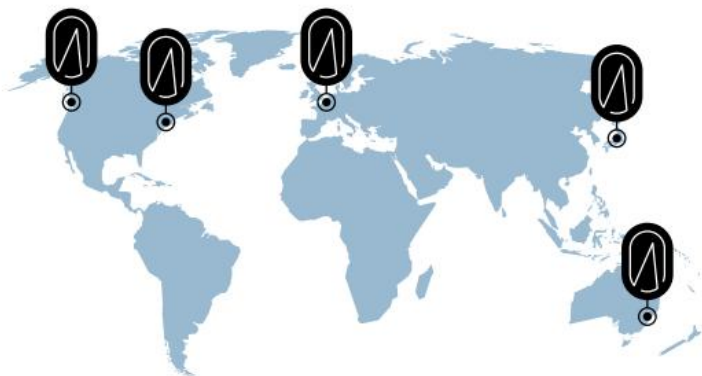
Bigger charges and wider adoption call for a renewed focus on precautions to minimize risks

50 More Accelerate America and Natural Refrigerant News

FEBRUARY 2018

ACCELERATE

ADVANCING HVAC&R NATURALLY AMERICA



About Accelerate America

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

<http://acceleratenews.com>

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

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Accelerate America

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VOLUME 4

EDITORIAL CALENDAR

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

// ISSUE #30 November-December 2017

FOCUS:
Leading end users
PUBLICATION DATE:
November 24

// ISSUE #31 January 2018

FOCUS:
CO₂ heat pump water heaters
PUBLICATION DATE:
January 10

// ISSUE #32 February 2018

FOCUS:
Research by Pega Hrnjak
PUBLICATION DATE:
February 14

// ISSUE #33 March 2017

FOCUS:
Low-charge ammonia
AD SUBMISSION DEADLINE:
March 8
PUBLICATION DATE:
March 13
PRINT DISTRIBUTION:
IIAR Natural Refrigeration Conference and Expo

// ISSUE #34 April 2018

FOCUS:
Heat pumps
AD SUBMISSION DEADLINE:
April 5
PUBLICATION DATE:
April 10
PRINT DISTRIBUTION:
IARW-WFLO Convention

// ISSUE #35 May 2018

FOCUS:
Self-contained hydrocarbon cases
AD SUBMISSION DEADLINE:
May 3
PUBLICATION DATE:
May 8
PRINT DISTRIBUTION:
National Restaurant Association (NRA) Show

// ISSUE #36 June-July 2018

FOCUS:
Policy & incentives
AD SUBMISSION DEADLINE:
May 31
PUBLICATION DATE:
June 5
PRINT DISTRIBUTION:
ATMOsphere America, Global Cold Chain Expo

// ISSUE #37 August 2018

FOCUS:
Accelerate America Awards
AD SUBMISSION DEADLINE:
July 27
PUBLICATION DATE:
August 1

// ISSUE #38 September 2018

FOCUS:
Food retail
AD SUBMISSION DEADLINE:
August 30
PUBLICATION DATE:
September 5
PRINT DISTRIBUTION:
Food Marketing Institute (FMI) Energy & Store Development Conference

// ISSUE #39 October 2018

FOCUS:
CO₂ in industrial refrigeration
AD SUBMISSION DEADLINE:
October 3
PUBLICATION DATE:
October 8

* Publisher reserves the right to modify the calendar.

#GoNatRefs



LETTERS TO THE EDITOR

MANY USES FOR IOT

Your article in the January issue of *Accelerate America*, "[Price Chopper Leverages the Internet of Things](#)," was very informative. Clearly, Price Chopper and Benny Smith understand the incredible power this developing technology will bring to improving the energy efficiency, reliability and performance of systems in food retail.

Echoing the thoughts in the article, a great first step to harnessing the advantages of IoT in food retail is case controllers. This is well-established technology that has been paying dividends to end users in other markets for decades. As energy costs increase and companies continue to focus on sustainability, this is an easy decision with a payback on the modest investment of well under 2 years. Additionally, the use of case controllers can enable the transition to natural refrigerants while providing ongoing benefits with any refrigerant.

Beyond optimizing the energy use and performance of equipment, IoT-enabled devices can provide significant savings to end users through utility services. Utility services can be implemented for major savings on energy bills as well as providing a more environmentally responsible approach to energy use. Across the country, local utilities are faced with complex power demands that change throughout the day and year. To more efficiently utilize the energy infrastructure, they have established rate structures, demand charges, and incentives to allow large energy users to help them manage this complexity.

Connected devices and systems today are taking advantage of these opportunities with a variety of programs. These include energy management, demand response, load shifting/scheduling, and even implementation of energy-storage devices to better accomplish many of these strategies.

In addition, there are regulations, standards, and practices for which connected IoT devices can provide both the data and reports to ensure organizational compliance. A common implementation of this is for HACCP (Hazard Analysis and Critical Control Points) reporting, required to assure that perishable food products are kept at appropriate temperatures. In addition, IoT can help in areas like refrigerant leakage/refrigerant charge monitoring and leak repair, lighting control and energy use, and comfort set-point/set-back monitoring, among others.

James K. Knudsen

*North America Food Retail Segment Leader
Danfoss, Baltimore, Md.*



COMMUNITY OF INTERESTED PARTIES

I am really excited about the NASRC Natural Refrigerants Service Network ("[An Angie's List for NatRef Contractors](#)," *Accelerate America*, January 2018). It is a great start to help bring us all together in a community of interested parties that are all working together for a global mission of reducing our carbon footprint with natural refrigerants. We are still seeing movement in the right direction with naturals and working hard to promote it to our customers. Anything that can be done to continually promote what we are doing, with a multi-faceted approach, will benefit all of us in the long run. We have to keep the mission strong and this is yet another vehicle to do that. We are happy to be part of this new community.

I also love the article on recruiting from the military ("[ARF Taps Military for Technician Apprenticeships](#)," *Accelerate America*, January 2018). This has been a great resource for us to find great people. Recruits from the military have a sense of loyalty and core values that often complement their skills to turn them into great technicians. However, I believe you have to be the right kind of company in order for that to work for you.

Todd Ernest

CEO

Climate Pros, Glendale Heights, Ill.

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.

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[www.parksassociates.com/
events/smart-energy-summit](http://www.parksassociates.com/events/smart-energy-summit)



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Workshop****Charlotte, N.C.**

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[conferences.k-state.edu/
industrial-refrig/](http://conferences.k-state.edu/industrial-refrig/)

**26-02****Global Forum Canada - 18
Temperature Controlled Life
Science Supply Chains****Toronto, Canada**

Event provides information on Health Canada Guide 0069 & international GDP requirements, supply chain collaborations to reach under-served Canadian patients, passive vs active packaging innovations, the impact of supply chain digitization, addressing drug shortages in Canada and more.



www.coldchainpharm.com

28-02**Climate Leadership Conference****Denver, Colo.**

Event attracts a global audience of over 400 climate, energy, and sustainability professionals in business, government, academia and non-profits.



www.climateleadershipconference.org



MARCH

06 2PM EASTERN

EPA GreenChill Webinar – Clearing the Hurdles: Top 3 Ways NASRC Is Removing the Barriers to Natural Refrigerants Online

GreenChill is an EPA partnership with food retailers to reduce refrigerant emissions and decrease their impact on the ozone layer and climate change.



epawebconferencing.acms.com/nasrc2/

11-15

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

Event is for seafood buyers in retail, restaurant, catering, foodservice and processing, who can meet with suppliers of seafood, equipment and services.



www.seafoodexpo.com/north-america/



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18-21

IIAR 2018 Natural Refrigeration Conference & Expo Colorado Springs, Colo.

Event is dedicated to the ammonia and natural refrigeration industry. It includes educational sessions and expo for manufacturers, contractors, trainers, and service providers.



www.iiar.org



20-22

2018 Hot Water Forum

Portland, Ore.

Technical conference is about efficiently making, distributing, and using hot water, regardless of its source. It's designed for experts and novices from manufacturing, distribution (plumbing), electricity, gas and water utilities, government, and the research community.



aceee.org/conferences/2018/hwf



#HWF18 @ACEEE

20 2PM EASTERN

EPA GreenChill Webinar: Regulatory Update on 608 and SNAP Online

GreenChill is an EPA partnership with food retailers to reduce refrigerant emissions and decrease their impact on the ozone layer and climate change.



<https://epawebconferencing.acms.com/sections608and612/>

25-28

Edison Electric Institute (EEI) National Key Accounts Workshop Orlando, Fla.

Semo-annual event is for national, chain, and multi-site energy users, who can learn about public policies affecting the energy industry, meet with utility account and energy supply representatives, and view new technologies, products, and services.



www.eei.org

ACCELERATE AMERICA OPENS AWARDS PROGRAM



To be presented at ATMosphere America 2018, the awards will recognize excellence in advancing natural refrigerant technologies – with new awards for best contractor and best utility

– By Michael Garry

The Best Contractor and Best Utility awards will go to the organizations that have done the most to facilitate the adoption of natural refrigerant systems in the past year.

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

The nominating process for the awards will remain open through April 13. 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/

The awards program was launched in 2016. The winners of the 2016 awards were: Marc-André Lesmiersies of Carnot Refrigeration (Person of the Year), Sobeys (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 Disrupters," *Accelerate America*, June-July 2017 ■ MG

Accelerate America is pleased to open the nominating process for its third 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 five categories: Best in Sector, Best Contractor, Best Utility, Person of the Year and Innovation of the Year; the Best Contractor and Best Utility awards are being introduced this year.

Winners will be selected by a panel of shecco and third-party experts. The awards will be presented at ATMosphere America 2018, to be held June 12-14 in Long Beach, Calif. The winning companies and the Person of the Year will be profiled in the August 2018 issue of *Accelerate America*.

A Best in Sector award will go to one end-user company in each of three sectors – food retail, foodservice and industrial – that has gone above and beyond in advancing the adoption of natural refrigerant technologies in HVAC&R applications in the previous 12 months.

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

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AMERICA IN BRIEF

EIA, Greenpeace Launch Green HVAC&R database

The Environmental Investigation Agency (EIA) and Greenpeace have launched the Cool Technologies database, which provides free information for those interested in moving away from climate-warming HFCs.

The database (<http://www.cooltechnologies.org>) lists climate-friendly air conditioning, refrigeration, compressors, foams and insulation, as well as installations of these products, by sector (commercial, domestic, industrial and mobile).

"Cool Technologies demonstrates the wide array of energy-efficient HFC-free cooling which is available," said Paula Tejón Carbajal, Greenpeace's senior strategist, campaigner and project leader. "Understanding what the options are gives people the opportunity to make the best choice for the future."

Cool Technologies is also designed to show how rapidly the market is moving to natural refrigerants and how easy it would be for "developing countries [to] leapfrog HFCs entirely by moving straight to energy-efficient sustainable cooling," according to the EIA.

The database excludes cooling technologies using HFOs "as their large scale use is not proven to be environmentally sustainable," states the Cool Technologies website.

The website also noted that the database has benefited from cooperation with shecco (publisher of *Accelerate America*). It invites submission of additional data on climate-friendly products or installations.

The website was launched during the Inter-Regional Thematic and Network Meetings for National Ozone Officers, which took place in Paris last month.

■ CM

AMCA Unveils Metric For Fan Efficiency

The Air Movement and Control Association (AMCA) International has released the publication of ANSI/AMCA Standard 208-18, Calculation of the Fan Energy Index – a new way of determining fan efficiency.

ANSI/AMCA Standard 208 defines the calculation method for fan energy index (FEI), an energy-efficiency metric for fans inclusive of motors and drives. This metric provides a standardized and consistent basis for comparing fan energy performance across fan types and sizes at a given fan duty point, according to AMCA, based in Arlington Heights, Ill.

ANSI/AMCA Standard 208-18 is available for purchase at <http://bit.ly/2sncEau> ■ MG

Canadian City Practices After Ammonia Accident

Delta, B.C., last month conducted an interagency emergency response exercise based on a simulated ammonia leak at South Delta Recreation Center.

The exercise took place in the wake of last October's fatal ice rink accident in Fernie, B.C., which left some worried about the use of ammonia in ice rinks.

But Delta is not currently looking at switching from ammonia to another refrigerants, said Ken Kuntz, acting Delta city manager, in the *Delta Optimist*.

"These are tried and true refrigeration systems and over the years with the WorkSafe and Technical Safety B.C. regulations we've had constant upgrades to the safety systems," he said. ■ AW

EPA Weighs Comments On HC Charge Proposal

The U.S. Environmental Protection Agency (EPA) is evaluating comments submitted in response to its proposal to increase the charge limit for hydrocarbons in domestic refrigerators from 57 g to 150 g.

If the agency finds "adverse" comments, the rule would be withdrawn and the EPA would address the comments in a subsequent rule on charge limits, said Chenise Farquharson, the EPA's coordinator for the Significant New Alternatives Policy (SNAP) program.

The 45-day comment period ended January 26. The EPA has until March 12 to withdraw the original proposal.

"We received about 20 comments and we're going through them," said Farquharson. "We're discussing with our attorneys whether any of the comments would be considered adverse."

If the EPA issues a subsequent rule on increasing the charge limit for hydrocarbons in domestic refrigerators, it could "go a different route," she said.

Last November the EPA proposed raising the charge limit for propane, isobutane and R441A to 150 g from 57 g in new household refrigerators and freezers under the SNAP program, a move that would open the U.S. domestic market to more hydrocarbon-based refrigeration appliances.

The EPA submitted the rule change – titled "Protection of the Stratospheric Ozone: Revision to References for Refrigeration and Air Conditioning Sector to Incorporate Latest Edition of Certain Industry, Consensus-based Standards" – for publication in the Federal Register December 11, 2017.

The change was considered "a direct final rule," barring "adverse comment" received within 45 days from the date of publication in the Federal Register.

The EPA initially announced that it was taking this action "as a direct final rule without prior proposal because EPA views this as a noncontroversial revision and anticipates no adverse comments. The action does not place any significant burden on the regulated community and ensures consistency with industry standards." ■ MG



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ME₂

WHAT TOOK SO LONG?

The industrial refrigeration industry is finally taking low-charge ammonia technology seriously, following decades of coasting on tried-and-true traditional systems

— By Derek Hamilton

“ The key driver for reducing ammonia charge will always be safety. ”

When I started working in the industrial refrigeration industry (almost 14 years ago!) we didn't really talk about “low-charge” systems. However, I was fortunate enough to learn from a very talented group of refrigeration engineers that charge minimization was a key consideration in any system design, and especially so when designing ammonia systems.

So in a way we were always designing low-charge systems. We just did so without thinking of it as such.

Ammonia has been the mainstay of industrial refrigeration for over a century for a very simple reason - it is an excellent refrigerant. Thermodynamically speaking, it's hard to beat for the majority of industrial applications and that's why a whole industry has developed around the design of ammonia equipment and systems, and their safe installation, service and maintenance.

For anyone designing an ammonia refrigeration system, charge reduction makes sense for a multitude of reasons. Low-charge systems can cost less to buy, be easier to install and, if designed and operated correctly, can run more efficiently than centralized systems.

All that being said, I still believe that the key driver for reducing ammonia charge will always be safety. A reduction in charge results in a proportional

reduction in the impact of a major leak of refrigerant (caused by earthquake or some kind of accidental event like pipe breakage). Charge reduction, coupled with good system layout and design, can also help to make systems easier, and therefore safer, to maintain.

So as we approach 3rd decade of the 21st century, all of this begs the question - why did it take until now for the industry to start talking seriously about low charge?

The answer for me is quite simple: We have been lazy. Much like the 75%-80% of ammonia that floats aimlessly around a traditional pumped-circulation system (not providing any useful cooling but merely along for the ride) refrigeration engineers have been happy to design system after system using proven designs and “rules of thumb” cooked up by our great grandfathers. This is somewhat understandable - refrigeration contractors want to provide their customers with proven and reliable systems, so it is natural to rely on time-tested designs.

It has taken a concerted effort by the industry to start to change this pattern. Customers are asking for low-charge systems. Heat exchanger manufacturers are developing lower-charge designs, and engineers are developing novel system architectures that optimize the balance between low ammonia charge and system reliability and efficiency.

This is driving a new wave of innovation in the U.S. and around the world, which has resulted in several new packaged ammonia systems entering the market in just the last few years. Alongside this we are also seeing the advent of various optimized, central plant designs, too.

Amidst all of this innovation, we are also seeing a coordinated effort to update various codes and standards so that they properly deal with the changing face of the ammonia industry.

It is a very exciting time, and here at shecco we have been closely following this trend. In the coming months we will begin sharing content from our upcoming *World Guide to Low-Charge Ammonia*. This guide will take a deep dive into the low-charge ammonia industry and will be the world's first comprehensive study on the subject.

I'm looking forward to sharing more with you - watch this space! ■ DH



Derek Hamilton is vice president of business development and technical editor of shecco America.

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Training, the European Way

The Real Alternatives 4 Life program is helping Europeans to transition from HFCs to natural refrigerants, and its online resources can help North Americans as well

— By Charlotte McLaughlin

Natural refrigerants like CO₂ and hydrocarbons are more widely used in Europe than anywhere else, thanks to an aggressive regulatory posture, highlighted by the F-gas Regulation. That has also given Europeans a head start on training for natural refrigerants.

That training expertise – in the form of an EU-funded program called Real Alternatives 4 Life – was shared with a U.S. audience (albeit with an international flavor) at a session last month at the AHR Expo in Chicago.

Based on two earlier programs focused on refrigerant leaks (see next page), Real Alternatives 4 Life was started in 2015 to address skill barriers, safety concerns, energy efficiency and “provide some training guides across Europe,” said Graeme Maidment, a professor at London South Bank University, and former president of the U.K.-based Institute of Refrigeration (IOR).

In 2017 the project ran a survey to identify what the European HVAC&R Industry needed in regard to natural refrigerant training. “That helped us work out what Real Alternatives 4 Life should focus on,” Maidment said, adding that the survey indicated that Europeans are still “not very well prepared” for the transition to low-GWP refrigerants.

According to “The Guide to Natural Refrigerants Training in Europe 2017,” produced by shecco (publisher of

Accelerate America), around 200 companies currently provide natural refrigerant training in Europe.

Marco Buoni, vice president of AREA (the European association of refrigeration, air conditioning and heat pump contractors), who spoke at the AHR Expo session and is involved in Real Alternatives 4 Life, noted that as the pressure from the European F-gas Regulation increases training on natural refrigerants will need to grow as well. “In Europe, we have this cut in [high-GWP] refrigerants and so we need training,” Buoni said.

The Real Alternatives 4 Life program, based online at <http://www.realalternatives.eu> and translated into 13 languages, offers free e-learning and free e-library resources on low-GWP refrigerants.



Marco Buoni, AREA

“ In Europe, we have this cut in [high-GWP] refrigerants and so we need training. ”

In addition, all the following guides for managing low-GWP refrigerants have been updated for 2018 and are available for free at the Real Alternatives 4 Life website in English:

- ▶ Introduction to Alternative Refrigerants - safety, efficiency, reliability and good practice.
- ▶ Safety and risk management for using alternative refrigerants.
- ▶ Design differences for alternative refrigerants.
- ▶ Containment of alternative refrigerants.
- ▶ Service and maintenance checklist for alternative refrigerants.
- ▶ Retrofitting existing systems with low GWP refrigerants.
- ▶ Legislation and regulation checklist.
- ▶ Measuring the cost of leakage of alternative refrigerants.
- ▶ Guidance on giving advice to customers for reducing leakage.

Though the guides are meant to help Europeans comply with current standards and not U.S. standards, they provide helpful information on alternative refrigerants.

Another part of the program is training certification, which has expanded beyond Europe so that trainers throughout the world can become certified on low-GWP refrigerant training. Buoni encouraged the U.S. audience to take part.

Real Alternatives 4 Life will now offer training at facilities in Belgium, Germany, UK, Poland and Italy, and "train-the-trainer" events at five locations.

Before the train-the-trainer events begin, Real Alternatives 4 Life will focus on expanding its expertise on safe maintenance of low-GWP refrigerant systems. Limburg Catholic University College (KHLim) in Belgium is working on propane maintenance, according to Karsten Beerman, from the IKKE regional training center in Germany, which provides Real Alternatives 4 Life training. PROZON, a non-governmental Polish climate protection foundation, is conducting work on CO₂.

The plan is for partners and trainers to visit Poland and Belgium from September to December 2018. Then, with stakeholders, they will update their training materials and begin five train-the-trainer events in March and June 2019.

These trainers "will work as a multiplier," spreading knowledge in these countries, added Beerman. At the end of the sessions the trainers will be tested, with these tests slated to be part of a standardization process for training that could be used anywhere.

Also discussed was the Refrigerant Driving License (RDL) initiative, launched by UN Environment and the Air Conditioning, Heating, and Refrigeration Institute (AHRI). It aims to create a qualification program for refrigerant management globally and provide training on alternatives ■ CM

Addressing Leaks in Europe

Refrigerant leakage was for a long time ignored in Europe as a way that supermarkets lost money and contributed greenhouse gas emissions.

Then, in 2008 the Real Zero project was born in the U.K., with funding from the U.K.-funded Carbon Trust, to look at leakage rates in supermarkets.

"At the time in 2008, [leaks were not the] focus – it was maintaining the store – and they actually realized there is a cost associated with [leaks]," said Graeme Maidment, professor at London South Bank University and former president of U.K.-based Institute of Refrigeration (IOR) at AHR Expo in Chicago last month. The data suggested that "some supermarkets leaked at an annual rate of more than 50% of the refrigerant charge."

An average supermarket will lose 20 kg (44 lbs) of refrigerant from one leak, Maidment said.

"The cost of refrigerant itself is fairly significant and then you've got the cost of sending a technician to make the repair." The price of high-GWP refrigerants like R404a has increased substantially in recent years from around \$10 to \$80 dollars per lb in Europe.

Moreover, by the time a technician gets there, the food is wasted. "Typically, one 20 kg leak costs \$5,000 [in food loss]. Even if that's wrong and it's \$2,000, that's a lot."

And 20 kg of high-GWP refrigerant accounts for about 80,000 tons of CO₂e emissions, he said.

"In my view, we need to align our environmental agenda with our cost agenda," he added.

To make sure leaks were reduced and equipment was properly serviced throughout Europe, the Real Zero project evolved into the EU-funded Real Skills Europe program, which ran from 2008 to 2013. This training helped end users contain the refrigerant in their systems. Leakage rates dropped dramatically in supermarkets, according to Maidment.

"Refrigerant was a consumable and now we've changed it to an asset," he said. "Assets you protect, consumables you use and I think we've made a big difference in that."

MILLENNIALS DRIVE SMART HVAC MARKET

They want connected devices that offer efficiency, optimization of conditions, and predictive maintenance

— By Mark Hamstra

The internet of things (IoT) is gaining traction in the home HVAC market, driven in part by the increasing familiarity with the technology among younger consumers, according to speakers at the AHR Expo in Chicago last month.

"It won't be long before the teenagers of today will pick up their first jobs and start buying their first homes, and these are the teenagers whose best friend is usually their smartphone," said Krystyna Dawson, director, Worldwide Marketing Intelligence at U.K. research firm BSRIA. "They embrace 'smart,' voice control, and the internet of things, as that's the natural environment in which they live and shop. They want things to be quick, easy and hassle-free."

In addition, by 2025 about 50% of the workforce will be millennials, she said, and they will expect their workplaces to have these advanced technologies for HVAC control as well.

These connected technologies hold the potential to optimize room conditions, enhance air quality and make operation more intuitive, said Dawson. In addition, they could be used to enhance energy and asset efficiency, assist in preventive and predictive maintenance, and optimize the energy footprint.

As a result of these trends, "we are seeing a very dynamic increase in smart connected HVAC, [as well as] a double-digit growth in the smart home market," said Dawson.

The North American smart buildings market, including products and services, is projected to grow significantly in the coming years, increasing from a little more than \$10 billion in 2014 to more



than \$20 billion in 2021, according to BSRIA estimates. And while the bulk of the smart home market has historically consisted of controls for building automation, in the coming years both smart connected HVAC systems and smart home technologies are projected to see significant growth, Dawson said.

In addition, new cloud-based technologies have been emerging, such as grid interactive water heating (GIWH), which uses two-way communication to allow for much quicker, much more flexible response to shave peak loads in energy usage, she said.

The demand for such advancements is leading to new partnerships among equipment manufacturers, makers of HVAC control systems and other companies that are seeking to gain inroads in the "smart home" industry. In addition, many of the companies that have traditionally supplied HVAC control technologies are being disrupted by energy providers, communication providers and high-tech companies, Dawson said.



For example, global tech giants including Google, Apple and Amazon are for the first time investing in the smart-home market with voice-activated programs that connect to an increasing array of devices in the home. In addition, smaller start-ups such as SolarEdge are providing new solutions that seek to simplify the control of a building's environment while maximizing efficiency. Similarly, Sonnen offers an energy storage solution for the home that automatically manages energy use throughout the day.

Shifting distribution channels

The distribution channels for smart home products diverge from the traditional distribution channels for air conditioning and heating products, according to BSRIA research. Distributors and wholesalers accounted for 54% of the North American sales volume for smart home products in 2016. By contrast, the distributor/wholesaler channel only accounted for 33% of the sales volume for ducted split air conditioning systems.

In addition, smart home technology companies are taking a different approach to the way they position their products in the marketplace. "These companies usually move away from product-oriented sales that included product choice, product installation and sometimes, subsidy advice, and they have moved toward service-oriented sales where they treat HVAC systems holistically," said Dawson.

In this holistic approach they offer a suite of benefits to end users, such as dealing with energy providers, and monitoring energy consumption and cost, along with installation and maintenance.

"They don't sell products any more — they deliver comfort in a quick, easy and hassle-free way, and of course they do it 24 by 7," said Dawson. ■ MH

Growth Seen in AC Market

The strong U.S. economy has continued to boost the air conditioning market in the U.S., and growth is expected to continue amid a drive for more energy efficiency and ongoing efforts to reduce the impact of refrigerants on the environment, according to U.K. research firm BSRIA's presentation at the recent AHR Expo in Chicago.

"The U.S. is a relatively mature air conditioning market, but it has experienced good growth," said Anette Holley, general manager, VACR and consultancy, Worldwide Market Intelligence at BSRIA. She also cited hot summers and new construction as drivers of the market. The largest market segments are single ducted splits and window units.

In addition, she said, although the U.S. has pulled out of the Paris Agreement on Climate Change, which seeks to reduce emissions to curtail global warming, it remains a party to the Kigali Agreement, which manages the phase-out of high-GWP HFC refrigerants. (The U.S. Senate has yet to ratify the agreement; [see page 28](#).)

But the U.S. Environmental Protection Agency's HFC-reduction plans are being impacted by the Court of Appeals decision limiting their scope. ([See page 24](#).)

Meanwhile, the drive toward using natural refrigerants and other low-GWP refrigerants is increasingly driven at the state level — particularly California — and by market forces, Holley said. California in 2016 passed a law that seeks to sharply reduce HFC emissions by 2030, for example, and could adopt further curbs on HFCs. ([See page 26](#).)

The market itself will also drive change because of restrictions on HFC refrigerants that are in force globally, such as the F-gas measures that are phasing out HFC usage in Europe, she said.

"Although the trends in refrigerants in some cases, like in Europe, are influenced by the F-gas regulations, the major issue is the soaring prices we have started to see in refrigerant prices, due to shortages," said Holley.

It is difficult to forecast which alternative refrigerants, including natural refrigerants, will become adopted on a wider scale in the U.S., Holley said. For some, such as propane, there are still some concerns about flammability, she added.

BSRIA also forecast that that the market for AC service and maintenance in the U.S. will grow at a compound annual rate of 0.6% from 2016 to 2021. The company estimated the market size at \$7.9 billion in 2016.

That market will also be impacted by the increasing number of "smart" AC products that are connected to the internet and often remotely managed, she said.

"One thing that is certain is that the industry is changing and moving in different directions," said Holley.

U.S. Court Denies Request to Rehear HFCs Case

Court of Appeals turns down petition by NRDC, Chemours and Honeywell to rehear ruling that blocks EPA from regulating HFCs – but Honeywell is appealing to the Supreme Court

– By Michael Garry



The U.S. Court of Appeals for the District of Columbia Circuit in late January denied petitions for a rehearing of a controversial ruling the court delivered in August 2017 that barred the U.S. Environmental Protection Agency (EPA) from prohibiting HFCs as replacements for ozone-depleting refrigerants by incumbent users.

In the original case, *Mexichem Fluor, Inc. v. EPA* (Arkema was another plaintiff), a three-judge panel ruled 2-1 that the EPA cannot require companies to replace HFCs in HVAC&R equipment with low-GWP alternatives under the SNAP (Significant New Alternatives Policy) program; these alternatives include natural refrigerants, HFOs and HFO blends.

The case specifically targeted a 2015 rule implemented by the EPA under the direction of the Obama administration.

In the absence of a response from the EPA, the Natural Resources Defense Council (NRDC) and the chemical companies Chemours and Honeywell – who were intervenors in the case – last September asked the full Appeals Court in Washington, D.C., to rehear and reverse its three-judge panel's ruling.

But on January 26, a majority of the nine judges on the court eligible to vote did not vote in favor of the petitions, which were thus denied. In addition, two of the original three judges who heard the case (the third retired) split their vote, denying the request for the panel to rehear the case.

Honeywell, a Morris Plains, N.J.-based manufacturer of HFOs and HFO blends, plans to appeal to the U.S. Supreme Court for a reversal of the Appeals Court ruling.

"Honeywell is deeply disappointed in the Court's decision not to review the August D.C. Circuit Court of Appeals' ruling regarding the EPA's Significant New Alternatives Policy (SNAP) program," said a Honeywell spokesperson in a statement. "We believe the Court missed an opportunity to reverse its initial decision, which ignored the original intent of SNAP to direct the Environmental Protection Agency to replace ozone-depleting substances with safer alternatives."

The spokesperson added that Honeywell's appeal to the Supreme Court intends "to ensure that American companies continue to innovate, manufacture and commercialize next-generation technologies that are better for human health and the environment."

Chemours had not publicly stated at press time whether it plans to also file an appeal with the Supreme Court.

The court's refusal to rehear the case leaves the U.S. HVAC&R industry, at least for the short term, in a state of some uncertainty with respect to the usage of high-GWP HFCs. On the one hand, the court's decision preventing the EPA from delisting HFCs for incumbent users is final for now. On the other hand, the EPA could still take steps that would enable it to regulate HFCs, particularly if the Senate ratifies the HFC-reduction scheme under the Kigali Amendment to the Montreal Protocol.

In the meantime, "it does not appear that firms which already switched away from HFCs under the early deadlines of the SNAP rules are intending to switch back," said David Doniger, senior strategic director of the NRDC's Climate and Clean Energy Program.

Disappointing decision

In a series of tweets issued on the day of the ruling, January 26, Doniger offered the NRDC's reaction to the court's decision not to rehear the case. "Disappointing decision today from divided D.C. Circuit not to rehear case on the super climate damaging HFCs," he wrote, adding that the EPA's HFC-delisting rules were defended by the Trump administration EPA and "supported by nearly entire industry and environmentalists."

At a conference hosted February 5 by the Hudson Institute in Washington, D.C., Doniger said the NRDC is seriously considering whether to ask the Supreme Court for review of the decision. "We'll decide in the next few weeks."

He noted that it can be more difficult to get the DC Court of Appeals to rehear one of its own opinions than it is to get the Supreme Court to take the case on appeal. "Not to say the Supreme Court will take the case but it may be of interest because there are some important legal interpretation principles at stake."

If NRDC is not successful in getting the Supreme Court to hear the case – or in parallel with trying to get it before the Supreme Court – NRDC will work with states like California that are moving forward with their own HFC-reduction schemes. (See page 26.) "Eleven states supported our position in the case," he said.

In addition to California, "you could expect a number of other big states which have an important share of the air conditioning and refrigeration market to be interested in doing what California does," said Doniger. In that case, he added, there may end up being a "patchwork" of state regulations and additional "uncertainty."

Other alternatives

There are other alternatives for the EPA. One way would be for the U.S. Senate to ratify the Kigali Amendment. (See page 28.) Following ratification, the EPA would be empowered to phase down HFCs. "Rest of world going ahead," Doniger tweeted. "American industry doesn't want to fall behind."

The NRDC plans to work with industry and members of the Senate "on both sides of the aisle" to move the Kigali Amendment to the Senate for ratification "and get two-thirds of the Senate to approve it," Doniger said.

The original court decision also left some additional avenues open to the EPA. For example, the agency could use other statutory authorities to phase down HFCs, such as the Toxic Substances Control Act. Alternatively, the EPA could explore implementing a "retroactive disapproval" of HFCs under the Clean Air Act, which the court ruled may be permissible if the EPA could explain why it is pursuing this under the current legislation.

Doniger wrote in a blog on the NRDC website last year that the original ruling bypassed a 1994 regulation that requires product manufacturers to switch to safer alternatives when EPA adds an existing substitute to the its prohibited list of refrigerants. EPA added a number of HFCs to that list in 2015 – a move that the court's panel upheld, he pointed out, adding, "That should have ended the case."

By ruling as it did, the panel "eviscerates EPA's Safe Alternatives program," Doniger added. "It will even block EPA from stepping in when substitutes are found to be acutely toxic – as EPA did some years ago when it stopped use of a refrigerant that caused kidney damage to exposed workers." ■ MG

CALIFORNIA REACTS TO COURT RULING ON HFCs

CARB looks at adopting EPA SNAP rules on HFCs, and Senator Lara introduces incentives bill

— By Michael Garry

California continues to react to environmental setbacks at the federal level with renewed commitment to state action.

Mary D. Nichols, chair of the California Air Resources Board (CARB) responded to the recent court decision reaffirming limits on federal oversight over HFCs by saying the state would continue to consider preserving the federal framework for controlling these gases in California.

Meanwhile, California State Senator Ricardo Lara introduced the California Cooling Act, which includes incentives for businesses and residents “to speed the replacement of these compounds with alternatives that have lower global warming potential.”

On January 26, the U.S. Court of Appeals for the District of Columbia Circuit denied petitions for a rehearing of its controversial ruling the court delivered in August 2017; that decision barred the U.S. Environmental Protection Agency (EPA) from requiring incumbent users to replace HFCs in HVAC&R equipment with low-GWP alternatives like natural refrigerants under the SNAP (Significant New Alternatives Policy) program. ([See page 24.](#))

“The recent court decision undermining the current federal program further underlines the importance of state regulation and innovation, even as we continue to seek strong federal controls,” said Nichols, in a statement.

“The California Air Resources Board is moving ahead to control super pollutants, including high global warming

potential F-gases like hydrofluorocarbons (HFCs) and has already developed draft regulations that would preserve the federal framework for controlling these gases in California.”

LARA CHIMES IN

Following Nichols’ statement, Lara said “This federal court decision on super-polluting refrigerants is the latest sign that California cannot look to the federal government for help in reaching our clean air goals.” In 2016, Lara authored the Super Pollutant Act (SB1383), which set the nation’s toughest standards for reducing HFC emissions — 40% by 2030.

He followed that statement by introducing the California Cooling Act, which restricts the use of HFC refrigerants in air conditioners and refrigeration while offering incentives for low-GWP replacements like natural refrigerants.

“The California Cooling Act supports companies as they develop alternatives to these dangerous super-pollutants and keeps California in the lead on cleaner air,” he said.

CARB began looking at adopting some of the EPA’s SNAP rules on HFCs on October 24, 2017, at a public workshop. Next month, CARB will hear “California’s version of the federal program, including possible adoption of some of the federal Significant New Alternatives Policy (SNAP) provisions into state regulation,” said Nichols.

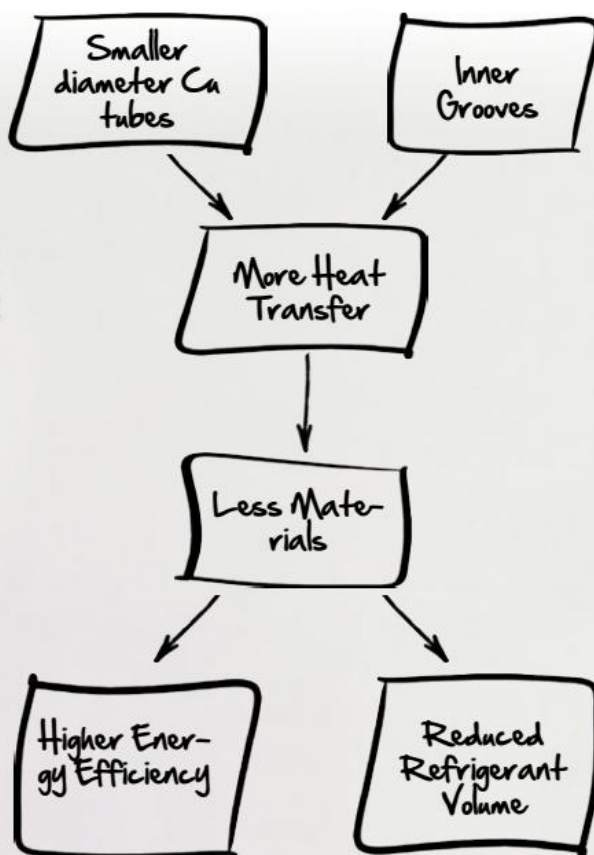
She added that CARB plans to consider further control “of these dangerous gases” with an additional regulation at a later date. Meanwhile, she said, “U.S. EPA should move quickly to explore its options to provide similar protections at the federal level, to the greatest degree possible.”

CARB is looking specifically at incorporating the parts of EPA SNAP Rules 20 and 21 that prohibit high-GWP HFCs in new retail food refrigeration, food dispensing equipment, air-conditioning chillers, and refrigerated vending machines.

Additional sectors covered by SNAP Rules 20 and 21, such as residential refrigerator-freezers, motor vehicle air-conditioning, insulating foam, and aerosol propellants, would not be addressed in these regulations, and could be addressed separately ■ MG



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Trump Administration Focuses on Economic Impact of Kigali

Before submitting the Kigali Amendment for Senate ratification, the administration wants assurance that U.S. business interests won't be hampered

— by Michael Garry

The Trump administration is evaluating the potential economic impact of the HFC phase-down scheme under the Kigali Amendment to the Montreal Protocol as it decides over the coming months whether to submit the amendment to the Senate for ratification, an administration official said on February 6 at a conference hosted by the Hudson Institute in Washington, D.C.

"If the president does decide to support Kigali — question there — it will be largely because he wants to protect and create U.S. jobs and advantage U.S. commercial interests," said David Banks, special assistant to the president for international energy and environment.

While acknowledging that the amendment has "broad industry support," he stressed the need for the administration to understand its effect on U.S. economic interests, including "how it can help the trade balance and foster exports to other countries."

"We welcome all stakeholders to engage us during these deliberations," he added.

A wide spectrum of U.S. industry — both the companies that market natural refrigerant systems and the chemical companies that make HFOs and HFO blends — have urged the Senate to ratify the Kigali Amendment. Industry representatives have pointed out that the competitive position of U.S. companies would be hampered if the U.S. does not ratify the amendment.

Banks' remarks are among the few made by the Trump Administration about the Kigali Amendment, which was established in October 2016 by almost 200 countries and will go into effect January 1, 2019, following ratification last November by the 20th nation that was a party to the amendment's creation.

Last November, Judith Garber, principal deputy assistant secretary of the U.S. State Department's Bureau of Oceans and International Environmental and Scientific Affairs, stated that the U.S. "has initiated the process to consider U.S. ratification of the [Kigali] Amendment."

While saying that the U.S. supports "the goals and approach of the amendment," Garber added that "there are a number of steps in our domestic process that we would need to complete before reaching a final decision on transmittal of the Kigali Amendment to the U.S. Senate for its advice and consent."

PARIS MINDSET

Banks elaborated on how the administration is assessing the amendment, noting the emphasis placed on "protecting and enhancing U.S. competitiveness, particularly in the manufacturing sector." That, he said, was the mindset used last year when the president announced that the U.S. would leave the Paris accord on climate change, making it the only country in the world to do so. More recently, Trump said he is "open to re-engaging in the Paris agreement if it's a fair deal," Banks noted.

"[Trump] is open to re-engaging in the Paris agreement if it's a fair deal."

In assessing Kigali, one of the most important issues, Banks said, is whether U.S. companies would face "discriminatory practices in international fora that unfairly disadvantage them." At the same time, the administration is also considering what would happen to U.S. manufacturing "if we don't ratify Kigali," he said.

Another concern of the administration, Banks said, was how the requirements of the Kigali amendment would be met if the U.S. Senate ratifies it. His administration colleagues "are working to determine if available authorities exist, or if there is need for additional legislative authority to implement Kigali."

The speaker who followed Banks, Jeff Holmstead, partner, Bracewell LLP, a Houston-based law and government relations firm, addressed the issue of whether U.S. authorities exist to carry out Kigali's HFC phase-down requirements. "Once [Kigali] is ratified," he said, "there's a provision [under Title 6] in the Clean Air Act that the U.S. Environmental Protection Agency has the authority to implement that amendment." ■ MG

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ALDI US Continues Transcritical CO₂ Rollout

The retailer has installed the technology in more than 100 stores – with more on the way

– By Elise Herron and Michael Garry

ALDI US, the leading supermarket user of transcritical CO₂ refrigeration systems in the U.S., had more than 100 stores using the systems as of early December 2017, according to a webinar hosted by the U.S. Environmental Protection Agency's GreenChill Partnership.

The December 5 webinar, "Supermarket Experiences Managing Refrigeration Systems in Small-Format Stores," was presented by Derek Gosselin, director, technical product support for Conyers, Ga.-based Hillphoenix, the primary provider of ALDI's transcritical systems.

Gosselin also said that ALDI US's transcritical installations included 60+ transcritical stores in a warm climate (Southern California and the lower third of the U.S.) and 55 GreenChill Platinum-certified stores.

This represents an increase from the 69 ALDI US stores using transcritical technology, and 43 GreenChill Platinum-certified stores, as reported by *Accelerate America* in its [September 2017 issue](#). Of those 69 stores, 66 were supplied by Hillphoenix (largely the AdvansorFlex unit designed for smaller formats), with the other three stores using systems provided by a partnership between Hussmann and Canadian OEM Systèmes LMP.

ALDI US, with headquarters in Batavia, Ill. – an independently operated member of Mülheim, Germany-based ALDI South (Sud) – runs approximately 1,700 value-oriented supermarkets in the U.S., and intends to expand to 2,500 stores by the end of 2022. The company's long-term plan is to standardize on transcritical CO₂, said Aaron Sumida, an ALDI US vice president quoted in the September *Accelerate America* article.



1/ ALDI US store with AdvansorFlex transcritical CO₂ system in Baldwinsville, N.Y

Future-proofing

In the webinar, Gosselin gave an overview of the benefits and challenges associated with transcritical CO₂ systems.

For example, at a time of regulatory uncertainty at the national and state level, he cited the "future-proof" nature of transcritical CO₂, which eliminates costs associated with retrofitting. "Now more than ever it's important to have some type of long-term refrigerant management program that helps you stay out in front of changes on local and national levels," he said.

Gosselin noted that before ALDI US entered the California market, the company analyzed local regulatory rules enforced by the California Air Resources Board (CARB), and formulated its refrigeration management plan accordingly.

CARB's proposed Short Lived Climate Pollutants (SLCP) reduction strategy includes a phase-down of high-GWP HFC refrigerants, leading ALDI US to choose CO₂ as its refrigerant of choice, he added.

Gosselin also listed the well-known benefits of CO₂ – that it has a GWP of one and an ODP of zero; it's non-toxic, and nonflammable and has no charge restrictions. In addition, CO₂ offers cost savings on refrigerant charge, electrical and piping installation, case performance and energy consumption, he said.

He noted that electronic expansion valves (EEVs) – required in cases refrigerated by transcritical systems – modulate the inlet-to-outlet temperatures in evaporators to constantly optimize the evaporator superheat, said Gosselin. With mechanical valves, he added, superheat is rarely optimal and should be seasonally adjusted per manufacturer recommendations – which, in practice, never occurs. EEVs also prevent case temperatures from fluctuating, which benefits the quality and shelf life of food products.

Other intangible benefits include: relief from leak and record-keeping requirements, better quality products because of case controls, savings from preventive maintenance, and a positive impact on the environment.

For ALDI, the decision to install Hillphoenix's compact AdvansorFlex CO₂ booster system in its small-format stores was also born from the flexibility of such systems.

"The AdvansorFlex compact CO₂ booster system provides them with the flexibility of either an indoor or an outdoor location – depending on site restrictions," Gosselin said. "It also allows them to adapt to an air-cooled gas cooler for cooler climates as well as adiabatic for warmer climates that will improve the performance of the system."

Training challenge

One of the challenges associated with CO₂ systems is providing training on installation, start-up and maintenance to contractors not versed in the technology. Another is maintaining energy efficiency in warmer climates, which can be accomplished with parallel compression as well as adiabatic condensers, he noted.

The equipment cost of CO₂-based systems is still higher than most traditional systems, ranging from 10% to 50%, Gosselin said. But that cost is starting to come down as the technology becomes more widely adopted – with uptake being driven by retailers like ALDI US. Moreover, compact transcritical systems support a lower first cost, and some utilities – such as the Sacramento Municipal Utility District – offer incentives for installing natural refrigerant systems.

He also pointed out the need to look not only at equipment cost, but installed cost, which reflects the savings on refrigerant and piping, as well as energy and refrigerant savings over time. This can result in a favorable ROI and total cost of ownership.

■ EH & MG

The AdvansorFlex compact CO₂ booster system provides [ALDI US] with the flexibility of either an indoor or an outdoor location – depending on site restrictions."

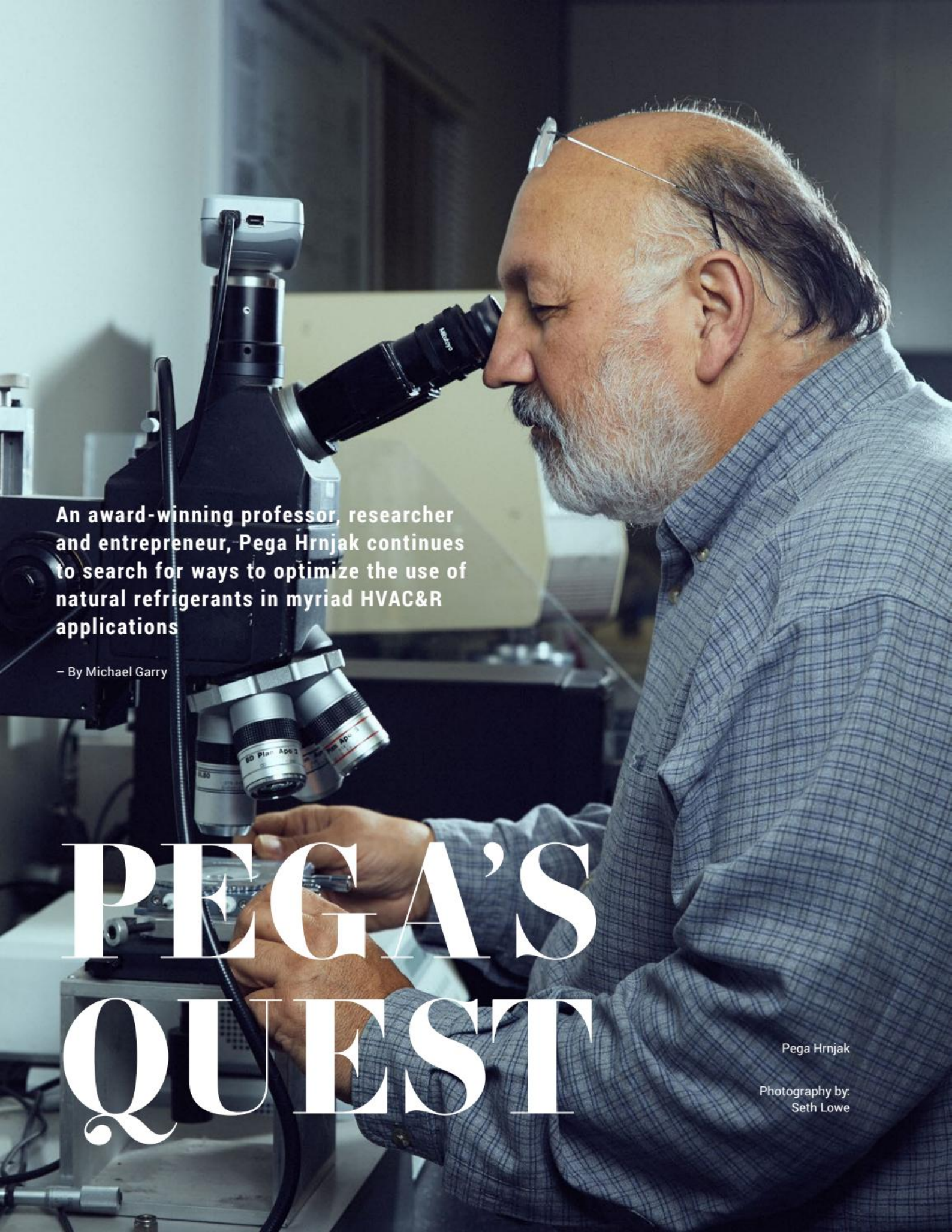
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2/ AdvansorFlex unit and gas cooler on roof of ALDI US store in Baldwinsville, N.Y.

3/ Refrigerant-grade CO₂ stored at Baldwinsville, N.Y., ALDI US store.



An award-winning professor, researcher and entrepreneur, Pega Hrnjak continues to search for ways to optimize the use of natural refrigerants in myriad HVAC&R applications

— By Michael Garry

PEGA'S QUEST

Pega Hrnjak

Photography by:
Seth Lowe

When Predrag Hrnjak – known universally as Pega – was a visiting scholar at the Technical University of Denmark in the early 1980s, he took a trip to the Norwegian Institute of Technology in Trondheim, Norway, where he met Gustav Lorentzen.

Lorentzen, already a renowned thermodynamics scientist, would secure his place in history in the late 1980s by rediscovering how CO₂ could be effectively used as a refrigerant in cooling and heating.

"I saw him at his desk meeting with a student," Hrnjak recalled recently in an interview with *Accelerate America* at Creative Thermal Solutions (CTS), his research and consulting business in Urbana, Ill. "He radiated strength, knowledge and charisma. Later, when I talked to him, he strengthened the initial impression he made. In a relatively short time, he left a deep impression. It was clear why they called him *Iron Gustav*."

Hrnjak, a charismatic and deeply knowledgeable figure himself, would also go on to leave an indelible mark on the global HVAC&R industry, helping to advance the CO₂ revolution that Lorentzen and his last Ph.D student Jostein Pettersen set in motion, and making significant contributions in many other applications as well.

Born in Belgrade, Yugoslavia (now Serbia), Hrnjak received a doctorate from the University of Belgrade, where he taught for many years. He resettled in the U.S. in 1993, becoming research professor at the University of Illinois at Urbana-Champaign, as well as co-director and then director of the University's Air Conditioning and Refrigeration Center (see page 39). He founded CTS in 2003.

In 2011, his accomplishments were recognized at the International Congress of Refrigeration in Prague, Czech Republic, where he fittingly received the prestigious Gustav Lorentzen Prize, one of many awards he has received. "That award reminded me of the man who influenced not only me but the entire world," he said. (Lorentzen died in 1995.)

Ammonia is another natural refrigerant for which Hrnjak has made major contributions, particularly in the development of microchannel heat exchangers that dramatically reduce its charge. This charge reduction technology, which he originally designed in the 1990s, has helped bring about the recent growth of low-charge systems and packaged units in industrial refrigeration, including an "ultra-low-charge" system made by CTS itself.

For all of the contributions he has made over the past three decades, Hrnjak shows no sign of slowing down, keeping up a schedule – split between the university and CTS – that would exhaust a much younger man. When he isn't in Urbana-Champaign, he's traveling the globe giving presentations at technical conferences – or indulging in his passion for scuba diving with his family.

CTS has grown from a small house and Quonset-style lab to a five-building, 100,000-square-foot campus, including 49 temperature- and humidity-controlled environmental test rooms and a 120-seat conference room. (See page 37.) It employs 42 full-time employees – more than half with advanced degrees – including engineers, physicists, brazing

1 / Vacuum brazing furnace



experts, metallurgists, machinists, and refrigeration, mechanical and electrical technicians.

Known globally as a hub for HVAC&R research, CTS is a kind of engineering playground, where Hrnjak and his crew can explore the fundamentals of heat transfer in creating their own innovations while at the same time helping clients optimize their HVAC&R systems.

From 50% to 60% of its projects involve natural refrigerants. "Whether natural refrigerants will take all applications in refrigeration, air conditioning and heat pumps – that remains to be seen," said Hrnjak. "But I'm absolutely certain that their growth is getting stronger and their operation is getting dramatically better – efficient and inexpensive. We will see more natural refrigerants in every segment."

CTS's clients span several industries, from automotive and residential to food retailing and industrial refrigeration. It has also worked on power generation, military, aircraft and space applications. For the military, CTS created a refrigerated vest that could keep soldiers from overheating in the desert.

Hrnjak sees CTS as a bridge from the more theoretical work he does at the University of Illinois to real-world projects that can be commercialized. "The objective from the beginning was to make prototypes and new systems, evaluate them, and present these new technologies with results in real conditions," he said.

CTS prides itself on being "unbiased and independent," he said. This, for example, enables CTS to be called upon to help in standards development. After working on several SAE International (Society of Automotive Engineers) standards, CTS is currently working a hot-gas defrost project for AHRI that "will result in a standard that's the same as an ongoing project for ASHRAE," he said.

With its myriad of projects across industries and applications, CTS is able to take advantage of the cross-fertilization of ideas. "This is our great opportunity," said Hrnjak. "[Other places] stay in their own silo." For example, microchannel heat exchangers, first developed for cars and airplanes, are now being employed in industrial refrigeration.

As a researcher pushing for the upper limits of HVAC&R systems, Hrnjak takes the long view of technology acceptance. "To be more than a niche application, it can take 20 years," he said. "Look at CO₂. We have been working with CO₂ for more than 20 years; it goes up and down and up and down – it's never completed."

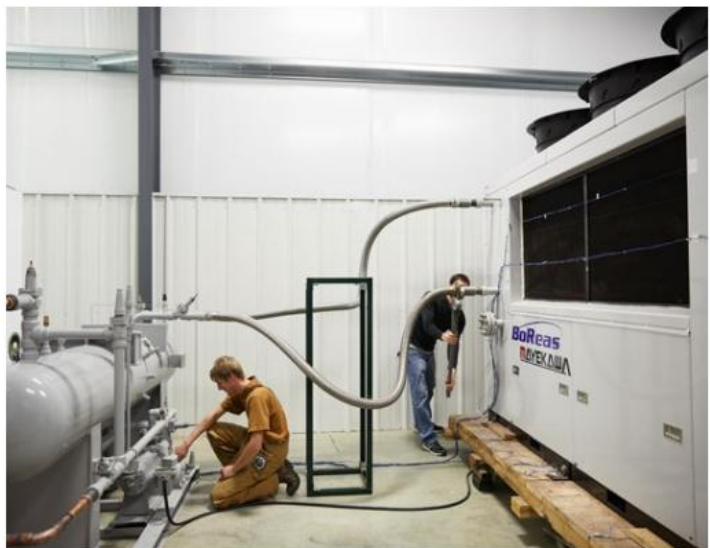
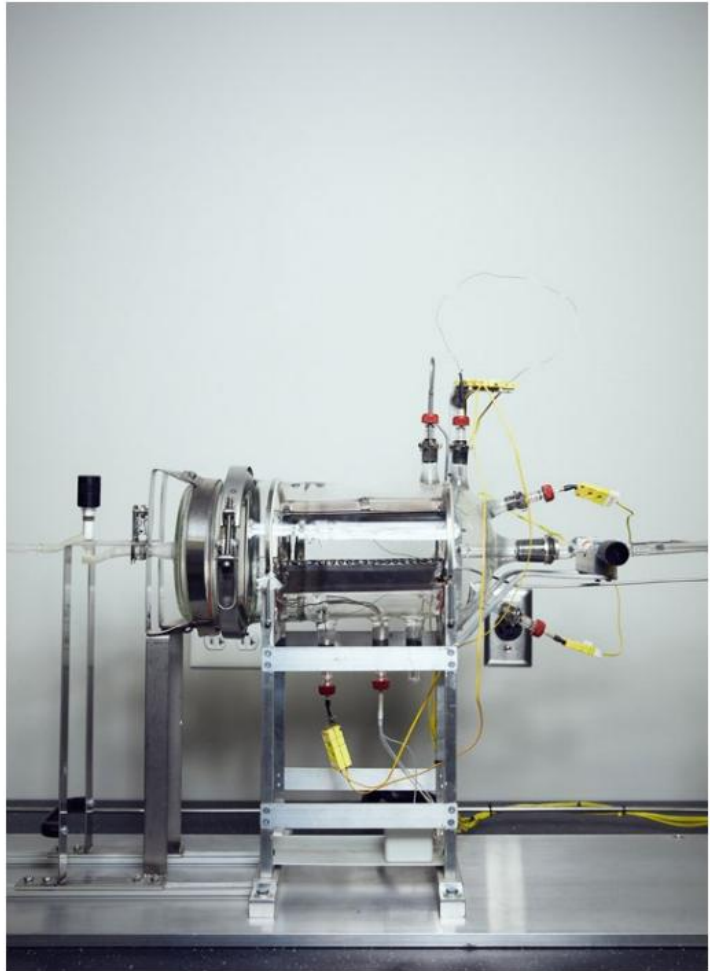
IT'S THE SYSTEM, NOT THE REFRIGERANT

Hrnjak likes to cite one of Lorentzen's guiding principles – that it's better to build a system around a refrigerant, rather than just drop a refrigerant into a system. "A good mechanical engineer can build a system to enhance the properties of the refrigerant," he said.

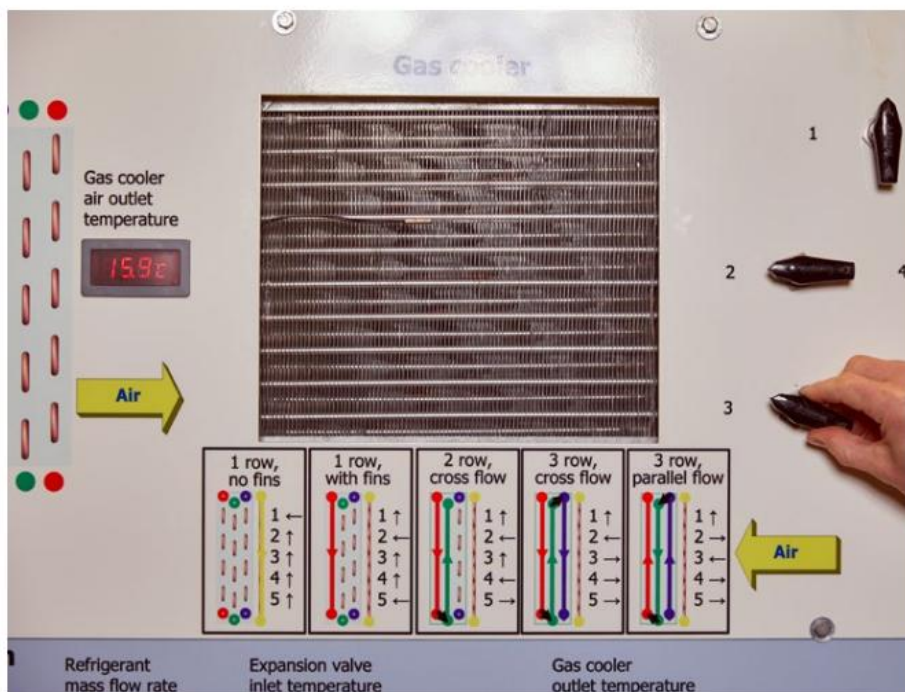
In explaining this philosophy, Hrnjak distinguishes between the thermodynamic properties of a refrigerant and its thermophysical properties. The former are the basic properties exhibited in the simple Reversed Rankine (or Evans-Perkins) cycle, the basis for the vapor compression systems used in most refrigeration, air conditioning and heat pumps. By contrast, thermophysical properties, often neglected in evaluations, are those that define how a refrigerant behaves in components of the cycle – like its heat transfer and pressure drop in the heat exchanger – which can be optimized through good engineering.

"People typically look at just the thermodynamic cycle," said Hrnjak. "They often forget the heat transfer and pressure drop, the efficiency of the compressor. All of that is engineering rather than thermodynamics and can make a significant difference in conclusions."

CO₂, with its low critical point (88°F and 1,071 psi), is an example of a refrigerant for which systems can be designed to



2 / Transparent control atmosphere brazing furnace
3 / Chad Meltzer (left) and Wes Schell working on Mayekawa's BoReas NH₃/CO₂ unit



4 / Gas cooler in educational R744 facility

maximize its thermophysical properties and take advantage of its non-flammability and GWP of one; this is what Lorentzen realized and what Hrnjak has helped to refine. "You need to make something different with CO₂ and then it works much better than when you just drop it in the existing system," he said.

Over the past 15 years, Hrnjak and his colleagues have made presentations and written papers on virtually every technical aspect of CO₂ technology. Some examples include: the effects of oil on transcritical CO₂ systems; ejectors in CO₂ air conditioners; heat transfer and pressure drop in CO₂ heat exchangers; flash-gas bypass for improving transcritical CO₂; control strategies for transcritical CO₂; and using ammonia and CO₂ in supermarkets.

Hrnjak and his team have done a lot of work on ejectors, the components that improve the efficiency of transcritical CO₂ systems in warm ambient climates. Stefan Elbel, chief engineer for CTS, and adjunct assistant professor at the University of Illinois, did his Ph.D. thesis under Hrnjak on ejectors, and is one of the leading experts on the technology. "We had papers and results on ejectors at the very start, 15 years ago" said Hrnjak. "And we make them here at CTS." Their design incorporates a needle to adjust the capacity.

In the automotive sphere, he developed some of the early CO₂ mobile air

conditioning systems in the mid-1990s. In a "CTS museum" section of one of his labs, he displays the first Denso CO₂ compressor made around 1994, as well as the first CO₂ evaporator and gas cooler for cars. Over the past year, German automaker Daimler has started commercially equipping some car models with CO₂ air conditioning.

Following a prototype built in 1997 (and described in a publication in 2000) CTS devised a CO₂ heat pump producing both cooling and heating for the emerging electric car industry. The company is currently working on minimizing noise from automotive air conditioning.

CTS has also done "big projects" for CO₂ heat pump water heaters, in both residential and commercial applications, he said.

CTS has highly refined leak measurement tools, calculating refrigerant leak rates with a resolution of 0.5 g per year. It has used this to determine the leakage of CO₂ in automotive AC. "A good new system leaks around 20 g per year," said Hrnjak. "If you have a 200 g leak, then you need to find where the leak is coming from and fix it." For that, CTS is able to locate the leaks in components like compressors, connectors and hoses.

In its supermarket lab, CTS has tested CO₂ transcritical and secondary systems as well as propane in bottle coolers. Its commercial research has also

included ultra-low temperature freezers (cascades and auto-cascades.)

While Hrnjak noted the progress CO₂ has made as a refrigerant in supermarket systems, he does not think it has reached its full potential. "It is excellent at low temperatures, but we don't see it used that much in low temperatures, except in some supermarket applications," he said. "At low temperatures, it's not difficult to make it efficient at all."

In the foodservice sphere, CTS designed a CO₂ unit for bottle coolers and vending machines at the same efficiency – and a similar cost – as R134a and hydrocarbon units, Hrnjak said. He has done this in part by modifying the design and materials of the heat exchangers.

He acknowledged that beverage brands often employ propane units because they are simpler to make, and use inexpensive refrigerant, components and oil that doesn't absorb moisture. "Propane is such a good refrigerant, and nothing is easier than working with propane – except that it is flammable."

Another example of an appliance for which CTS has developed a CO₂ option – though (outside of North America) it has widely incorporated hydrocarbons – is the home refrigerator. "We made it 10 years ago but acceptance of hydrocarbons made it less attractive," Hrnjak said. "It's so much easier with isobutane." The CO₂ unit's

5 / Alex Castaneda working on
CTS ultra-low-charge
NH₃ Chiller



6 / Fiona Zang controls compressor evaluation in calorimeter.



COP was “only 15% lower than the best refrigerators, still better than 85%-90% of the refrigerators on the market.”

CTS’s pioneering work on microchannel heat exchangers has helped make its CO₂ residential systems “as good as they are,” said Hrnjak. For example, the company has made high-speed videos showing the movement of liquid and vapor along with oil in microchannel heat exchangers, which have enabled CTS to locate ways to improve heat transfer and reduce pressure drops. “We get a dramatic improvement – 30%, 40%, 50%, depending on capacity.”

Paul Delaney, senior engineer for Southern California Edison (SCE), was visiting CTS on the day of *Accelerate America’s* interview with Hrnjak. He was joined by Terry Chapp, national business development manager for Danfoss. “[SCE is] looking for a long-term relationship with CTS for evaluating energy-efficient low-GWP technologies,” said Delaney.

CTS is currently engaged with a project, funded by SCE and the Electric Power Research Institute (EPRI), to evaluate the performance (efficiency, capacity, operational characteristics, and the possibility of thermal storage) of a low-charge-ammonia system from Evapco and an ammonia/CO₂ chiller from Mayekawa. In addition, Azane and Hillphoenix/NXTCOLD have contacted SCE about evaluating their low-charge-ammonia packaged units later this year.

Delaney and Hrnjak discussed another project whereby CTS would develop a CO₂-based rooftop packaged system for fast-food restaurants that could cost-effectively handle cooling, freezing, ice making and hot-water generation for all equipment, along with

other applications. Delaney said he is interested in such a system for restaurants and fast-food chains in Southern California.

CHAMPION OF LOW CHARGE

“I have been working all of my life with ammonia, mostly in industrial refrigeration,” said Hrnjak. His first job after graduating was building ammonia industrial refrigeration equipment.

In the 1990s, after joining the University of Illinois, he began what became one of his most important projects – developing microchannel heat exchangers and chillers for ammonia with reduced charge. In 1999, he made his first presentation on the topic (and again in 2001) at IIR’s annual conference. “I was very much involved with microchannel condensers for ammonia.” (He has also worked on small-diameter microfinned heat exchangers.)

Early on, though, the reception he got was unenthusiastic. “All the pipes in industrial refrigeration were ¾-in to 8-in in diameter, and suddenly I came with something like 1 mm, and nobody was thinking about that being realistic,” he said.

Slowly the low-charge concept began to gain attention for a variety of reasons, including the need to improve safety of the mildly flammable and potentially

PEGA’S LABS

To plumb the depths of heat transfer, Creative Thermal Solutions (CTS) has built 49 temperature- and humidity-controlled environmental test rooms, many focused on natural refrigerants.

For example, there are labs for CO₂-based mobile air conditioning and packaged low-charge ammonia refrigeration units. The supermarket test chamber features display cases with doors that are programmed to open periodically. There’s a lab for calibrating instruments as well as a machine shop.

CTS also has a brazing furnace for making prototype aluminum heat exchangers, brazing with aluminum-silicon alloy in a controlled atmosphere. “We look at the quality of the brazing joints, showing fascinating metallurgical samples,” said Predrag (Pega) Hrnjak, president and owner of CTS.

In building a heat exchanger for an application, CTS starts from scratch, using computational fluid dynamics (CFD) to evaluate what fins should be made for a particular application. “Then we make a prototype, and if it passes, we put it in a system and evaluate it completely,” Hrnjak said. “So we go through multiple steps to eliminate unsuccessful ideas early.”

CTS has a machine that allows its engineers to observe the power and flow rate of a system under different circuiting options. “You can see the change in flow and power by selecting a different circuiting, expansion device or compressor,” explained Hrnjak.

7 / Pega Hrnjak with transcritical CO₂
system for high-ambient conditions



toxic chemical and reduce regulatory oversight. But, even today, he noted, a handful of companies in the U.S. have just begun offering systems that significantly reduce ammonia charge.

Hrnjak would like to see a federally approved charge limit, accepted by the industry, for applications of ammonia – similar to the 150 g limit on propane for commercial HVAC&R applications. This limit would put ammonia applications "in the same position as other refrigerants," he said. "I'd like to see some charge defined as safe." He acknowledged the pungent odor even small amounts of ammonia exhibit.

Meanwhile, Hrnjak has developed a CTS low-charge air-cooled chiller that uses only 420 g (0.9 lb) of ammonia in concert with glycol to produce a 5 TR-10 TR capacity (with a sweet spot of 7.5 TR). It uses a microchannel condenser and a stainless steel plate evaporator to produce freezing temperatures (14°F or lower) or air conditioning levels. He is working on increasing the COPs, which are already high. "The chiller works perfectly well," he said.

Hrnjak is looking into commercializing the low-charge chiller as a rooftop unit replacing R22 or HFC units for industrial and commercial applications. "This is a good application for ammonia because the charge is extremely low and the efficiency is very high, and it's very good for the environment. And we have the technology to make it extremely low cost – comparable to R22 or R410A chillers."

Just as he was inspired by Lorentzen and carried on his mission, Hrnjak has a message for the colleagues and students who will succeed him:

"Try to go beyond the tracks that have been running for many years. Think about inexpensive, good ways to improve efficiency and capacity and reduce cost with creative, innovative approaches. Don't be shy of that." ■ MG



8 / Outside chillers for environmental chambers in adjoining building

PRECOMPETITIVE RESEARCH

In addition to running Creative Thermal Solutions, and advising more than 20 Ph.D students, Predrag (Pega) Hrnjak is also director of another research operation – the Air Conditioning and Refrigeration Center (ACRC) at the University of Illinois at Urbana-Champaign.

Founded in 1988 by the National Science Foundation, ACRC is a \$5 million industry-university cooperative research center allowing its industry members to coordinate and share "precompetitive research" on energy-efficient, environmentally friendly HVAC&R technologies.

Its 30 members include "anybody who means anything in the world of air conditioning, refrigeration and heat pumps," said Hrnjak.

Overseen by about 15 professors, the research at ACRC is conducted by about 35 graduate students; also participating are a similar number of undergraduates and visiting scholars.

Research project proposals are based on "our understanding of the interests of industry," said Hrnjak. "Thirty years and 30 members indicate that something is right." Company members vote on which projects will be funded.

AHR Expo Roundup

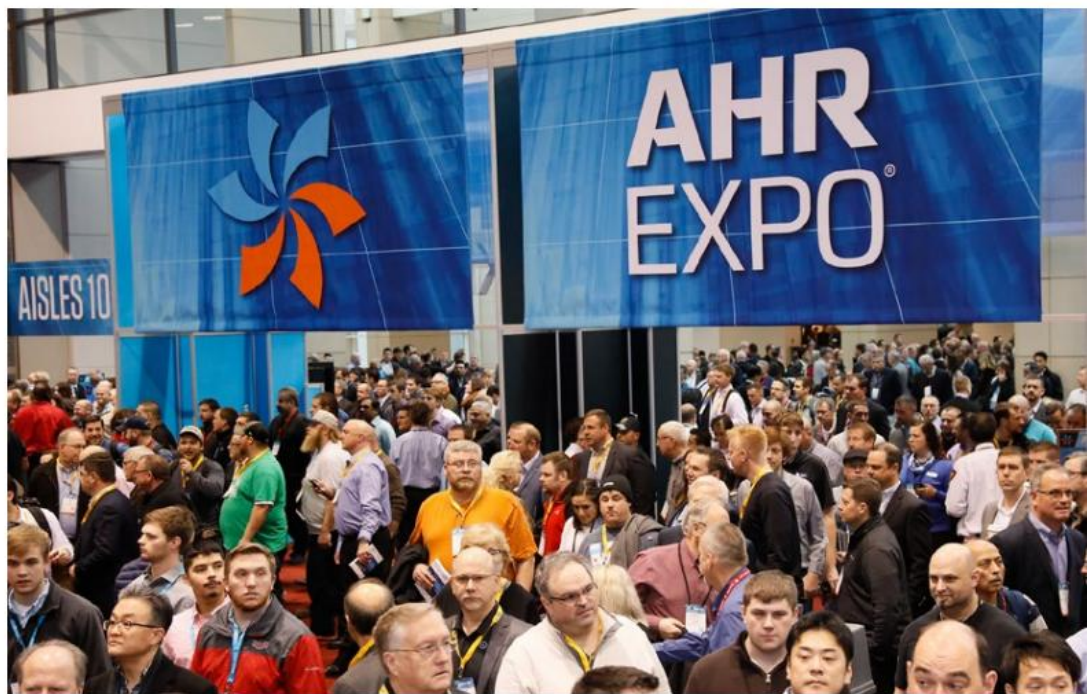
— By Michael Garry and Charlotte McLaughlin

Already one of the largest HVAC&R trade shows in the world, the AHR Expo set several new attendance and exhibitor records at its latest gathering in Chicago last month.

Total attendance (exhibitors and visitors) exceeded 72,000, while visitors alone fell just shy of 50,000. Virtually every country in the world – 169 – was represented.

There were 2,155 exhibiting companies occupying over 534,000 sq ft of floor space. Among those exhibitors, *Accelerate America* observed and spoke with many featuring products or services related to natural refrigerants. In many cases, these exhibitors increased the scope of their natural refrigerant equipment from previous expos.

The following provides some natural refrigerant highlights from the event.



CO₂

Dorin's industrial CO₂ compressor

Italian compressor manufacturer Dorin, which is celebrating its 100th year of business in 2018, showcased its first CO₂ transcritical compressors for the industrial market at the AHR Expo.

"Our feeling is this will be a reliable alternative to ammonia," said Giovanni Dorin, marketing director. "Ammonia has issues with security and safety."

"Especially in the U.S., we got very good feedback about CO₂ entering the ammonia field," said Giacomo Pisano, Dorin's sales manager, CO₂ compressors.

The new semi-hermetic reciprocating compressors, marketed under the CD500 line, feature six cylinders, 50-80 HP and displacements of 40-60 m³/h. Like the two-year-old CD400 line, the CD500

compressors are designed such that the manifold is outside the crank case, rather than inside, and the two are separated by a pocket of air. This allows the CO₂ gas to cool before being discharged by the compressor, lowering temperature of the oil inside the crank case and increasing efficiency and reliability, Dorin said.

"This [design] is totally unique in the market," he said.

The high capacity of the CD500 line means fewer compressors are needed for an application, reducing costs, added Pisano.

Dorin sold the first 30 CD500 compressors in 15 days last June; the units are now available globally.

Emerson's larger compressors

At the AHR Expo, Emerson launched 35 and 40 HP semi-hermetic reciprocating Copeland CO₂ compressors, with the 50 HP version slated for late fall. The compressors offer capacity ranging from 40,000 BTU/h to 320,000 BTU/h at 20°F SST.

"There is a demand for larger CO₂ compressors because CO₂ is growing in large commercial and small industrial applications," said André Patenaude, director of food retail growth strategy, cold chain, for Emerson Commercial and Residential Solutions platform.

Emerson also plans to bring its Dixell IProRack controller for CO₂ systems, sold in Europe, to North America, said Patenaude.

"It has built-in, native CO₂ functionality," overseeing suction groups, high-pressure and flash-tank by-pass valves, heat reclaim, condenser VFDs, and parallel compression, he said. By integrating these functions, the unit helps "eliminate extra controllers and lowers cost."

It does not control ejectors, though that "is in the plans," he added.

Carel's modulating ejector

Italian component manufacturer Carel displayed its EmJ modulating ejector line, which it is introducing to the North American market this year.

"After the interest we got in Europe, this is another important market for CO₂ transcritical," said Brandon Marshall, application manager refrigeration, Carel USA, based in Manheim, Pa. "The ejector should facilitate this." Ejectors enable transcritical systems to run efficiently in warm climates.

The EmJ line made its debut in 2016 in partnership with Carrier at the ATMOSphere Europe conference hosted by shecco (publisher of *Accelerate America*). The ejector is being piloted in transcritical systems installed in 15 supermarkets in Europe. Carel will begin selling it in North America and Europe in June.

The modulating ejectors, which allow a transcritical system to continuously adapt to variations in operating conditions, can accommodate smaller transcritical racks used in convenience stores, Marshall noted.

The ejector works by receiving a portion of the CO₂ suction gas from medium-temperature evaporators. When the CO₂ gas coming to the ejector from the gas cooler "hits a certain high pressure," a valve opens and allows the suction gas to enter the ejector, mix with the gas from the gas cooler, and go to the pressure vessel (receiver) where some will liquefy, said Marshall.

"So we're taking a portion of that suction gas back and thereby increasing the COP on the medium-temperature compressors and saving energy."



1/ Dorin's CD400 CO₂ compressor

2/ André Patenaude, Emerson

Refrigerator's CO₂ valves

Italian manufacturer Refrigerera Industriale S.r.l. launched new CO₂ valves that can withstand the high pressures of transcritical systems.

Refrigerera's new ball valve uses stainless steel with a K65 connection. "This product was developed for the U.S. market to meet the requirements of the UL certification," said Gabriele Bertossi, export area manager for Refrigerera.

The valve can be used in transcritical installations safely. "The pressure is very high; we're talking 150 bar," Bertossi said.

The company has also launched a new strainer valve with stainless steel and K65, and a V-port valve.

The V shape allows for better control of the refrigerant, according to Bertossi, "so if you open the valve at 60% you will have 60% flow rate [from] the valve."

Parker Sporlan sees demand for CO₂

In a sign of the growing popularity of natural refrigerant systems in U.S. supermarkets, Micro Thermo Technologies, a maker of control and energy management systems, is increasingly seeing its units used with CO₂ transcritical installations in the U.S., said Charlie Cunliffe, senior technical sales engineer with Micro Thermo, a division of Sporlan (a subsidiary of Parker Hannifin).

Cunliffe explained that most of the demand comes from the Midwest area from Milwaukee to Chicago and on the East Coast between Maine and New York. "This is the hot bed," he said.

For example, Parker Sporlan is currently operating one of the Micro Thermo systems in a Hannaford supermarket with CO₂ transcritical. The system allows the store to be monitored with an app remotely.

Cunliffe demonstrated to *Accelerate America* through the app that the Hannaford store was running perfectly and all its components and racks were operational.

Cunliffe acknowledged he was skeptical of transcritical at first. "Now I know the power of CO₂. When you watch the temperature drop [during the hot gas defrost cycle] with CO₂, the temperature drops like a rock," he said.

By contrast, HFC systems, he said, have a slow defrost cycle. "This means when you have your Häagen-Dazs ice cream, the ice cream melts a little and forms with ice crystals [but] with CO₂ you get back to the temperature quickly."

Kaori supports CO₂ research

Kaori, a Taiwan-based brazed plate heat exchanger (BPHE) manufacturer, has been supporting U.S. universities that want to study CO₂ heating and cooling technologies for different applications.

"We have been selling CO₂ [heat exchangers in the U.S.] mainly to labs and universities," Allan Han, Kaori Thermal Products' sales director, said.

The company has marketed CO₂ heat exchangers, from 30 to 140 bar, for five to six years. Han expects sales of lower-pressure CO₂ products to take off in the U.S. as ammonia/CO₂ cascade systems become more popular.

The heat-exchanger manufacturer mainly operates in the Chinese market, where it has seen demand for its CO₂ BPHE's used in heat pumps. "A lot of CO₂ heat pumps in China," he said.

China is investing in heat pump technology so they can reduce the pollution from fossil fuels in big cities, he explained.

Alfa Laval to open plant

Swedish manufacturer Alfa Laval announced at AHR Expo that it will open a new factory for brazed heat exchangers in Richmond, Va.

The new production facility in the U.S. will focus on configuration, assembly, brazing and testing, according to the manufacturer. The facility is planned to start production in the first quarter of 2019.

"This is a key step to strengthen Alfa Laval's competitiveness in North America," said Fredrik Ekström,

president, business unit, Braze and Fusion-Bonded Heat Exchangers. "Local manufacturing brings us the benefits of flexibility and speed needed to strengthen and grow our local business, and enables us to supply low-volume configured units with short lead times."

The company currently does not sell many CO₂ heat exchangers in the U.S. market. "Japan [and Europe] is driving the move to CO₂," said Pierre Hultbäck, Alfa Laval's VP Braze & Fusion-Bonded Heat Exchangers - Head of Channel Sales. He believes "the U.S.A. will be last on this."

Hultbäck estimated only 2% of its portfolio in the U.S. is with CO₂. On the other hand, "Ammonia is very present in industrial systems."

Alfa Laval hopes that the California Short-Lived Climate Pollutants (SLCP) Strategy, which includes an HFC phase-down plan, will be implemented soon. "We hope that the work U.S. states are doing [like California] on HFCs will push uptake faster," he said.

Adiabatic coolers storm U.S.

Adiabatic coolers are proving a big hit with U.S. customers, said Jerry Lozano, sales and applications engineer for German manufacturer Güntner.

"One thousand [from all manufacturers] have been sold so far [in the U.S.], of which 250 are probably CO₂," Lozano said. The component supplier, which manufactures adiabatic condensers, estimates that the main source of this growth in CO₂ adiabatic coolers comes from innovative end users like the retailer ALDI US.

Other manufacturers of adiabatic condensers include Baltimore Aircoil and Evapco.

Lozano said that adiabatic technology is much more efficient than traditional evaporative coolers.

He believes the sales of its CO₂ products will further increase as the move towards CO₂ transcritical and ammonia/CO₂ cascade systems in larger applications picks up in North America.

Hydrocarbons

3/

Embraco's multi-voltage compressor

Embraco new FMFT413U Bivoltage hermetic R290 compressor is actually multi-voltage, accommodating the voltage of any country in the world. The end user simply attaches a geographically correct power cord, whether for the U.S. (120 V), European countries (230 V), Japan (200 V) or elsewhere.

"We came up with one solution; you just change the power cord," said Michel Moreira, commercial refrigeration sales senior manager, North American region.

The Bivoltage compressor employs variable-speed technology, helping to improve temperature control and reduce energy consumption up to 30%, said Embraco.

Another new product, Embraco's FMXA6C Fullmotion variable-speed compressor for R600a, is a low-profile unit that incorporates an inverter, allowing Embraco "to get the price to the more reasonable range of fixed-speed compressors," said John Prall, technical support engineer. "So the ROI to go variable speed with a natural refrigerant becomes much shorter."

In addition, the R600a compressor's shell is small "so you get more selling space for products," said Moreira, adding that it also generates very little noise.

Embraco also showcased its first Plug N' Cool condensing unit for low-temperature applications. The previous version, designed for medium-temperature case, is installed in a MIG supermarket in Brazil, with 12 units replacing a remote R22 system; the Plug N' Cool reduced energy consumption along with total cost of ownership.

Emerson's propane condensing unit

Emerson debuted its first line of propane Copeland M-Line condensing units, which include Copeland reciprocating hermetic compressors. "It was based on customer demand from foodservice [companies] like convenience stores and restaurants," said André Patenaude, director of food retail growth strategy, cold chain, for Emerson Commercial and Residential Solutions platform.

The R290 units are designed to deliver energy improvements of up to 30%, said Emerson.

"Emerson continues to focus its efforts on solutions that help our customers make the transition to DOE- and EPA-compliant technology," said Allen Wicher, foodservice director of marketing, Emerson's Commercial and Residential Solutions platform in a statement. "This new solution offers increased performance in low- and medium-temperature refrigeration applications and is designed with OEM and end-user concerns in mind that go beyond meeting the DOE and EPA mandates, such as capacity equivalence and same or reduced footprint."

Patenaude acknowledged that the line could also accommodate small-format grocery stores.



4/

3/ Embraco's Bivoltage R290 compressor

4/ Tecumseh's IntelliCOOL R290 VTC cassette

Tecumseh's intelligent R290 system

Compressor manufacturer Tecumseh showcased a modular, self-contained R290 refrigeration system at the bottom of a refrigerated cabinet with a variable-speed compressor and advanced electronic controls.

The system, called the VTC Cassette, features Ann Arbor, Mich.-based Tecumseh's VAE Series variable-speed compressor, which extends the company's line of variable-speed commercial refrigeration compressors to a capacity of 7,300 BTU/h.

Using variable speed technology, the VAE reduces overall energy consumption by dynamically matching the capacity of the compressor to the cabinet's cooling demand. The VAE Series is optimized for use with R290.

A key feature of the VAE series is that the electronic controller can handle voltage inputs from 85 to 260 volts AC and both 50 and 60 hertz. This provides significant benefits to equipment manufacturers that sell commercial refrigeration equipment in geographic regions where voltage requirements and power stability vary significantly, said Tecumseh in a statement.

By operating at higher speeds, the VAE compressor can greatly reduce the time needed to pull-down cabinet temperatures after restocking and during initial stocking, Tecumseh said, adding that low-speed operation is used to maintain cabinet temperature with minimal energy consumption.

The variable-speed compressor is one element of Tecumseh's new IntelliCOOL Technology Platform, which also encompasses intelligent control, energy management and heat transfer.

IntelliCOOL, said Tecumseh, offers electronic protection, on-board diagnostics, and remote communications with technicians. The platform supports hydrocarbon and A2L refrigerants,

The VTC Cassette represents the "epitome of IntelliCOOL – it's where we're going to bring value to our customers," said Robert Terry, Tecumseh's director, global product management, during a press event at Tecumseh's AHR Expo booth.

IntelliCOOL, he added, "focuses on energy savings, system performance, connectivity, serviceability and reliability."

As an example of IntelliCOOL's diagnostic capability, the system can "detect high current and low voltage very fast, so you don't expose motors and compressors to these conditions and allow them to have a longer life."

During 2018, Tecumseh will begin applying various elements of the IntelliCOOL technology platform to its line of commercial refrigeration compressors, condensing units and value-added systems.

INFICON presents propane detector

During the first day of the AHR Expo INFICON explained how its Gas-MATE combustible gas leak detector for gas boilers has found other uses.

Michael Wood, technical support engineer – service tools at INFICON, said the detector is now in demand from the refrigeration industry, and could be adapted for hydrocarbon refrigerants, including propane, isobutane and HC blend R441a.

The adjustable sensitivity of the leak sensors makes detection quick, according to the company.

Wood said MET laboratories had certified the product intrinsically safe for use in combustible/explosive environments, Wood said.

This is significant as more companies in the U.S. and around the world opt for propane technology.

Kulthorn, Huayi see compressor growth

Thailand-based Compressor manufacturer Kulthorn is seeing growth for light commercial and fractional HP units using hydrocarbons in North America.

"There is more and more demand for small and commercial applications", said Dean Rafiee, Kulthorn's director of business development. "There has been some small demand for household, not much, [and some demand for] bottle coolers."

In North America, the company is focusing on further optimizing its complete range of hydrocarbon compressors. He explained that Kulthorn "has variable-speed compressors [and is now] developing DC compressors with R290."

The firm's latest innovation for R290 condensing units used in light commercial applications is an open-protocol EC motor to increase efficiency and reduce noise.

Meanwhile, Huayi Compressor Barcelona, a Chinese-Spanish manufacturer of hydrocarbon compressors, is also optimistic about the market prospects for hydrocarbons.

"We see the U.S. market as promising a lot of opportunities and especially with natural refrigerants," said Pedro Olalla, sales director at Huayi Compressor Barcelona. "Some customers are already going to – and a lot are thinking about – natural refrigerants."

The company is working with OEMs and end users to drive the light-commercial market towards hydrocarbons. "We have a lot of experience with R290," Olalla said.

A major driver in the U.S. has been large food and beverage manufacturers that have converted many of their HFC-based fridges to hydrocarbons.

The U.S. has stringent Department of Energy (DOE) energy-efficiency standards that apply to light-commercial refrigeration products and this has moved many OEMs to invest in hydrocarbons.

Hydrocarbons allow companies to meet the efficiency regulations, according to Olalla. "Some want to not just comply with DOE but meet Energy Star [a n EPA program that lists the most energy efficient products in the U.S.]. You can only do this with natural refrigerants."

The company's compressors can increase energy savings still further. "We have also improved our fixed-speed and high-efficiency ranges further," he noted.

Asked whether the perceived slowdown in environmental regulations in the United States would have an effect on the HVAC&R sector, Olalla replied: "OEMs that have started will continue. Everyone will make it to natural refrigerants."

5/ Mayekawa's Sierra-A NH₃/CO₂ compact chiller



Ammonia

Mayekawa's latest ammonia/CO₂ chiller

Following up on its NewTon ammonia/CO₂ packaged refrigeration unit, Japanese manufacturer Mayekawa launched an ammonia/CO₂ compact chiller called the Sierra-A at the AHR Expo.

The Sierra-A has a "smaller capacity than the NewTon and is air-cooled," said Tadashi Hamaoka, vice president, Mayekawa Canada. It's suited for "smaller jobs," including dock cooling at industrial plants, he added. It can also be used with display cases, walk-in coolers, process cooling, HVAC and data centers.

According to Mayekawa, the Sierra-A uses "the world's first semi-hermetic ammonia scroll compressor." It uses an IPM compressor motor "to match the precise load," the company said.

The Sierra-A contains 7.8 lbs of ammonia to support a capacity of 8.2 TR at 20°F. Its CO₂ supply temperature ranges from 5°F to 41°F.

Last year at the AHR Expo, Mayekawa introduced two chillers: the BoReas ammonia/CO₂ system delivering CO₂ for medium-temperature loads in supermarkets, cold-storage facilities and other applications. The other unit, the AuRa, is an ammonia/water-glycol chiller for air-conditioning in commercial buildings like hotels and hospitals.

Carlyle bullish on ammonia

Carlyle, a UTC Climate Technologies brand (part of the Carrier group), believes ammonia is more efficient than other refrigerants for bigger systems.

Chris Dahar, application engineer at Carlyle, said ammonia compares favorably with HFCs in large-scale cooling applications. "Ammonia is way more efficient. [Compared] to R404A, the energy content can be six times higher." Ammonia also has "10 times less pressure."

This has an impact on the amount of refrigerant used in a refrigeration system per hour. Ammonia would use significantly less refrigerant, meaning lower cost for end users, "especially if you consider ammonia is cheap," he added.

Dahar also draws attention to environmental benefits. "Anyone in the refrigerant business now knows you need a refrigerant strategy," he noted.

As for HFOs, Dahar said, "A2Ls are flammable and very expensive" ■ MG & MC

Revisiting Hydrocarbon Safety

Bigger charges and wider adoption call for a renewed focus on precautions to minimize risks

— By Mark Hamstra

Hydrocarbons are hot.

Not just in the flammable sense, but also in popularity, as hydrocarbon-based refrigeration and air conditioning systems are gaining adoption worldwide, both in commercial and domestic applications. The IEC is working on raising the international charge limit of propane from 150 g to 500 g, which would spur even wider uptake.

In the U.S., thousands of propane and isobutane self-contained display units and vending machines have been installed in food stores, with more on the way. The Environmental Protection Agency has proposed raising the charge limit for domestic refrigerators from 57 g to 150 g, though a final decision has not yet been made pending review of stakeholder comments ([See page 16](#)).

"There's no turning back — hydrocarbons are here to stay," said Arthur Miller, principal at KAM Associates, Apollo, Pa., during a presentation on behalf of the Refrigeration Service Engineers Society (RSES) at the AHR Expo in Chicago last month. "Those who think it's not going to work are going to be dinosaurs. That's the bottom line."

But bigger hydrocarbon charges in commercial refrigeration and domestic refrigeration and air conditioning systems call for a renewed focus on safety precautions for the technicians who install and service this equipment, said Miller, a training expert who outlined the proper approach to servicing hydrocarbon equipment at his four-hour morning session on the first day of the expo.

The higher efficiency of hydrocarbon refrigerants will continue to attract users to these technologies, said Miller. In addition, the increased limit on the size of the charges will allow the refrigerants to become available for a wider variety of commercial and domestic applications.

But the growing use of hydrocarbons, while expected to benefit the environment due to their low GWP and Ozone Depleting Potential (ODP), at the same time presents safety challenges for technicians because of the flammability of hydrocarbons. Contractors and technicians, said Miller, need to rethink their entire approach to installing and maintaining these refrigeration systems.

Propane, isobutane and ethane are rated A3 — the highest degree of flammability — by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), which is why the size of the charge has historically been limited.

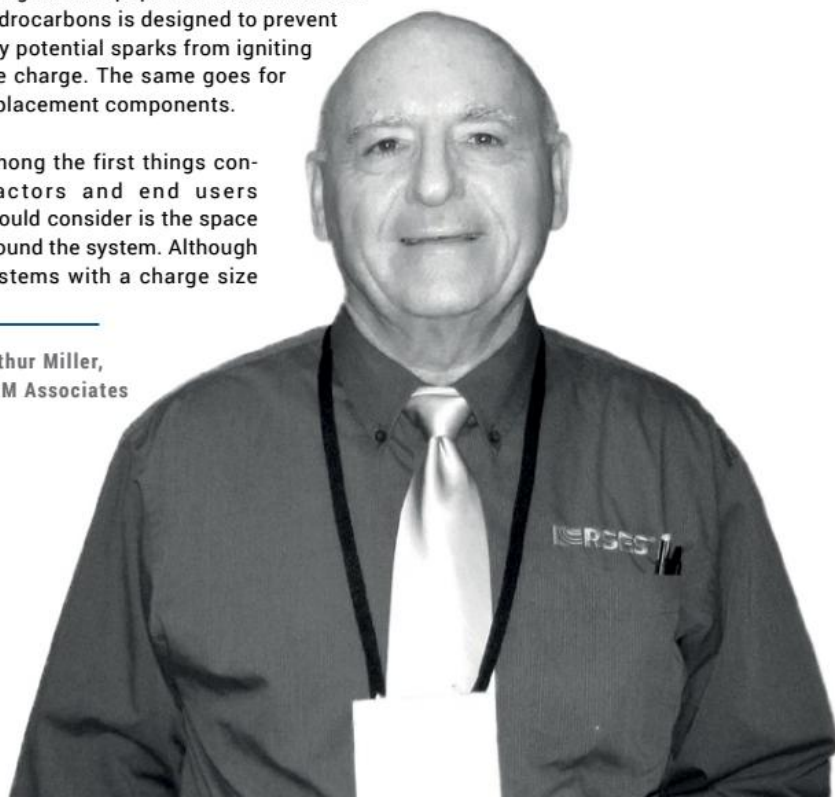
Hydrocarbon refrigerants are considered safe, however, if the proper equipment is used and safety protocols are followed. If not, refrigerants such as propane, isobutane and ethane have the potential to cause a fire or an explosion, or as Miller described it, "not a pretty day."

Proper installation

Hydrocarbon refrigerants should only be used in refrigeration equipment that is designed specifically for their use, and not as a drop-in replacement for a non-hydrocarbon refrigerant. Equipment that is built for hydrocarbons is designed to prevent any potential sparks from igniting the charge. The same goes for replacement components.

Among the first things contractors and end users should consider is the space around the system. Although systems with a charge size

Arthur Miller,
KAM Associates



“There's no turning back — hydrocarbons are here to stay.”

of 150 grams or less can be installed in any size room, according to EPA guidelines, Miller suggests that contractors ensure that there's enough space so that an accidental release of the refrigerant would not cause an explosion.

“You wouldn't want to put it in a tiny closet somewhere,” he said.

In addition, the installation should allow free air movement around all of the refrigerant containment parts of the system, and the space should be well ventilated.

“The amount of ventilation is going to determine how much of the vapor can build up in a space,” said Miller. “A release of flammable liquid could form a pool, and you have a vapor cloud explosion.”

While the danger is minimal with small charges of 57 or even 150 grams, it becomes more important as larger charges are being used, he said.

“I think it changes the whole perspective somewhat,” said Miller.

Installers should also be mindful of floor voids, as the gases are heavier than air and could cause a safety hazard if they escape into a drain. Ventilation should be close to the floor and lead directly to the outside of the building.

The EPA requires that both domestic refrigeration equipment and commercial units must be clearly labeled with warnings about the flammability of the refrigerants.

Consider the hazards

Contractors and technicians should always evaluate the risks involved in working on flammable systems ahead of time, and prepare for the worst-case scenarios.

“You always have to be thinking, ‘What can go wrong? If there is a fire, where is the fire extinguisher? Do I have an exit route?’” said Miller. “In a lot of the places I've been servicing, there's so much stuff lying in the way, you'd kill yourself trying to get out fast.

“Play the ‘What if’ game,” he said. “What if this happens? What if that happens? You've got to raise your consciousness up.”

Technicians who work on hydrocarbon systems should be thoroughly trained in safety procedures and should have studied any materials from the equipment manufacturer before beginning to work on the system.

“I think that's what scares me the most about our industry — the last thing you do is read the directions,” said Miller. “When all else fails, you read the directions last. But in fact, that's what you always have to read first.”

The EPA recommends that technicians wear protective gloves and eyewear when working on hydrocarbon systems, to prevent against possible frostbite and to protect the eyes from the oils used in the systems.

Perhaps most importantly, technicians need to take precautions to ensure that no spark or flame comes anywhere near the equipment or storage devices that hold the charge. That includes sparks from static electricity, as well as sparks given off by tools the technician may be using.

Some commonly used tools, such as those used for leak detection, can give off a spark and should not be used when working with hydrocarbon-based refrigeration systems, Miller pointed out. Technicians should ensure that any leak detectors they are using have been approved for use with hydrocarbon systems. He cited liquid-based and ultrasonic leak detectors as options designed for this purpose.

If there is a leak, Miller cautioned against unplugging the equipment from the wall. He cited one incident in which a technician did just that, and the spark from the plug coming out of the socket caused an explosion. Instead, simply shut the power off and leave the room, he said. Planning ahead for such a scenario will help technicians react better in such a situation.

It's also important for technicians to use a hydrocarbon detector properly throughout the service call.

"You go in with it on, because you don't know what's going on in the building," said Miller. "And you leave with it still on. We need to get in the habit of doing that."

A gas leak can displace the oxygen in a room and quickly cause death if there's inadequate ventilation, or it can build up in a room and cause an explosion. Technicians should be aware of the symptoms of lack of oxygen, which can include headache, drowsiness, dizziness, oxidation, excess salivation, vomiting and unconsciousness.

"If you're around some of these chemicals, and there is a release, you need to recognize that these are the symptoms of it," said Miller. "It's not because you were out half the night and you have a hangover."

Rethink legacy procedures

Hydrocarbons call for rethinking many commonly used work procedures that are dangerous when hydrocarbons are present, such as using a torch or other open flame to clear frost buildup. Instead, technicians should use a handheld steam cleaner to defrost coils, Miller suggested.

Similarly, brazing a pipe to seal it off is not advised when hydrocarbons are in the system. Other options are to use the Lokring [solder-free] method of joining tubing or – what Miller said has been an increasingly common practice – braze the pipes when there are no hydrocarbon refrigerants present.

Technicians also have to be aware of the lower pressures associated with hydrocarbon refrigerants, so they don't overfill the system.

"You always have to be thinking, 'What can go wrong?'"

"If you don't look at your PT [pressure-temperature] charts, and this is the first unit you've ever worked on, and you put your gauges on there, you would swear it's undercharged," said Miller. "We have to rethink some of this, because we're not used to seeing those kinds of low pressures."

Transportation of hydrocarbons to and from the site is a potentially hazardous aspect of servicing and installing these systems, and rules are still in flux about how the materials should be secured in a vehicle, Miller explained.

Some jurisdictions may require flammable refrigerants to be stored in explosion-proof cabinets that are ventilated to the exterior of the vehicle, he said.

In any event, cylinders should be stored in a secure, upright position. Miller also recommends traveling with a fire extinguisher just in case – which technicians should have with them anyway for potential use at the job site in case of fire.

Charging and venting

Equipment should always be labeled with the type of refrigerant that is in the system, and technicians should always be careful never to mix different types of refrigerant in the same system.

"I can't say this often enough — read, read, read the label to make sure you don't mix refrigerants," said Miller.

That includes ensuring that hoses used in charging refrigeration systems do not contain traces of other refrigerants, he said.

If the labels on the compressor and the refrigerant container don't match, technicians should assume the system has been retrofitted, stop work immediately and contact the owner to minimize liability in the event of an incident.

"Don't continue with something that's not right, and if you do, don't call me to be your witness in court, because it won't be pretty for you," Miller said.

Another key step is to make sure the refrigeration system is grounded prior to charging to prevent a spark, he said.

Hydrocarbon refrigerants are always charged in the liquid phase and should be charged from the high-pressure side, Miller noted. Other considerations are to keep the cylinders upright when charging and to keep hoses as short as possible — as short as six inches, he said.

Miller also recommends the use of electronic scales when measuring the charges, as the charges for hydrocarbons are much smaller than those that technicians may be accustomed to in conventional systems.

Conventional procedures may be used for venting hydrocarbon refrigerants when breaching the system to make repairs, although flammability must be taken into consideration, Miller said. The EPA allows venting of propane and isobutane from refrigeration systems outdoors.

Technicians should also be aware of any local safety regulations concerning hydrocarbons, although Miller said in many cases the regulations have not yet caught up to the technology.

"The local regulations are behind," he said. "The hydrocarbons are showing up first, instead of the regulations first. We've got the cart a little bit before the horse, and we're concerned about that — at least some folks are."

Of particular concern is that if there is a fire in the building, firemen could respond without knowing that there are potentially explosive chemicals at the site. Miller said local codes appear to be about three to five years behind the deployment of the technology.

In any case, hydrocarbon refrigerants are here to stay, so contractors, technicians and end users should get on board and prepare as best they can to prevent the possibility of a fire or explosion, he said.

"If you bury your head in the sand, you're going to be a dinosaur," said Miller. "Or, you can try to keep up with the technology, and keep up to date, and guess what? You'll make money, because you'll be the only kid on the block that knows what's going on." ■ **MH**



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