MARCH 2019

ACCELERATE AMERICA

ADVANCING HVAC&R NATURALLY

HOW TO SAVE MORE ENERGY IN A NATREF SYSTEM

Experts weigh in with low- or no-cost tips

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IIAR's CO_2, HC Safety Standards

p. 28

Roche's NatRef Remedy

p. 36

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LOW-HANGING FRUIT

— by Michael Garry

In the battle against climate change, there is a growing recognition of the need to transition – sooner than later – from fossil fuels to renewable sources of energy, chiefly solar, wind, hydropower, geothermal and bioenergy. Nuclear is another, more controversial alternative.

All of these methods serve to keep the primary heat-trapping greenhouse gas, CO_2, from streaming into the atmosphere. While each is gaining traction around the world, much more progress needs to be made against entrenched interests and political inertia.

But there are other ways – what could be called "low-hanging fruit" – to attack the climate problem that face far less pushback. These strategies, at a minimum, can help prevent global temperature increases from rising more than 3.6°F (2°C) above pre-industrial levels, the point where environmental impact becomes significantly worse.

It is the mission of this magazine to report on one such strategy – the use of climate-friendly natural refrigerants (ammonia, hydrocarbons and CO_2) in place of "super greenhouse gases" (HFCs, HCFCs and CFCs).

Natural refrigerants have a secondary benefit besides minimal or zero global warming potential – energy efficiency, a sure-fire, widely accepted way to curb carbon emissions. In properly designed HVAC&R systems, ammonia, hydrocarbons and CO_2 offer energy benefits over traditional refrigerants.

Hydrocarbons, an extremely efficient refrigerant, would gain wider traction in self-contained refrigerated display cases if their charge limit standard could be raised from 150 g to 500 g. This 500-g limit is now being voted upon by national committees in the International Electrotechnical Commission (IEC), and it is my hope that the higher charge, which has been determined to be safe, will be enacted.

Energy efficiency, of course, has been around as long as there have been fossil fuels, but the opportunities for reducing energy usage have never been greater. Moreover, as our cover story (page 44) explains, in the industrial and commercial refrigeration industry there are numerous energy-saving techniques that are low or even no cost.

Simply by tweaking the temperature and pressure dynamics of a refrigeration system and its interaction with the environment, one can improve that system's efficiency, thereby cutting operating costs.

In some instances, investments would need to be made in efficiency-enhancing technology like VFDs and controls, but the return on those costs is often very favorable.

What is especially promising is the emergence of "smart" controls that give real-time feedback on performance so that adjustments can be made immediately to maximize efficiency. In this issue we have two good examples of how this works.

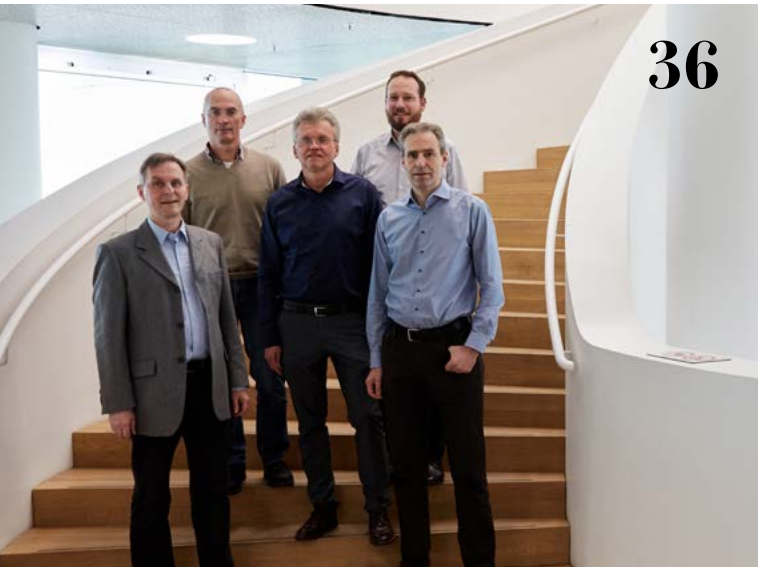
The Canadian ice rink industry has launched a website – smartrinkconnect.ca – that features 200 products from several suppliers, most of which are enhanced by IoT (internet of things) "smart screen" technology that provides technicians with actionable performance data. (Page 20.) And industrial OEM Azane has equipped its new low-charge ammonia chiller with Ethos, a performance-optimization and energy-monitoring system. (Page 34.)

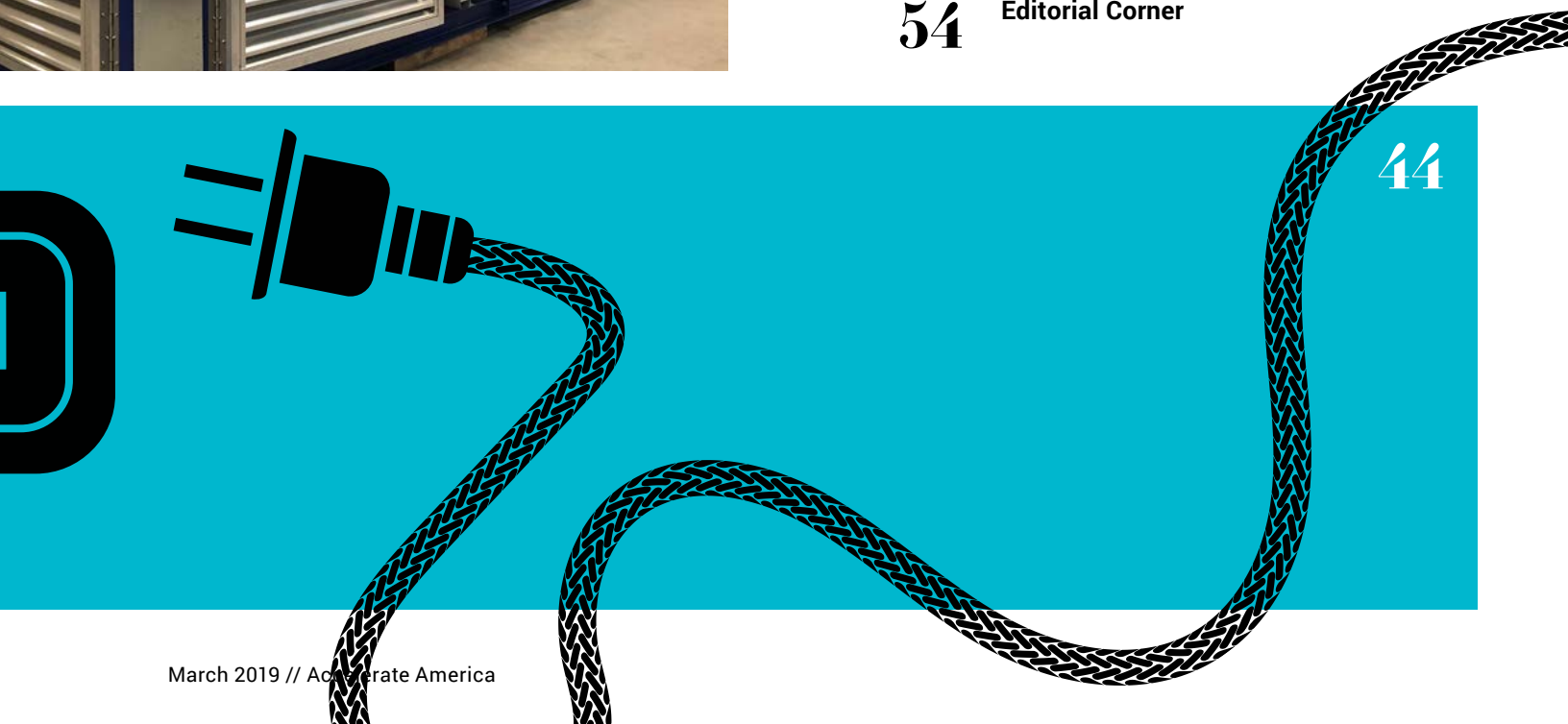
While the means are available to slash energy usage, it's still incumbent upon corporate leadership to take advantage of these opportunities. This may involve facing down traditionalists who prefer an energy-wasting status quo.

But with the right mindset, there is plenty of low-hanging fruit to be grabbed. ■ MG

Michael Garry
Editor

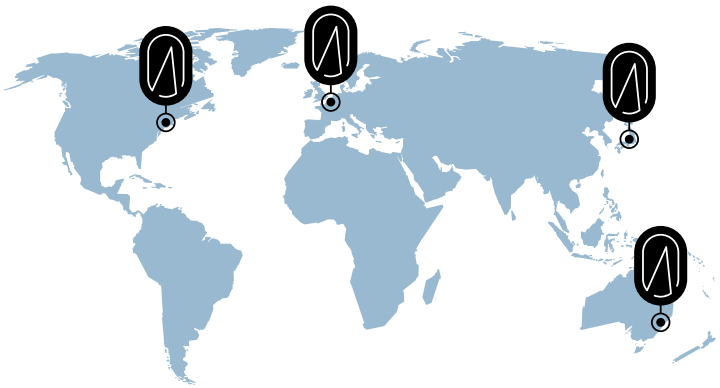
In this issue





MARCH 2019

ACCELERATE
ADVANCING HVAC&R NATURALLY
AMERICA



About *Accelerate America*

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

http://acceleratena.com

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

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Accelerate America
March 2019
// Volume 5, Issue #43

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LETTERS TO THE EDITOR

SELF-CONTAINED: A MATURE SYSTEM

Your January 2019 cover story ("R290: The Future of Retail Refrigeration?" *Accelerate America*, January 2019) was an interesting discussion of the application of a remote central closed-loop fluid chiller to remove heat from water/glycol that is used to cool condensers in distributed refrigeration units throughout a food retail facility.

Certainly the use of R290 at each refrigerated display case's condensing unit is relatively new. However, except for the R290 refrigerant, this system configuration is a mature solution used to reduce refrigerant piping, operating refrigerant charges and associated unintentional refrigerant releases.

I was director of facility engineering for thirty years at Giant Food of Landover, Md., which is now an Ahold/Delhaize brand similar to Hannaford Supermarkets. In 2000, we designed and installed the industry's first remote air-cooled R404A fluid chiller with distributed low-temperature refrigerated display cases during a major remodel of a Springfield, Va., store, which continues to operate today. At Giant we referred to this system configuration as distributed "near-self-contained" (NSC) refrigerated display cases. The near-self-contained R404A cases were factory-charged and operated by the manufacturer before they were shipped to the job site.

The remote fluid chiller with integral water/glycol circulating pumps was preinstalled in a compressor room, including all supply and return piping (main and branch), complete with station shut-off valves throughout the store. Flexible clear reinforced PVC tubing jumpers connected the cases to the in-place individual station piping. The fluid chiller supplied 50°F water/glycol, which allowed compressor selections at 60°F condensing temperature at the cases.

In addition, an entire near-self-contained store located in Washington, D.C., was constructed in 2004 in the basement level of a high rise building, with the remote fluid chiller located on the second level of an adjacent building; it is also operational today.

Robert E. Bittner II
BEECON PROFSERV
Palm Coast, Fla.

500-G CHARGE LIMIT NEEDED

I concur with Geoff Amos (Letters to the Editor, *Accelerate America*, February 2018) on the seeming dragging of the feet on U.S. approval of a 500-g charge limit for hydrocarbons in commercial refrigeration.

I find it unsettling that the National Fire Protection Association (NFPA) has fully tested hydrocarbons and has a report out, in addition to more than enough data from the International Electrotechnical Commission (IEC) to allow the U.S. to be in step with the rest of the globe. One may only wonder as to which influence has more weight on the code writers.

Who would benefit most from a 300-g charge limit? Might it be those who have developed equipment that has up to three compressors to do the work that could be done by one?

The object is public and personnel safety, not special concerns or those who wish to do smaller kitchen-type units.

When the U.S. refrigeration industry takes the bull by the horns and ensures that qualified people are there to work on higher-charge flammable refrigerants, then end users will be the beneficiaries.

The total cost of ownership on these hydrocarbon fixtures vs. built-up or distributed piped systems is no contest. The smart controls for these fixtures can be accessed via a computer or even a cell phone.

The times are a-changing. Get on board or be left behind.

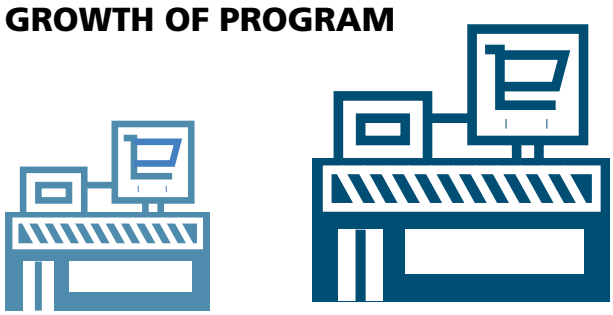
J. A. Kokinda
President/CEO
Professional HVAC/R Services
Avon Lake, Ohio

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.

EPA GreenChill Program: Progress Report*

GROWTH OF PROGRAM



2007
4,508 STORES

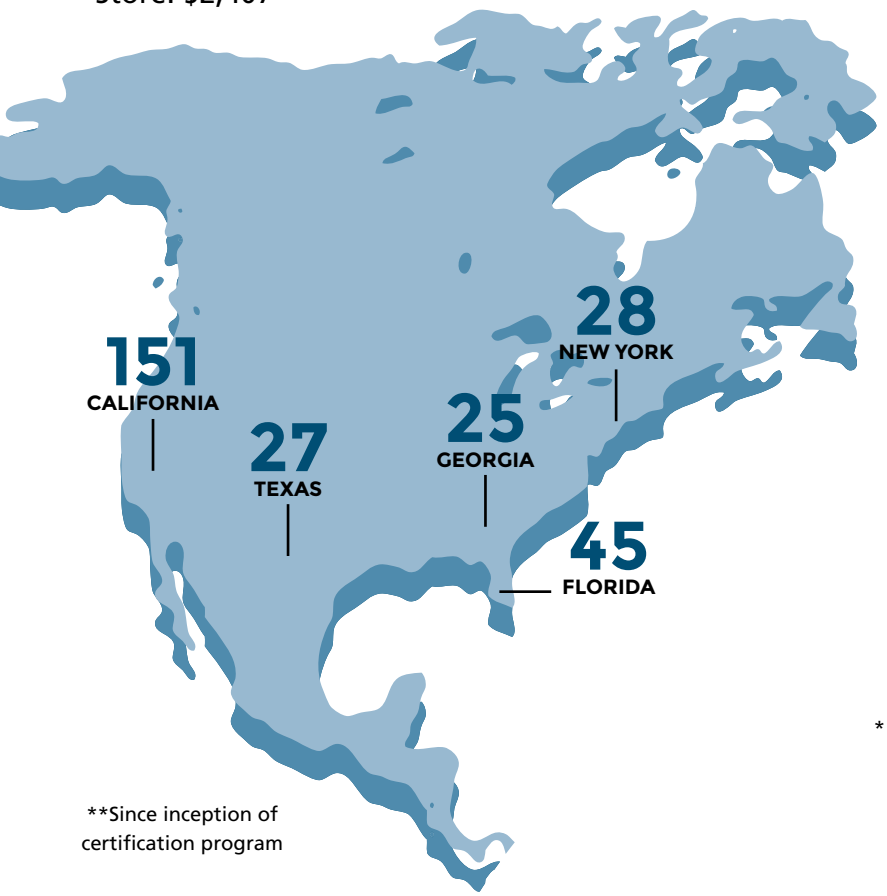
2017
11,257 STORES

GROWTH OF CO_2 INSTALLATIONS (ALL CO_2 SYSTEMS)

Year	CO_2 Charge (lbs)	% of All Refrigerants
2017	101,837	0.42%
2016	55,839	0.24%
2015	35,630	0.15%
2014	26,392	0.11%
2013	16,397	0.10%

STATES WITH MOST GREENCHILL-CERTIFIED STORES**

Annual Cost Savings per Certified Store: $2,407



**Since inception of certification program

REFRIGERANT LEAK CONTROL

11 Number of retail partner companies in 2017 with leak rate under 10%

12.9% Average 2017 corporate leak rate of all retail partners

* All data from Environmental Protection Agency's GreenChill Partnership

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APR

01-04

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

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

https://bit.ly/2L8IpT7

@HPCTweets

02 2PM ET

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

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

https://bit.ly/2DIF77T

@EPAgreenchill

07-10

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

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

https://bit.ly/2HU0Eyq

@gccaorg

16 2PM ET

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

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

https://bit.ly/2UKCNmk

@EPAgreenchill

23 2PM ET

GreenChill Webinar: Retrofit Doors, Online

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

https://bit.ly/2BopXTk

@EPAgreenchill

MAY

06-08

AHRI Spring Meeting, Baltimore, Md.

This event will feature the first meetings of the all-new Industry Sector Leadership Councils, as well as policy updates for members. Several certification, regulatory, and technical working groups will meet to discuss sector- and product-specific issues.

https://bit.ly/2F89ncW

@AHRIEngage

14 2PM ET

GreenChill Webinar. Navigating Technician Shortages: How Service Contractors Are Preparing Staff to Handle New Refrigerants in Advanced Systems, Online

Environmental Protection Agency's GreenChill program hosts webinar featuring Bryan Beitler of Coolsys and a community college representative.

https://bit.ly/2VTMKyi

@EPAgreenchill

18-21

NRA Show 2019, Chicago, Ill.

The 100th anniversary of the National Restaurant Association Show will feature more than 43,000 restaurant industry executives and suppliers, including refrigeration equipment manufacturers.

https://bit.ly/2HuFkgQ

@NatlRestShow

21 2PM ET

GreenChill Webinar. Real-World Applications and Operation of Ammonia/Carbon Dioxide Systems, Online

Environmental Protection Agency's GreenChill program hosts webinar featuring Rob Arthur and Jim Armer of CTA, and food retailers.

https://bit.ly/2TI9xzH

@EPAgreenchill

21-24

North American Rink Conference & Expo, Buffalo, N.Y.

The North American Rink Conference & Expo (NARCE), presented by the United States Ice Rink Association, is an annual meeting of ice rink and ice sport industry professionals. The four-day event will bring together hundreds of ice rink professionals, ice sport national governing body representatives and industry suppliers.

https://bit.ly/2F8MmXb

@usicerinkassoc

AMERICA IN BRIEF

CoolSys Acquires ABC Refrigeration

CoolSys, Brea, Calif., parent company of several HVAC&R outfits, announced March 4 the acquisition of ABC Refrigeration & HVAC, based in East Syracuse, N.Y.

ABC has installed commercial refrigeration equipment for U.S. retail natural refrigerant leaders ALDI, Hannaford and Target.

"The acquisition of ABC is a major milestone for CoolSys, as we continue on our path of expansion throughout the U.S.," said Adam Coffey, CEO of CoolSys, in a statement. "Adding ABC to the CoolSys family establishes our presence in a significant way in the strategically important Northeast region."

CoolSys has previously acquired Source Refrigeration & HVAC, Advanced Refrigeration Systems, Certified Refrigeration & Mechanical (CRM), Legacy Air, RSI, Service Refrigeration and Axiom Energy Solutions.

Source Refrigeration is known for its work with natural refrigerants, including transcritical CO_2 systems, and the installation of the first U.S. ammonia/CO_2 cascade system at an Albertsons store in Carpinteria, Calif.

"Like CoolSys, we take pride in our reputation and strive to ensure that our customers receive the highest standards of service, quality and value by extensively and consistently training our technicians," said Joseph C. Ligoci, owner of ABC. CM

Whirlpool Sues Nidec Over Embraco Deal

White goods manufacturer Whirlpool, based in Benton Harbor, Mich., initiated a lawsuit in the United States District Court for the Southern District of New York against Japanese company Nidec over an alleged "breach of its obligations" in Nidec's stock-based acquisition of Embraco from Whirlpool last year.

Nidec is required under the stock purchase agreement (SPA) to obtain antitrust approval for the Embraco acquisition within a year of announcing the acquisition on April 24, 2018. The acquisition permits the SPA to close six months after this deadline.

The transaction, according to S&P Global, has antitrust authorization from regulators in the U.S., Brazil and China but has hit speed bumps in Europe.

In November 2018, the European Commission announced an "in-depth investigation" into the deal on the grounds that it could create an unfair marketplace for light-commercial compressors.

The commission has until May 20, 2019 to make a ruling.

Nidec "believes the claims to be without merit and intends to vigorously defend the action," the company said, adding that it remains focused on completing the transaction. CM

'Yes' Vote on HC Charge Gets Widespread Push

NGOs and companies throughout Europe and the United States called on national representatives in the International Electrotechnical Commission (IEC) to vote "yes" in the final IEC vote on whether to increase the charge limit on A3 (flammable) refrigerants in commercial refrigeration to 500g.

The vote is slated to close April 12.

IEC standard 60335-2-89 currently limits the charge of flammable refrigerants such as propane and isobutane in hermetically sealed commercial refrigeration equipment with an incorporated or remote refrigerant unit or compressor to 150 g.

"An important vote concerning climate-friendly alternatives to fluorinated gases has started on 1 March," said ECOS (European Environmental Citizens' Organization for Standardization) in a position paper co-signed by NGOs and industry in early March. "National representatives have now six weeks to decide whether to allow larger quantities of climate-friendly flammable refrigerants in commercial refrigeration."

The signatories urge the national committees "to vote positively and support the standard."

Along with ECOS, the NGO signatories included the North American Sustainable Refrigeration Council (NASRC), the Environmental Investigation Agency (EIA), Climate Advisors Network, ECODES (Foundation Ecology and Development), HEAT International GmbH, Legambiente, and ZERO Portugal.

HVAC&R manufacturers AIT Deutschland GmbH and NIBE also co-signed with shecco, the publisher of *Accelerate America*. shecco coordinates LIFE FRONT, an EU-funded project aimed at removing barriers posed by standards for flammable refrigerants in refrigeration, air conditioning and heat pump (RACHP) applications. CM

China Cuts 280,000 Metric Tons of ODS

China announced on March 19 that it had phased out a total of 280,000 metric tons of ozone-depleting substances (ODS), according to Chinese news publication *Xinhua Net*.

The announcement was made by the Ministry of Ecology and Environment at a Montreal Protocol implementation capacity building seminar held in Beijing from March 18-19, according to *Xinhua Net*.

Last November, the Environmental Investigation Agency (EIA), based in Washington, D.C., issued a report on the potential impact of ozone-depleting CFC-11 use in China.

"The Chinese government has no tolerance for any illegal production of ODS," said Guo Jing, a senior official from the Ministry of Ecology and Environment, according to *Xinhua Net*.

Jing referenced China's special ODS law enforcement campaign announced in July of last year, which said that "enterprises (or individuals) suspected of producing and selling [ODS] will be seriously investigated and punished." DY

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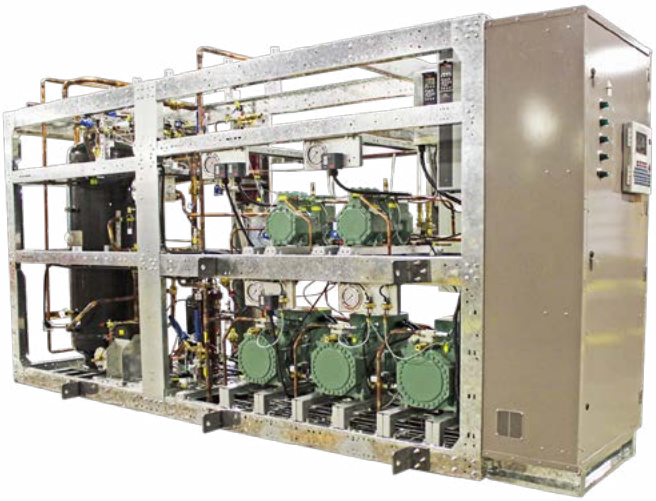
AMMONIA/CO2 CASCADE



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The High Cost of Refrigerant Leaks

Leak detection and prevention are an economic and environmental necessity

– By Jason Ayres

As the cost of refrigerants has increased dramatically during the past several years, leak detection and prevention have become a high priority for supermarkets, large chilling plants, food processing and cold storage facilities, and large air conditioning installations.

Since 2017, the cost of hydrofluorocarbon (HFC) refrigerants has increased between 275%-700%, especially in the EU, which has imposed f-gas regulations based on the global warming potential (GWP) of these gases. The older refrigerants with a high GWP are being gradually phased out in favor of newer compounds with a lower GWP. These newer refrigerants carry a CO_2- equivalent much lower than the compounds they replace. But as a result, the upward trend of refrigerant prices is expected to continue worldwide.

With these ongoing price increases, the cost of replacing leaked refrigerants – not to mention the cost of lost inventory, increased utility consumption, damaged or overworked equipment and potential fines from regulators – far outweighs the cost of the technician's time to locate and repair these leaks.

Given these high costs, a proactive leak detection program can significantly benefit the bottom line. The average refrigerant leak rate for a grocery store is estimated to be about 25% per year, but a best practices implementation can reduce that rate to 7% per year. That means the return on investment (ROI) can be realized in a matter of months rather than years.

Refrigerant leaks are not only costly, they can also be hazardous under certain conditions. ASHRAE Section 8.11.2.1 deals with the safety of personnel who may be inadvertently exposed to harmful gases from a refrigerant leak.

These developments have brought a new focus on a comprehensive refrigerant management strategy incorporating low-level leak detection. And now that the revised Environmental Protection Administration (EPA) Section 608 rules are in effect, it is more important than ever to use a permanent leak detection system that ensures compliance with the latest regulations—or risk fines for failure to comply. (The EPA is looking at rescinding rules that extend Section 608 to HFC refrigerants.)

Dramatic price increases, along with a heightened concern for the environment, safety and regulations, have motivated a significant change in operations strategy. Today, the goal of a refrigerant leak detection program is to find small leaks before they become big and costly problems.

Where do leaks occur?

Where do leaks typically occur in a commercial refrigeration system? Leaks often take place in mechanisms where there are changes in temperature, pressure and vibration, such as valves, pipe joints and compressors. Leaks can also be caused

by poor installation or maintenance procedures. Any device that is poorly restrained or supported within the system can cause leakage. In some instances, leaks can also be caused by unintentional damage by a third party, such as cleaning machines, trucks or forklifts.

It is important to note that the majority of refrigerant loss is due to a number of small leaks that often exist for a very long time, making them more difficult to detect.

In a study of several million leak events, it was discovered that leakage from mechanical joints tends to be progressive, starting small and working their way up to full-blown events. The gradual breakdown of aging equipment also contributes to the failure of mechanical joints and seals, and thus leaks.

Monitoring and tracking

With various types of monitors on the market today, selecting the right one for the installation is a critical first step. These include infrared, semiconductor, electrochemical and catalytic bead options. The most sensitive and reliable type of monitor is infrared, which can detect gas leaks at 1 ppm. They can also be recalibrated to detect new gases as old ones are phased out.

While most applications have some form of leak detection, the question is whether the system is adequate. A proactive leak management program should include the correct type of detection technology coupled with a comprehensive remote monitoring and refrigerant tracking system in order to detect and repair leaks as early as possible. Each event should be weighted by its status: Alert, Alarm or Critical.

State-of-the-art systems include continuous monitoring with multi-party alerts that can be accessed from any location. The latest refrigerant management software can also determine patterns showing which asset is typically the cause of the leak. The availability of this data can have a strong impact on the overall energy efficiency and effectiveness of the refrigeration system, and define its long-term performance. In addition, the data acts as an early warning of a pending increased use of refrigerant.

The goal is to get and keep a low leak rate and to respond to leak events detected by the monitor quickly and effectively.

For permanent monitoring, aspirated multi-point leak detection systems can continuously monitor up to 16 locations across the refrigeration system, and for larger installations, monitors can be networked together. Also available are smaller monitors for less complex installations.

As refrigerant prices continue to spiral upward and new environmental and safety regulations are introduced, the long-term success of the enterprise will no doubt call for a proactive refrigerant management program that can lower costs, reduce utility consumption and help protect the environment. JA

Jason Ayres is an application support engineer at Parasense, a Bacharach Company. He has 25 years of experience delivering Parasense hardware and software solutions for customers covering refrigerant-gas detection, refrigerant-reduction strategies, energy monitoring and energy-reduction programs. He is primarily focused on the food retail sectors in the U.K., Europe and North America.

GREENCHILL REPORTS GROWTH IN CO_2 SYSTEMS AT U.S. SUPERMARKETS

But CO_2 refrigerant was still only 0.42% by weight in 2017 across 11,257 stores in EPA program

– By Charlotte McLaughlin and Michael Garry

Installations of CO_2 systems in U.S. supermarkets participating in the U.S. Environmental Protection Agency's GreenChill Partnership have grown steadily since 2013, reported Tom Land, manager of the program, at the IIAR Natural Refrigeration Conference & Expo, held in Phoenix, Ariz., March 4-6.

Land presented data on the number of lbs of CO_2 installed in all types of CO_2 systems (transcritical, cascade and secondary) between 2013 and 2017. (See Infographic, page 10.) The amount of CO_2 grew to 101,837 lbs in 2017, from 16,397 lbs in 2013. However, the 2017 number still represented just 0.42% by weight of all refrigerants installed by GreenChill stores.

"It's going to take time," said Land, referring to CO_2 system adoption. "It's going to change. These [HFC] systems are put in for 20 years."

The GreenChill Advanced Refrigeration Partnership, launched in 2007, supports leak and charge reduction, and the use of advanced refrigeration technology. In 2017, 11,257 U.S. supermarkets (operated by 41 partners) from all 50 states were in the program, representing about 29% of U.S. stores, up from 4,508 stores (seven partners) in 2007.

GreenChill also awards one-year certification to stores (including those that are not in the program) that meet certain leak and charge criteria (at silver, gold and platinum levels) over a 12-month period running from July 1 to June 30; platinum stores can also be certified for using refrigerants with a GWP under 150. Many stores are recertified after one year, including one Weis Market outlet that has been recertified 10 times at the silver level. GreenChill also has an annual awards program for partners.

ALDI US's impact

Much of the growth in CO_2 refrigeration comes from one retailer, ALDI US, which as of last July had installed 130 transcritical systems. All of these stores were slated to receive platinum certification from the GreenChill program in 2018; according to Land, ALDI US certified 163 stores in 2018 at the platinum level, which accounted for 40% of all certified stores that year.

"Platinum certified stores have exploded principally due to [ALDI US]," Land said.

In a 2018 study of certified stores open at least one year, a total of 196 (from all retailers) used transcritical systems, Land said. Those stores were found to have a high leak rate – 48.3%, which Land attributed to the high pressures under which CO_2 operates; he also noted that the environmental impact of those leaks is negligible given CO_2's GWP of one. However, attendees at Land's presentation pointed out that some of the leaks could be attributed to venting by technicians during maintenance, since recovery of CO_2 is not required.

"I would be interested to know how much is this is due [only] to leaks," he said.

The leak study also revealed that three ammonia/CO_2 cascade systems, all platinum certified, experienced no leaks; for one platinum-certified propane/CO_2 cascade system, no leak data was available.

Overall, GreenChill's retail partners have succeeded in cutting their leak rates for all refrigerants, including HFCs and R22, to an average of 12.9% in 2017, far below industry levels. Eleven partners reported a leak rate under 10% in 2017. The average GreenChill store saved $2,407 annually from leak prevention.

GreenChill is exploring whether to expand the program to small-format retailers like convenience stores, and to industrial refrigeration plants, said Land. ■ CM & MG

CANADIAN RINK EMPLOYS 'SMART' PRODUCTS IN LOW-CHARGE SYSTEM

Outdoor ice rink cuts refrigerant charge by more than 90% with system supplied through Smart Rink Connect

– By Charlotte McLaughlin and Michael Garry

"Smart" low-charge ammonia/glycol system at Covent Garden Market Rotary Rink, London, Ontario

The Covent Garden Market Rotary Rink, an outdoor ice rink in London, Ontario, leveraged a website representing a consortium of refrigeration equipment manufacturers in purchasing a low-charge ammonia/glycol system that reduced its refrigerant charge more than 90%.

The website, Smart Rink Connect (https://www.smartrinkconnect.ca), features 200 products from CIMCO Refrigeration, Mayekawa, Evapco, Alfa Laval, Rink Seal Pro and Dry Solutions. Most of the products are enhanced by IoT (internet of things) "smart screen" technology that provides technicians with real- time, actionable performance data on components and the overall system. The site stresses "efficiency, reliability and safety."

"We've partnered with Alfa Laval, Mycom [Mayekawa], Evapco, Ring Seal Pro and Dry Solutions, and we've created a suite of products called Smart Rink Connect," said Dave Fauser, director of sales, CIMCO Refrigeration at the IIAR Natural Refrigeration Conference & Expo in Phoenix, Ariz., March 4-6. He described the partnership as an "association" of like-minded companies. The site could expand to serve the cold-storage sector, he said.

According to Fauser, the website, launched two years ago, sold 200 units last year and has supplied about 100 ice rinks.

CIMCO's product on the site, "Smart Hub," is a controller for the entire refrigeration system that analyzes data to "keep the plant at maximum efficiency and reliability," said Fauser.

The website allows end users to retrofit systems piecemeal with the technology on the site, noted Benoit Rodier, director of business development, CIMCO, at the IIAR conference.

REPLACING R22

Covent Garden's low-charge (65-lb) ammonia/glycol system, which is owned and managed by the City of London, Ontario, was installed in November 2017, as a replacement for an 18-year-old system with 700 lbs of R22 refrigerant.

The system includes four "smart" products from the website: two Mycom 50-HP compressors, one Alfa Laval chiller and one Alfa Laval plate-and-frame condenser. According to the *London Free Press*, the system cost $450,000.

By providing technicians with performance data on screens, the system is designed to help "employees who are not as confident with refrigeration systems," said Brad Wilkins, CIMCO's team lead for Ontario recreation.

Mike Knowler, technologist for the City of London (Ontario) facilities design and construction group, said in a YouTube video about the Mycom compressors that the smart technology enables his staff to "see problems and anticipate problems coming." He said he has realized simplicity of operation and operational savings including "energy savings we started seeing from day one."

The system will allow the City of London longer intervals between maintenance events, said Wilkins.

Wilkins observed that, after not advancing during his first decade in the business, he "can't believe how much the industry has been evolving over the past two or three years with smart components connecting people with equipment at different levels than before." ■ CM & MG

NH_3 OPERATORS REMINDED OF NEW RMP RULE

Facilities need to coordinate with emergency responders under the EPA's amended Risk Management Plan, though the EPA may change that by summer, says IIAR official

– By Devin Yoshimoto and Michael Garry

Lowell Randel, IIAR

While the U.S. Environmental Protection Agency (EPA) attempts to rescind or modify amendments made by the Obama administration to the agency's Risk Management Plan (RMP), one major compliance deadline has passed, and its requirement is now in effect, reported Lowell Randel, director of government affairs for the International Institute of Ammonia Refrigeration (IIAR).

That requirement calls for operators of refrigeration facilities using more than 10,000 lbs of anhydrous ammonia (among other users of dangerous chemicals) to coordinate with emergency responders, said Randel during his annual government affair update at IIAR's Natural Refrigeration Conference and Expo, held March 4-6 in Phoenix, Ariz. The reminder was as part of a broad overview of IIAR's efforts to reform federal ammonia regulations.

"Be sure you are coordinating [with emergency responders], and document your attempts to coordinate," Randel urged attendees of his session.

Randel noted that some operators may already have an ongoing relationship with emergency responders that has an "annual documentation element to it." But if they don't, "that should be first and foremost in your mind."

A number of other requirements under the Obama RMP amendments rule, including third-party audits, root cause analysis, safer alternatives analysis, emergency response exercises and information sharing with the public, do not take effect until March 2021, he noted.

Meanwhile, the EPA has been engaged in rulemaking since last May to rescind or modify the changes enacted in the amendments rule. The requirements to coordinate with emergency responders and to conduct emergency response exercises would be modified, while third-party audits, root cause analysis and safer alternatives analysis would be rescinded. Information sharing with the public would be mostly rescinded, noted Randel.

"We're actively participating in [the rulemaking process," said Randel. "We've done comments and I've done oral testimony." The EPA has informed him that it expects to have a final rule out "sometime this summer."

The RMP is a longstanding EPA regulation calling for safety measures in plants with dangerous chemicals. The Obama administration's RMP amendments rule, developed after a deadly ammonia fertilizer explosion in 2013, was published January 13, 2017, shortly before the Trump administration took over.

The rule was delayed three times during 2017 – in January, March and June; in the last delay, the effective date of the rule was extended until February 2019. However, In September 2018, the U.S. Court of Appeals for the District of Columbia changed the effective date to December 3, 2018, at which point the emergency coordination provision would apply.

The emergency coordination provision requires operators to "coordinate and document annual engagement with responders and provide facility emergency information," noted Randel. Operators also need to inform federal and state emergency response agencies about accidental releases, update emergency response plans, and share those plans with employees.

Finally, operators must adopt changes to preventive program provisions, including safety information, hazard review, training, audits, incident investigations, process safety information, and process hazard analysis.

GENERAL DUTY CLAUSE PILOT

On a smaller scale, EPA's Region 1, which covers the Northeastern U.S., is implementing a General Duty Clause pilot program impacting facilities with less than 10,000 lbs of ammonia; these facilities are not subject to the RMP but do fall under the federal government's General Duty Clause, which requires operators to identify hazards and maintain a safe facility.

"The goal is to improve compliance at non-RMP ammonia facilities," said Randel.

Under the pilot, companies with ammonia systems will be queried on whether they have performed a process hazard review, followed by spot checks of facilities. Companies that have failed to perform the review could accept an "expedited settlement agreement," which would include a $5,000 penalty and the completion of the review with assistance from a third-party, among other measures.

Operators of ammonia facilities with 10,000 or more lbs of ammonia are subject to the Department of Homeland Security's Chemical Facility Anti-Terrorism Standards (CFATS) program, which was extended for 15 months in January. Established in 2007, the program calls for measures based on tiers (degree) of risk, including ammonia quantity and proximity to people.

New "risk-tiering" methodology introduced in 2017 started impacting ammonia facilities last year, said Randel. IIAR recently met with DHS to address industry concerns, and identified opportunities for technical consultations and new designs "to minimize risk and CFATS program impact."

THREE TARGETED REFORMS

IIAR is also targeting three areas for federal ammonia regulation reform. The first is an increase in the EPA's reportable quantity threshold for ammonia releases.

Currently the EPA has set a 100-lb release of ammonia as the reportable threshold, or the minimum amount requiring notification of authorities. This amount is for all releases of ammonia whether in liquid or vapor form. The IIAR is seeking to increase the reportable quantity to 500-lbs for aerosol (vapor) releases.

This change, Randel argued, would limit the over-reporting of releases, which he said ties up resources at both the facility where a release occurs and among government agencies and responders.

The IIAR is "very hopeful that the EPA is going to recognize that we have a good and strong case here," he said.

On the other hand, Randel expects no progress with the EPA regarding IIAR's efforts to extend the ammonia-release reporting time requirement. Currently, chemical spills need to be reported within 15 minutes to local, state and national authorities, which Randel argued ties up critical resources in the first few minutes of a release. While maintaining the requirement for local reporting, IIAR would like to extend it to eight hours for the National Response Center.

"Unfortunately, I think this is one where the EPA is going to probably stand firm," he said. "But we're going to keep pushing for it because we recognize that the reportable quantity issue and this one go hand in hand. Maybe we can leverage the fact that they're not going

to move on this issue to help move them on the reportable quantity issue."

IIAR is also seeking to increase the Immediate Danger to Life and Health (IDLH) value for ammonia, currently set at 300 ppm, to 500 ppm, while also allowing the use of air-purifying respirators (APRs) up to 1,000 ppm "for certain time periods for emergency response," said Randel.

The current level "is too low and restricts use of air-purifying respirators (APRs) for critical life safety and emergency shutdown activities during a release," argued Randel.

This is the issue about which Randel is most optimistic. "We're getting a really good sense of momentum with this particular proposal," he said, though a final ruling may be two years away.

Overall, the current political climate is presenting both advantages and disadvantages for ammonia regulation reform.

"Ultimately, we still have an executive branch that has a lot of autonomy and discretion in how it is implementing and enforcing regulations," he said. "So that's why we have an opportunity to review and reform regulations."

HFC confusion

With respect to HFC phase-down policies, the lack of certainty on the federal level is potentially resulting in a patchwork of policies at the state level, Randel said.

Asked if he thinks the EPA will return to regulating HFCs under the SNAP (Significant New Alternatives Policy) program, Randel replied, "Under this administration, it is unlikely, at least in the next year and a half." (The U.S. Court of Appeals was recently asked to review one of the EPA's HFC rules; see sidebar on this page.)

However, Randel noted that U.S. Senate ratification of the global Kigali Amendment to the Montreal Protocol, which established a global HFC phase-down plan, "would provide the authority to move forward with regulating HFCs."

In any event, said Randel, "while the short-term [situation] with the EPA is cloudy at best, I think the long-term national policy and the long-term state policies are going to continue to trend away from HFCs." ■ DY & MG

COURT OF APPEALS ASKED TO REVISIT HFCS RULING

U.S. chemical manufacturers Honeywell International and Chemours, along with the Natural Resources Defense Council, in early March once again asked a three-judge panel of the U.S. Court of Appeals for the District of Columbia Circuit to maintain the Obama-era authority of the U.S. Environmental Protection Agency (EPA) to ban high-GWP HFCs in certain applications.

The action was first reported in *E&E News*.

In August 2017, the same court ruled in the case *Mexichem Fluor, Inc. v. EPA* that the EPA cannot require companies to replace HFCs with low- GWP substances under the agency's 2015 SNAP (Significant New Alternatives Policy) Rule 20. The Court of Appeals declined to reverse its panel's ruling on appeal, and the U.S. Supreme Court later declined to hear the case. The reversal of the SNAP rule has since roiled the U.S. HVAC&R industry.

The new action revisits the 2017 ruling and urges that it not be applied to EPA SNAP Rule 21, issued in 2016.

Under EPA's SNAP Rule 20, HFCs could not be used in a variety of retail food refrigeration applications, motor vehicle air conditioning, certain foam-blowing uses and aerosol propellants after specified dates. Rule 21 extended those bans to other applications, including cold- storage warehouses, certain chillers, household refrigerators and freezers, retail food processing and dispensing equipment, and other foam-blowing uses.

The 2017 ruling by the Court of Appeals, written by Brett Kavanaugh (now on the U.S. Supreme Court), said the EPA's authority only pertained to banning ozone-depleting substances (ODS) and could not be applied to ODS substitutes like HFCs.

According to the *E&E News* report, Thomas Lorenzen, representing the U.S. manufacturers, argued that the original ruling did not account for a provision in the 1994 SNAP regulation stating that "no person may use [an ODS] substitute after the effective date of any rulemaking adding such substitute to the list of unacceptable substitutes."

CALIFORNIA SEEKS INPUT FOR 750-GWP LIMIT ON AC REFRIGERANTS

CARB meeting addresses definition of 'new equipment' and whether chillers should be included in regs

— By Marie Battesti and Michael Garry

In a technical working group meeting in March, the California Air Resources Board (CARB) sought input from industry stakeholders on a proposal to cap the GWP of refrigerants in stationary air-conditioning equipment to 750 starting January 1, 2023.

Among the topics discussed at the March 6 meeting were whether CARB should set a GWP limit for chillers; how "new equipment" should be defined; and what mechanisms best support enforcement.

In 2017, California determined that commercial air conditioning accounts for 18% of HFC emissions while residential air conditioning generates 16%. (See chart.)

California has already taken a number of steps toward regulating the use of high-GWP HFC refrigerants in order to meet its mandate of cutting HFCs by 40% below 2013 levels by 2030. For example, in March 2017, CARB approved an SLCP (Short-Lived Climate Pollutant) Strategy), which includes cutting HFCs.

And last year, the state passed legislation called the California Cooling Act that adopted the U.S. Environmental Protection Agency's SNAP Rules 20 and 21 by reference, with the exception of motor vehicle air-conditioning. SNAP rules 20 and 21 include bans on high-GWP HFCs in a variety of applications by certain dates.

The SLCP Strategy allows CARB to set more stringent regulations than the SNAP bans adopted in the California Cooling Act, including a 750-GWP cap on refrigerants (two or more lbs) in stationary ACs, and a 150-GWP cap on refrigerants (50 or more lbs) in new stationary refrigeration beginning in 2022.

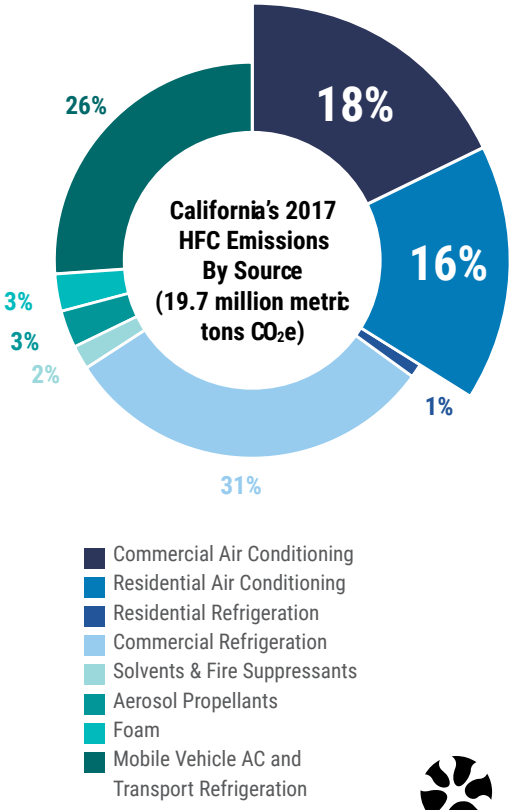
ACs that would be covered by the 750-GWP cap include room and portable units, packaged terminal ACs and heat pumps, commercial ACs and heat pumps, computer room ACs, among other AC types.

The 750-GWP cap for ACs was endorsed in a letter last year to CARB from an industry coalition and the National Resources Defense Council. Manufacturer Emerson (not in the letter) expects CARB to announce a final regulation on ACs by the end of 2019.

WHAT ABOUT CHILLERS?

Though used in commercial air conditioning, chillers were not included In CARB's original AC plans, though SNAP rule 21 includes bans on high-GWP refrigerants (such as R410A and R134a) in a variety of new chiller types by 2024. At the March 6 meeting, CARB raised whether to set a GWP limit, such as 750, for particular chiller types by 2024 (as opposed to 2023 for the rest of AC applications).

"We want to set a GWP limit for chillers for 2024," said Kathryn Kynett, CARB's air pollution specialist during the meeting. "It is hard to predict what may happen with HFCs in future [EPA] approvals. That is why we're asking what type of chillers may not be able to [achieve] that 750-GWP limit."



Source: CARB

CARB estimated that AC equipment under the new regulations would cost up to 15% more to purchase, ranging from 0-1% for room/portable equipment to 5-15% for commercial ACs and heat pumps. Installation costs were estimated to go up 5%-10%.

The CARB meeting also addressed whether "new AC equipment" should be defined as only new construction or also modified systems – such as when major components are replaced or added, or when a certain cost threshold is passed.

Also considered was the type of mechanism that would best support enforcement, including labelling, disclosure, recordkeeping and reporting. ■ MB & MG

IIAR'S NEW NATURAL REFRIGERANT SAFETY STANDARDS

A CO_2 standard is out for review; work on a hydrocarbon standard is underway

– By Michael Garry

Expanding from its longtime focus on ammonia, the International Institute of Ammonia Refrigeration (IIAR) released a 128-page safety standard for CO_2 systems on March 1 on its website, and has begun work on a safety standard for hydrocarbons.

Both standard apply to central commercial and industrial systems.

IIAR is seeking comments on the CO_2 standard during an initial public review period that ends on April 15. Interested parties can access a draft of the standard and submit comments at https://bit.ly/2tUgU8t.

IIAR identified a "need to provide this resource to the industry at this time," said John Collins, industrial sales manager for Zero Zone and chairman of the IIAR's CO_2 Committee. The official name of the standard is the "Safety Standard for Closed-Circuit Carbon Dioxide Refrigeration Systems."

Collins spoke about the standard at a session on commercial standards at the 2019 IIAR Natural Refrigeration Conference & Expo, held in Phoenix March 4-6.

The standard is "limited to the minimum requirements for providing safe [CO_2] systems," noted Collins, adding that it is not reflective of best practices. It is also intended to serve as a basis for model code compliance.

The standard covers all phases of CO_2 system's lifecycle, from design, installation and start-up to inspection, testing and maintenance. It encompasses the CO_2 portion of a cascade system, systems using CO_2 as a secondary fluid, systems operating part- or full-time in the transcritical cycle, and heat pumps.

John Collins, Zero Zone

Low-temperature propane chillers on roof of Whole Foods Market in Santa Clara, Calif.

The standard addresses areas "where our industry has been lacking in clear and consistent guidance," such as installation and start-up requirements as well as inspection, testing and maintenance, said Collins.

IIAR standards typically go through two or more iterations of public review, said Collins. Following review, the standard is evaluated by a consensus body of stakeholders, voted on by the IIAR Standards Committee and submitted for approval to the IIAR board and the American National Standards Institute (ANSI), after which it would be published.

Publication of the standard "is where things will get interesting," said Collins. "How the standard is received and used in the coming years is to be determined."

Hydrocarbon effort underway

IIAR has started work on a safety standard for hydrocarbon refrigerants in commercial and industrial applications, including chillers and heat pumps.

Though traditionally focused on ammonia, IIAR "is fully capable of developing ANSI-approved safety standards for hydrocarbons," said Bruce Nelson, president of Colmac Coil Manufacturing, and chairman of an IIAR task force that looked into developing a hydrocarbon standard last year. "A hydrocarbon safety standard – which is needed and missing – fits our mission to make the world a safer place."

Nelson, who is the new IIAR chair, gave an update on the hydrocarbon standard at the IIAR Natural Refrigeration Conference & Expo. He said the standard work was "underway."

The IIAR standard is officially known as "Design, Installation, start-up, Inspection, Testing and Maintenance of Closed-Circuit Hydrocarbon Refrigeration Systems." The standard will focus on commercial and industrial applications used in engine rooms or outside facilities, "where ventilation and the lower flammability limit can be controlled," said Nelson.

Few centralized propane systems exist in North America. One example is a Whole Foods Market in Santa Clara, Calif., that has been testing a propane/CO_2 system.

Approval last August

The IIAR board approved the formation of committee to work on the hydrocarbon standard last August. Joseph Pillis, director of engineering, industrial refrigeration for Frick, will serve as the commitee's chairman.

The hydrocarbon standard committee "will evaluate existing standards, especially those in Europe," said Pillis.

Because ASHRAE already has a design standard for hydrocarbons, IIAR will be working with ASHRAE's Standard 15 committee "to determine current gaps in their design standard," said Dave Rule, president of IIAR, in an interview last year.

Rule noted that the hydrocarbon standard would not address low-charge (150 g or less) commercial display cases or residential refrigerators. Those "are considered to be covered under UL standards," he said.

An application to the Environmental Protections Agency asking the agency to legalize the use of propane in rack systems is "85% done," said Keilly Witman, owner of KW Refrigerant Management Strategy and former manager of the EPA's GreenChill program.

In terms of a charge limit for rack systems, "EPA like to incorporate industry standards," Witman said. The IIAR hydrocarbon committee will be looking at including a charge limit in its standard, Nelson said.

Nelson ranked hydrocarbons highly as a refrigerant, pointing out that it is very efficient. He cited ASHRAE statistics that listed propane (R290) as having a COP (coefficient of performance) of 5.987 in a refrigeration system at 20°F evaporating and 86°F condensing, just below ammonia's COP of 6.254, and higher than the COPs of R507A (5.564) and R744 (3.514).

Nelson said the price point and ROI for hydrocarbon systems are better than those for ammonia and CO_2. "In my opinion, hydrocarbons are the only natural refrigerants that meet or beat f-gases on first cost and energy efficiency combined," he said.

Another advantage of hydrocarbons is their low liquid density, said Nelson. "They have about half the liquid density that HFCs do. So for the same amount of work, you use half the charge." ■ MG

NAFEM SHOW HIGHLIGHTS: PART 2

The foodservice equipment show continues to showcase the transition to propane (R290) refrigeration, as OEMs grapple with the U.S. market

– By Charlotte McLaughlin, Andrew Williams and Michael Garry

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

Led by True Manufacturing, which has offered R290 display cases for retail and foodservice outlets in North America since 2015, a slew of OEMs showcased their hydrocarbon equipment at the NAFEM Show in 2015, and 2017, including Beverage- Air, Delfield (Welbilt), Minus Forty Technologies, Liebherr, Imbera, SandenVendo America, Arctic Air, and others. (See, "OEMs Flock to Hydrocarbons", *Accelerate America*, March 2017.) And other manufacturers acknowledged being in the process of moving to R290, or at least considering it.

The trend continued at the 2019 NAFEM Show, held February 7-9 in Orlando, Fla., at the Orange County Convention Center. Manufacturers interviewed at the show described the challenges they are facing as they transition to hydrocarbons in this second installment of NAFEM show coverage. (For the first installment, see "NAFEM Show Highlights: Part 1," *Accelerate America*, February 2019.)

SANDENVENDO SEEKS CHANGE IN VENDING MACHINE RULES

SandenVendo, a Japanese OEM with a factory and U.S. subsidiary in Dallas, Texas, is hoping that standards pertaining to the placement of hydrocarbons-based vending machines in public areas will be revised soon.

Those standards significantly impact SandenVendo. The company, which had been using CO_2 as a refrigerant, has transitioned to hydrocarbons in some of its new vending machines.

"We just started and brought our factory online with R290 last month," said Larry Hieb, vice president of engineering, SandenVendo, in an interview at the NAFEM Show. "With California making the switch away from R134a, we built our first production unit as a pilot at the facility last week."

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and Underwriters Laboratories (UL) have standards stating that vending machines using flammable refrigerants are "not intended for use in high traffic environments such as those used for ingress or egress," according to the website VendingMarketWatch.com.

"That means vending machines using R290 as a refrigerant are not allowed in hallways, corridors, lobbies and other currently common locations," Jason Eberstein, director, state and federal affairs for National Automatic Merchandising Association (NAMA), told the vending website.

SandenVendo is hoping the rules will change. "Until the limitation on placement is resolved," said Hieb, "it takes out 50% [of the] units placed in grounds of stadiums or other places."

Lieb said that NAMA is working with industry stakeholders and the standard bodies to allow placement in currently restricted areas. "We do expect eventually the restrictions will be addressed," he said.

In California, which is phasing down HFCs, new vending machines with HFCs cannot be used, supporting the market for hydrocarbon machines. "[In California] the choice right now is R290 or nothing, or they'll find an older unit," Hieb said.

SandeVendo booth at the NAFEM Show

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ARCTIC AIR RESPONDS TO CALIFORNIA

Arctic Air Commercial Freezers & Refrigerators is transitioning to natural refrigerants propane (R290) and isobutane (R600a) to stay ahead of the HFC phase-down curve now being implemented in California and other states, said Walter Broich, the company's president, at the NAFEM Show.

Arctic Air, based in Eden Prairie, Minn., makes refrigerators, freezers and bottle coolers for the foodservice sector. It is adopting hydrocarbons for many of its models – one of numerous OEMs promoting this transition at NAFEM.

The company previously used R404A in freezers and R134a in refrigerators. "As of now, we've transitioned to R290 for everything but reach-in freezers," Broich said.

OEMs had been required to drop R404A and R134a in stand-alone cases by the U.S. Environmental Protection Agency's SNAP (Significant New Alternatives Policy) program Rule 20, but the rule was cancelled following a U.S. Appeals Court decision in 2017. However, California adopted the rule, which went into effect for low-capacity medium-temperature cases January 1 of this year, and will go into effect for low-temperature cases like reach-in freezers in 2020.

Arctic Air has been making the switch to hydrocarbons gradually over the course of 2018 and early 2019, depending on the product category. Its bottle coolers for use in bars switched to propane over a year ago, for example.

What motivated Arctic Air to adopt propane? "We were preparing for new federal requirements, and then California moved first," Broich said. "So we said, 'let's just do it.'"

The company uses isobutane in some of its smaller under-counter freezers.

MINUS FORTY SEES MORE R290 TECHNICIANS

Minus Forty Technologies, a Georgetown, Ontario-based manufacturer of freezer and refrigerated cabinets, believes that the number of technicians trained to handle flammable hydrocarbon refrigerants has increased since the company first released propane products two years ago.

Minus Forty converted its entire portfolio to propane (R290) in 2017 due to new U.S. Department of Energy (DOE) regulations.

"There was a little concern about safety at first for repairs as there was not enough qualified technicians in the field to repair them [in 2017]," said Domenic Ciullo, business development manager, Minus Forty, at the NAFEM Show. "There are much more technicians out there now."

Since March 27, 2017 – which marked the entry into force of tougher DOE standards governing the energy consumption of new stand-alone commercial refrigeration equipment – many U.S. light commercial refrigeration manufacturers have shifted to hydrocarbons.

Ciullo believes much of the concern about propane was overblown at first. "They don't realize [the charge of] propane [is small]. You're taking more risk barbequing next to a 40-pound tank."

The Canadian company has orders for propane equipment from stores, gas station chains, supermarkets, foodservice outlets, and, notably, pet stores. "We pretty much dominate [the pet store] market," Ciullo said. "You name the chain, we sell there."

IMBERA LAUNCHES R290 FOR U.S. FOODSERVICE

Kennesaw, Ga.-based OEM Imbera, a division of Mexico-based Femsa, is "just launching our U.S.-spec [propane] products on the foodservice side," said Brent Parkinson, foodservice commercial director, Imbera, at the NAFEM Show.

The company has already converted its entire commercial refrigeration portfolio to propane except for three models, one of which is a reach-in freezer. "Almost all our equipment is R290- based," he said. "We're 99% there,"

Imbera R290 refrigerator at the NAFEM Show

Imbera, which operates all over the world, is not new to hydrocarbons. "We've been supplying hydrocarbon-based models in Europe for over 15 years," said Parkinson.

He suggested that this experience could give Imbera competitive advantages in terms of energy efficiency and performance over U.S.-based OEMs that may be using hydrocarbons for the first time.

Outside the United States, Imbera is a major supplier of hydrocarbon-based bottle coolers, counting Heineken among its customers. In 2017, the company announced it was tweaking its cooler design to ensure that its hydrocarbon models met ENERGY STAR 4.0 and U.S. Department of Energy efficiency standards.

It also supplies hydrocarbon-based bottle coolers to the Coca- Cola Company. "Coca Cola challenged us to get the charge down below 150 g," said Parkinson, alluding to Imbera's double-door model whose charge is 105g.

"With our engineering efficiency, we don't need to go above 150 g except in a few scenarios, such as walk-ins," he stated. ■ CM, AW & MG

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AMMONIA AND CO_2 SHARE IIAR STAGE

The IIAR Natural Refrigeration show featured a mix of ammonia and CO_2 systems, including a Heatcraft transcritical unit and Azane's new low-charge chiller

– By Michael Garry

The International Institute of Ammonia Refrigeration (IIAR)'s Natural Refrigeration Conference & Expo, traditionally focused on ammonia, has grown over the past few years to include more and more CO_2 systems.

This year's event, held in Phoenix March 4-6, expanded upon that trend by featuring more CO_2-related educational sessions and CO_2 equipment on the show floor. An example of that was an industrial transcritical system from Heatcraft Worldwide Refrigeration.

Azane's updated low-charge freezer was one of many low-charge systems on display.

HEATCRAFT'S FIRST TRANSCRITICAL SYSTEM

Heatcraft Wordwide Refrigeration has installed its first transcritical CO_2 system for cold storage at a new cheese processing plant in Wisconsin, the company said at the 2019 IIAR Natural Refrigeration Conference and Expo.

"The contractor wanted to go natural" – though this was the contractor's first transcritical project – and brought the idea to the cheese processing company, said Grady McAdams, director of cold storage sales for Heatcraft, based in Stone Mountain, Ga. "[The contractor] saw the future and wanted to be ahead of it." (He declined to identify the companies without their permission.)

Heatcraft showcased an industrial transcritical CO_2 rack at its booth at the IIAR Conference.

The start-up of the transcritical system at the cheese processing plant took place in frigid temperatures (-24°F, with -50°F wind chill) in January. The contractor was impressed with the ability of the system to operate at such low temperatures, said McAdams. "With a lot of HFCs, you can't do that."

The system serves both medium- (35°F) and low-temperature (-10°F) rooms with a capacity of 96 TR and between 800 and 900 lbs of CO_2, said McAdams. It uses a gas cooler to condense the CO_2.

AZANE'S UPDATED LOW-CHARGE FREEZER

Azane Inc, U.K.-based Star Refrigeration's low- charge ammonia manufacturer for the U.S. market, launched the latest version of its packaged low-charge ammonia refrigeration unit, Azanefreezer 2.0, at the IIAR Natural Refrigeration Conference & Expo.

Designed for cold-storage warehousing and food-processing applications, the air cooled Azanefreezer 2.0 will be manufactured in the U.S. The unveiling of the new product range follows the launch of the Azanechiller 2.0 last year.

According to Azane, the Azanefreezer 2.0 reduces ammonia charge by up to 96% compared to traditional ammonia systems, increasing safety and diminishing regulatory burden while avoiding future regulation and the higher running costs of HFC refrigerants.

Azane also touts the efficiency of the system. For example, the company has added a "variable compressor Vi," which "optimizes the Azanefreezer efficiency and brings something totally unique in a distributed system package," said Caleb Nelson, vice president, business development for Azane. "The updated product brings an allowance for an even lower minimum condensing temperature and gives us an exceptionally efficient solution for convertible rooms as well."

"Altogether, we have reduced running costs by 10% at low temperature and by over 20% at chill temperature," said Nelson.

Other physical improvements, he added, "reduce maintenance costs further and extend life-span with the use of stainless steel piping, stainless steel electrical cabinets, and improved insulation systems."

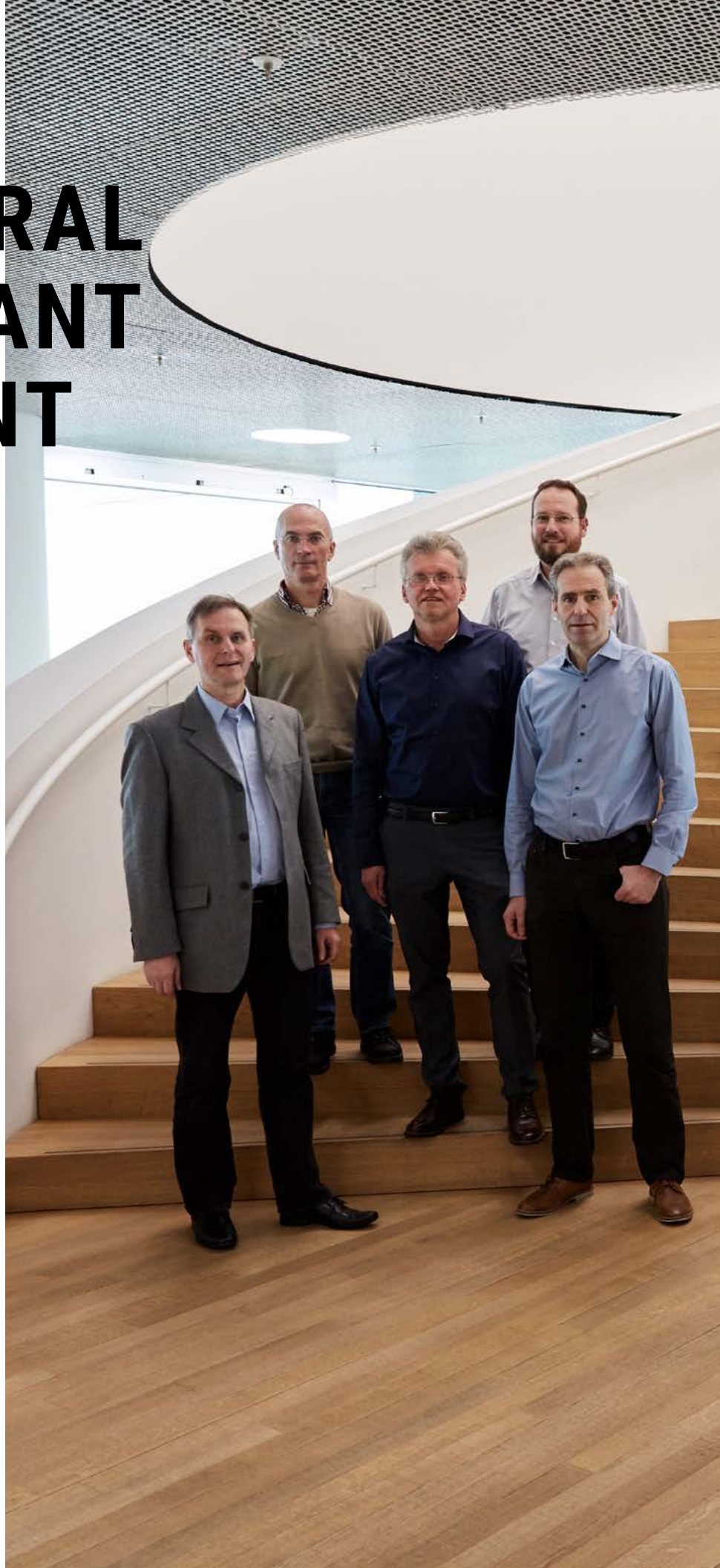
In addition, every Azanefreezer 2.0 and Azanechiller 2.0 now come with Ethos, Star Refrigeration's performance-optimization and energy-monitoring system. The remote monitoring technology monitors output 24 hours a day. ■ MG

Heatcraft's transcritical CO_2 system at the IIAR Conference.

THE NATURAL REFRIGERANT TREATMENT

Biotechnology giant Roche is committed to phasing out halogenated refrigerants. *Accelerate Europe* visited the multinational biotechnology company at its headquarters in Switzerland to hear why natural alternatives are the best medicine for achieving this.

— By Andrew Williams



In the city of Basel, Switzerland, international cooperation is a way of life. Bordering France and Germany on its outermost edges, it is little wonder that the city is an outward-looking place. This easy confidence makes Basel the natural home of multinational biotechnology company F. Hoffmann-La Roche Ltd. (more commonly referred to as Roche), whose high-rise headquarters looks out on all three countries.

The Roche Group, founded in 1896, is split into two divisions – pharmaceuticals and diagnostics. Focusing on oncology, immunology, ophthalmology, infectious diseases and neuroscience, Roche ranks among the world's leading developers of targeted treatments combined with corresponding diagnostics. It is also a leading provider of clinically differentiated medicines. In the U.S., it owns several companies, including biotechnology company Genentech.

All told, Roche Pharmaceuticals is the world's largest biotechnology company and the world's leading provider of cancer treatments.

From left: Roche's Thomas Wolf, Andreas Hug, Joachim Lemberg, Scott Hemphill & Jürg Walder.

Photography by Gabriel Hill

With its global reach, Roche understands the responsibility it shares to help put the world on a more sustainable environmental path. "Eliminating halogenated substances in all areas is a big step to achieving our goals here," Dr. Joachim Lemberg, Roche's head of safety, security, health and environment (SHE) data analysis and reporting, told *Accelerate Europe* (a sister publication to *Accelerate America*) at the company's Basel headquarters.

The Roche Group's commitment to phasing out halogenated refrigerants is governed by the K6 Directive, one of 24 mandatory corporate directives that every part of the Group must follow. Lemberg is part of the team responsible for implementing K6.

Roche is phasing out halogenated refrigerants across its cooling portfolio of laboratory refrigerators, cold storage facilities, walk-in research coolers, stability chambers for product testing, cafeteria equipment, heating, air conditioning, centrifuges, freeze drying, fire suppression systems, packaging foam and data centers.

The company applies the policy of adopting natural refrigerants where reasonably possible to all the above applications.

The K6 Directive guides Roche in discontinuing its use of substances that have a negative impact on the environment caused by ozone depletion, global warming or persistence in the atmosphere with potential long-term negative effects.

"We have a clear target of phasing out these substances 100%," said Thomas Wolf, Roche's chief environmental sustainability officer. "We want to eliminate them completely."

Wolf held Lemberg's position until 2012 and was a key figure in getting Roche's halogenated refrigerant phase-out program off the ground.

"Other companies harbor similar aspirations to ours, but I can't think of another firm that's as progressive in pursuing these goals as us," Wolf said.

The journey began in the early nineties, when Roche decided to put in place a strategy for dealing with ozone-depleting substances (ODS). One trigger was the entry into force on January 1, 1989 of the Montreal Protocol on reducing their production and consumption. Later on, the Kigali Amendment to the Montreal Protocol – which was signed on October 15, 2016, and which entered into force on January 1 of this year – retrospectively confirmed the wisdom of Roche's early move to include HFCs in the global phase down picture.

"We wanted to stay ahead of any potential new legislation in countries around the world," said Lemberg.

The first edition of the K6 Directive was published on September 22, 1994. "This is when we formally adopted the ambition to phase out ozone-depleting substances," Lemberg said.

Roche's primary target was to eliminate ozone-depleting substances: CFCs, HCFCs and HBFCs (hydrobromofluorocarbons) by December 31, 2015, which it nearly achieved. Only small residual amounts were left over, which were then eliminated in 2016.

Starting from 95 metric tons, the Roche Group was then left with 9.5 metric tons of other fluorinated gases (f-gases) – namely HFCs and PFCs (perfluorinated compounds) – in its inventory. By 2018, there were just 7.5 metric tons of f-gases left. The ultimate goal is to eliminate them all.

Hoffmann-La Roche headquarters in Basel, Switzerland.

While Roche sought to replace ODS with alternative solutions like natural refrigerants from day one of the K6 program, in certain cases it installed HVAC&R equipment using HFCs and PFCs as an interim step for business continuity reasons. "But it didn't take long for scientists to discover that fluorinated gases contribute to global warming," Lemberg recalled.

So Roche set its sights on completely eliminating its inventory of halogenated refrigerants. On December 20, 2002, it formally extended the scope of K6 to target a 100% phase out of both substance classes – ODS, and HFCs/PFCs.

When did natural refrigerants come into the picture? Wolf picked up the story. "We began to adopt natural refrigerant systems at the very beginning of the K6 process," he said. "Now we're much stricter about this, after we tightened our approach in the early 2000s."

Scientific uncertainty surrounding the environmental impact of halogenated refrigerants was a key factor influencing Roche's decision to replace them with natural refrigerants.

"We decided to eliminate halogenated refrigerants not just because they damage the ozone layer and contribute to global warming, but also because their ultimate impact on the climate and environment is not yet fully understood," said Jürg Walder, global lead – sustainability in the global technical operations department of Roche's pharmaceutical division.

"As a large company, Roche wants to demonstrate that it's an opinion leader on this," Walder said. "We want to go further than what's required by legislation."

Less than 1% of the Roche Group's greenhouse gas emissions come from halogenated refrigerants in refrigeration and

cooling plants. The majority is attributed to the use of energy and for the most part comprise CO_2, according to the company's latest Sustainability Report.

The precautionary principle

Roche strives to apply the precautionary principle in evaluating different technology options. Its HVAC&R portfolio is no different in this regard.

As HFCs are phased down, some users of HVAC&R technologies are turning to hydrofluoroolefins (HFOs) – the new generation of synthetic refrigerants – as replacements. But HFOs are an issue of concern for some environmental agencies.

In 2017, a report on HFOs by the Norwegian Environment Agency recommended that a number of "knowledge gaps" needed to be addressed before the ultimate effect of the chemical decomposition in the atmosphere of R1234yf into trifluoroacetic acid (TFA) could be determined. It recommended pre-emptively phasing out the refrigerant. Similarly in 2018, Germany's Umweltbundesamt (Federal Environment Agency) warned that TFAs could contaminate the water supply and cannot be removed after contamination has taken place.

Did Roche consider going down the HFO route? Lemberg could not make his opposition any clearer. "No way! We ban them. This is part of our precautionary principle. It's Annex 5 of the K6 Directive," he said.

Walder is keen to offer his own thoughts. "The chemical companies have had some 30 years to develop a new business model," he said. "But every new generation of refrigerants they have come up with has harmed the environment."

He called on synthetic refrigerant makers to develop new business models based on

Roche's CO_2 transcritical double-stage system in Basel, Switzerland.

> **"ELIMINATING HALOGENATED SUBSTANCES IN ALL AREAS IS A BIG STEP TO ACHIEVING OUR SUSTAINABILITY GOALS."**
>
> – Joachim Lemberg, Roche

natural refrigerants instead. “They could involve technology vendors in this, because in most cases, the end user does not buy refrigerants,” he noted.

As Roche moves towards a 100% phase-out of halogenated refrigerants, soon the group will put in place new targets for the period 2020-2025 – perhaps a reduction by a further 20-25%, Lemberg said. “This will be harder to achieve, because the low-hanging fruits have already gone.”

Most of the HCFCs and HFCs in the Roche Group’s inventory are contained in large chillers used in major manufacturing facilities. In some cases, the existing technology is yet to depreciate. “We have to look at the best cost-benefit ratio, which means running them until the end of their lifetimes,” Walder said.

But as natural refrigerants acquire a greater market share, competition between different options is increasing in certain applications. “We use CO2 for cold chambers, ammonia for big chillers, and hydrocarbons for applications both large and small – particularly for air conditioning in office buildings,” said Walder.

The Roche Group’s halogenated refrigerant phase out applies to all acquisitions. All ODS must be removed within five years of an acquisition and all HFCs and PFCs must be eliminated within 10 years. Roche Diagnostics has acquired 11 companies since 2011.

For example, in the U.S., Roche’s halogenated refrigerant phase out is being applied to two major wholly owned subsidiaries, Genentech and diagnostics company Ventana Medical Systems. Roche sought to eliminate ODS from both entities by 2018, and was able to cut the inventory to 2.3 metric tons. By 2022, it wants to reduce non-ozone-depleting substances to 8.3 metric tons.

The K6 Directive also stipulates how Roche Group entities must dispose of equipment. All f-gases must be disposed of by vendors that Roche has approved.

Roche also conducts regular audits on sites around the world to ensure compliance with K5 and other directives.

At Roche, just like in any large company, implementing major change is a complex matter. The challenges range from the financial and organizational to the technical and personal. “We would not be able to achieve our goals without strong governance and commitment,” Lemberg said.

The team is proud of the transformative role that Roche plays in implementing a halogenated refrigerant phase-out program on such a large scale.

“We’re achieving something that’s making a huge contribution to what the company wants to achieve,” says Lemberg. “We can see the outcome, and it’s rewarding.” ■ AW

Parts of a Roche ammonia chiller installation in Basel, Switzerland.

World Guide to CO_2 transcritical refrigeration

- Market analysis • Technology trends
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AJINOMOTO FROZEN FOODS TO ELIMINATE HCFCS BY 2020, HFCS BY 2030

The Ajinomoto Frozen Foods management team (from left): Kazushige Honma, Tomomitsu Yamasaki and Kazumi Yatsugi. Photography by Tomoro Satoro

The Japanese food manufacturer, has been installing natural refrigerant-based HVAC&R systems for nearly a decade as it leads Japanese industry towards a more sustainable future.

— By Devin Yoshimoto, Rena Okabe & Tomoro Sato

Japan's ratification of the Kigali Amendment to the Montreal Protocol in December 2018 gave users of HVAC&R equipment there a clear policy signal to phase down the use of f-gases in their businesses – especially HFCs.

Japanese food manufacturer Ajinomoto Frozen Foods Co., Ltd. has already made significant progress in this regard. It has been retrofitting its facilities with natural refrigerant systems for close to a decade.

Headquartered in Tokyo, Ajinomoto Frozen Foods is a division of Japanese multinational Ajinomoto Co., Inc. — a food and amino science corporation best known for creating the original monosodium glutamate (MSG) product branded 'AJI-NO-MOTO'.

The company markets its products through the Ajinomoto Group, which develops, makes and sells frozen food items in Japan as well as in Europe, Asia and North America.

All told, the company is striving to eliminate the use of HCFCs by 2020 and HFCs by 2030 from all of its domestic frozen and cold storage warehouses.

The transition began in 2006, when the company pledged to completely eliminate its use of R22 in freezer systems in its domestic food processing factories by 2020, instead employing natural refrigerant-based systems.

The move was motivated by increasingly strict regulations on the use of Freon that were put in place in Japan in 2001, as well as the advent of global regulations such as the Montreal Protocol and its subsequent Kigali Amendment.

As of February 2019, the company had converted a total of 24 freezer units to natural refrigerant systems, with six left to be converted by 2020.

Tomomitsu Yamasaki, Ajinomoto Frozen Foods

In addition to food processing freezers, Ajinomoto Frozen Foods also operates frozen and cold storage warehouses, which it has included in its Freon phase-out plan.

The company aims to replace 75 refrigeration systems at cold storage warehouses by 2030, instead adopting natural refrigerants or refrigerants with a GWP value of less than 150.

During a recent tour of one of the company's frozen food processing facilities, Ajinomoto Frozen Foods' Executive Officer Tomomitsu Yamasaki spoke to *Accelerate Japan* (a sister publication to *Accelerate America*) about the role that natural refrigerants play in the firm's sustainability initiatives.

At its food processing facility in Gunma, the company uses NH_3/CO_2 secondary brine refrigeration systems, provided by Japan-based OEM Mayekawa, in the freezing process for several food items it sells, including the Japanese dumplings commonly referred to as "gyoza."

Ajinomoto has also installed transcritical CO_2 systems from Japanese manufacturers Nihon Netsugen Systems (NNS) and Mitsubishi Heavy Industries Thermal Systems Co. Ltd. (MHI) at two of its cold storage facilities in Japan.

Asked about the company's motivation to transition to natural refrigerants, Yamasaki explained that, "by introducing natural refrigerant-based equipment, we have achieved a certain amount of energy efficiency."

But its biggest incentive is to continue taking taking action "until we have completely eliminated our use of Freon," he added.

Government policy has a role to play here. "The production and consumption of HCFCs in Japan will officially be prohibited in 2020," Yamasaki said.

The general attitude within the industry, he noted, is that 'it will be fine even if we do not switch to natural refrigerant equipment just yet.'"

But he sees a threat in continuing to use Freon. "If there is a refrigerant leak, our plant would stop operating and we would cease to function as a frozen food company. To avoid such risks and to sustain ourselves as a company, we are aiming to completely eliminate our use of Freon."

HELP FROM SUBSIDIES

Several of Ajinomoto Frozen Foods' natural refrigerant system installations were supported with subsidies provided by the Japanese Ministry of Environment.

These subsidies are awarded specifically to natural refrigerant system installations in the food retail, food manufacturing and cold storage industries.

The ministry's budget for the 2018 fiscal year was ¥6.4 billion ($53 million). In December, the ministry confirmed that a budget of ¥7.4 billion ($66 million) had been set for financial year 2019.

These subsidies, Yamasaki explains, are especially important for end users in the food manufacturing and cold storage industries, which often see initial costs as the biggest barrier to natural refrigerant adoption.

"In our industry, the profit margins are never high and it is the same even for major companies," said Yamasaki.

"Product prices are low and there are operational costs," he continued. "When adopting natural refrigerant equipment, the initial costs are currently 20% to 30% higher than existing Freon-based systems. For the frozen food industry, which has many small and medium-sized enterprises, not much progress can be made due to these financial concerns."

Yamasaki, however, remains committed to the company's Freon elimination goal.

"It is our single mission to work on the complete elimination of our use of Freon. Although for the past two to three years we've not been able to replace as much as we expected, we're determined to continue. We've made progress with establishing our replacement process and we plan on proceeding with replacing the rest of the equipment at our remaining facilities as planned," he says.

Overseas, the company operates cold storage and food processing facilities in Thailand, China and Poland. The company aims to eliminate the use of HCFCs by 2020 and HFCs by 2030 at these facilities as well.

Ajinomoto Frozen Foods, Yamasaki explains, is keen to spread the word about the benefits of natural refrigerants to the wider world.

"I hope to communicate beyond the industry's borders about our company's future environmental sustainability efforts," said Yamasaki.

"Both our environment and way of life are continuing to be threatened by global warming, as evidenced by the recent increase in natural disasters and various environmental problems," he said.

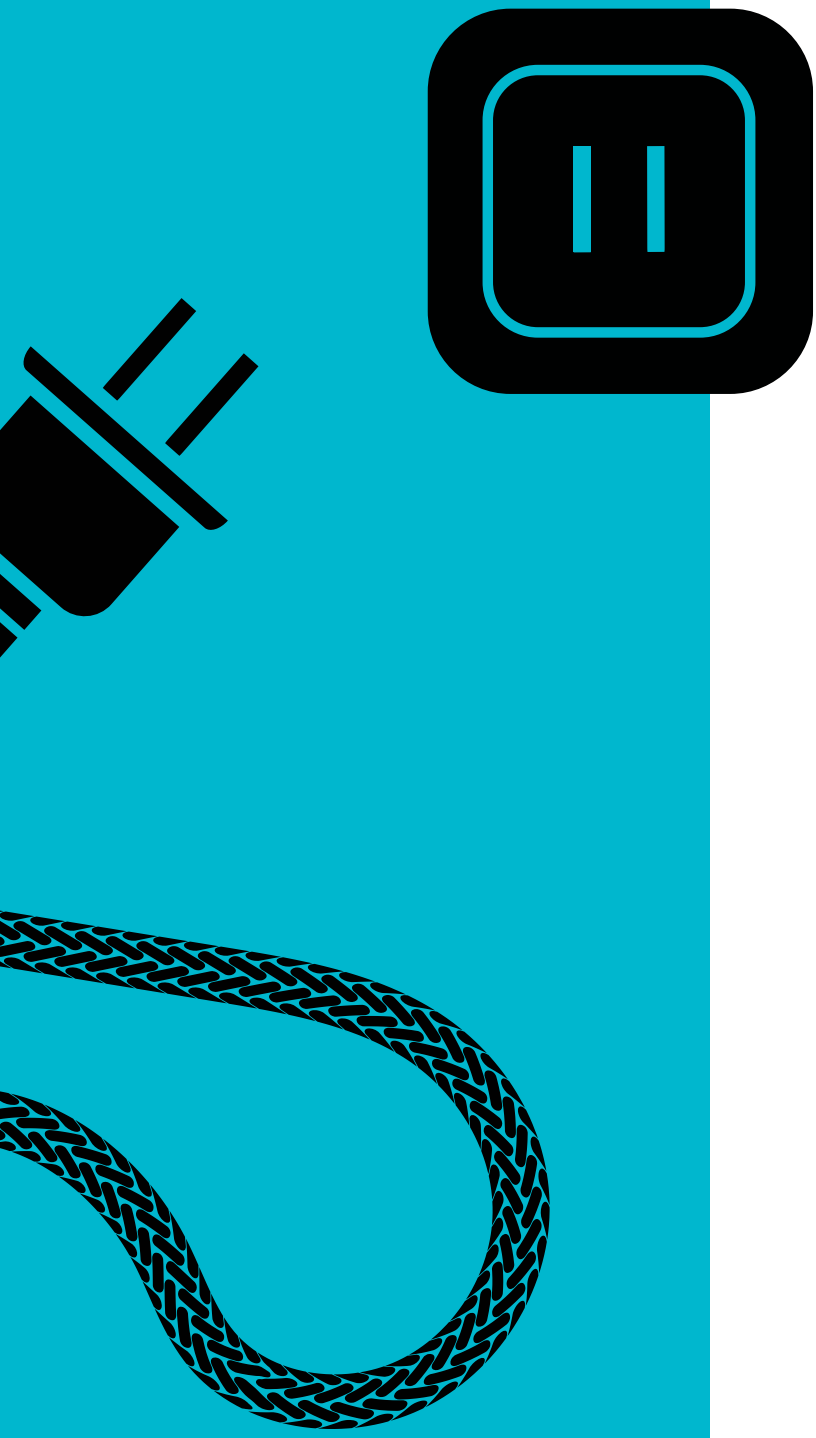
While manufacturers are continuing to pursue technological development, Yamasaki believes end user companies also need to "fulfill their responsibilities" to shift towards using renewable energy and natural refrigerants as effective measures to prevent global warming.

"We intend to lead this industry in this respect," Yamasaki said. ■ DY, RO & TS

HOW TO SAVE MORE ENERGY IN A NATREF SYSTEM

Low- or cost-free changes can cut substantial amounts of energy consumption in industrial and commercial systems, explained experts at the IIAR Conference

– By Michael Garry



In the pursuit of future-proof and sustainable cooling and heating technologies, the refrigerant is often the center of attention – rightfully so, since synthetic refrigerants have been a bane of the environment for decades.

But in terms of greenhouse gas (GHG) emissions, refrigerants (a direct source) are only part of the issue. An even bigger (though indirect) contributor is energy consumption, if the energy is derived from a fossil fuel-based power plant.

According to the International Institute of Refrigeration (IIR), 37% of GHG emissions produced by refrigeration (including air conditioning, heat pumps and cryogenics) come directly from CFCs, HCFCs and HFCs, while 63% come indirectly from energy consumption. (Refrigeration accounts for 7.8% of all GHG emissions.)

From an operating cost perspective, energy is also extremely significant, second only to labor. It therefore behooves end users of refrigeration to make the right choices with respect to managing their energy consumption. “Small changes to a system can produce substantial savings – or loss,” noted Eric Smith, vice president and technical director for the International Institute of Ammonia Refrigeration (IIAR).

While energy efficiency is always a major topic at industry conferences, it was particularly top-of-mind at the IIAR Natural Refrigeration Conference & Expo, held in Phoenix, Ariz., March 4-6.

The IIAR event for the first time devoted its four-hour pre-show Sunday afternoon program to “Energy Efficiency in Natural Refrigeration Systems.” And several other educational sessions and expo exhibits dealt squarely with how to cut energy usage in ammonia and CO_2 equipment.

Some opportunities to save energy require investments in equipment such as compressors with VFDs or better controls. But some improvements are cost-free. “The beauty of industrial refrigeration is there’s a lot you can do with what you have,” said Josh Bachman, director of customer engagement for Cascade Energy, an energy consultancy in Portland, Ore. who spoke at the IIAR energy efficiency educational program. “There are a lot of low- or no- cost ways to save energy.”

Stefan Jensen, managing director for Australian OEM Scantec Refrigeration Technologies, who attended the IIAR Conference, noticed a "new wind blowing" at the conference in regard to interest in energy efficiency.

Energy efficiency is certainly a high priority for new IIAR chair Bruce Nelson, president of Colmac Coil Manufacturing, who would like IIAR to create an Energy and Sustainability Committee.

"If we want to apply good science and really recognize where our carbon footprint comes from, we need to think about the indirect emissions in our systems, not just the direct emissions related to refrigerants," Nelson said in an interview at the IIAR conference.

Nelson plans to appoint a task force to identify the scope of activities and mission of his proposed Energy and Sustainability Committee, and present the results to the IIAR board. So far his idea has been "well received," he said.

He envisions the committee would, among other things, "advocate on the part of the IIAR membership with regard to existing energy codes," such as Title 24 in California.

A PROGRAM, NOT A PROJECT

The natural refrigerants ammonia, hydrocarbons and CO_2 are all regarded as typically contributing to higher energy efficiency compared to many synthetic refrigerants, depending on factors such as ambient temperature and equipment design. Within the natural refrigerants industry, there are varying viewpoints on which natural refrigerant should be used to maximize efficiency (See page 53).

However, there are a number of strategies that can be applied to any system, regardless of refrigerant, to improve efficiency. This articles touches on some that pertain particularly to industrial refrigeration, but could apply in most cases to commercial refrigeration as well.

Bachman urged companies to adopt a "program" rather than a "project" approach to energy management. "You get your best reduction with a program approach – every week and day, like labor," he said.

Sysco, a giant food provider to foodservice operators, launched an energy management program in 2006 to improve energy efficiency "primarily by identifying and implementing more efficient processes and equipment upgrades," said its 2016 Corporate Social Responsibility report.

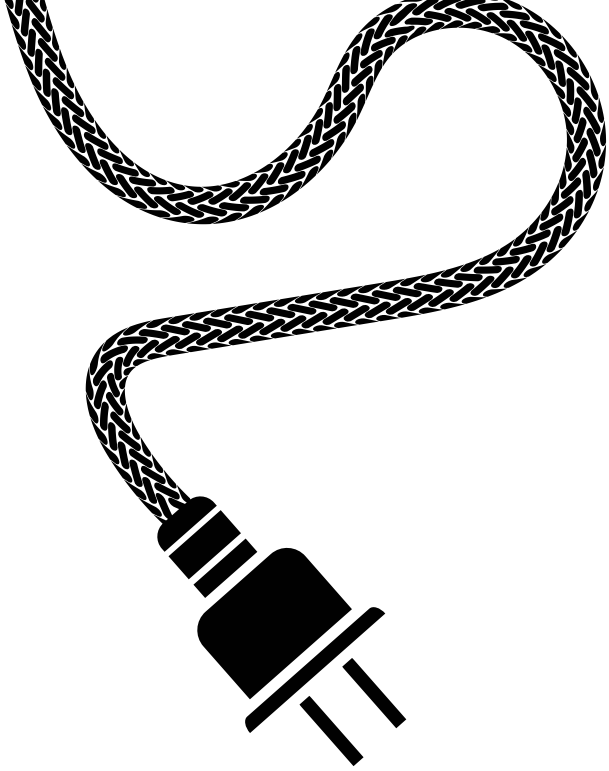
At the end of Sysco's 2016 fiscal year, 108 facilities were included in the program and its energy management initiatives had generated cumulative energy savings of 42% since the baseline year of 2006, achieving more than $200 million in total avoided energy costs. "Over 10 years, there's been a huge savings [at Sysco]," said Bachman.

STEFAN JENSEN
SCANTEC REFRIGERATION TECHNOLOGIES

'BUT THE TEMPERATURE IS JUST FINE'

Doug Scott, president of VaCom Technologies, pointed out seven scenarios where food stays cold but efficiency is still lost:

- Photo eye failed and freezer door does not close automatically.
- Loss of liquid seal.
- Valves fail or stick.
- A valve is installed backward.
- Air (a non-condensable) raises pressure.
- Defrost is set for worst-case conditions.



BRUCE NELSON
COLMAC COIL

Leadership support of the kind manifested at Sysco is the "No 1 metric" for a successful energy management program, said Bachman.

"[Leadership] needs to have clear goals, communicate a vision and create accountability," he said. It may also be necessary to confront "tradition" in order to "make changes and save energy." Technology is about 20% of what's needed while "80% is about leadership and motivation."

In terms of executing an energy management program, Bachman stressed proper training of the "small number of people with their fingers on the switches." Those technicians should know how to "tune" the system to maximize efficiency. They should also track performance but "can't just rely on a utility bill; you need more data than that," he said. Finally, companies should look into capital projects to save energy.

Bachman reminded IIAR attendees that utilities offer funding for energy projects, citing private utilities (Duke Energy and ComEd), public (Bonneville Power Administration and Tennessee Valley Authority) and state (Energy Trust of Oregon and the New Jersey Clean Energy Program).

Utilities can cover more than half the cost of efficiency upgrades, as well as pay for technical assistance, he said. "It's your money, paid through your utility rates. "It's up to you to get your money back – or someone else will!"

BOX OF PARTS

It helps to think of refrigeration systems as a "box of parts," each of which can be adjusted for greater energy performance, said Doug Scott, president of VaCom Technologies, a La Verne, Calif.-based energy consulting company, who also spoke at the IIAR energy efficiency educational program. "The challenge of energy analysis is taking a box of parts and making it run like one system."

Energy in a refrigeration system is roughly consumed in compressors (65%), condensers (15%), evaporators (15%) and refrigerant pumps (5%), according to Bachman.

Efficiency in refrigeration systems is highly sensitive to changes in temperature and pressure. For ammonia systems, an increase of 1°F in the temperature of the suction gas heading back to a compressor produces a compressor efficiency gain (energy savings) of 2%. "That is why we work so hard for a few degrees difference in application conditions," said Scott.

Bachman considers reducing "compressor lift" – by optimally increasing suction pressure/temperature and/or lowering condensing (discharge) pressure/temperature – to be among the best ways to save compressor energy in an industrial or commercial refrigeration system.

"When you raise the suction pressure, the compressor grabs more [refrigerant] gas and you increase capacity," Bachman said. "The power goes up as well, but the capacity goes up more than power." This results in better efficiency.

Often resistance to change keeps the suction pressure where it is. "Nobody questions it," said Bachman. "Does it need to run at three pounds? It's worth investigating." Raising the suction temperature may require nothing more than a "no-cost set-point change," said Bachman.

At the other side of the system, lowering the condensing pressure/temperature reduces the power used by the compressor. In an ammonia system, every 1°F drop in condensing temperature improves compressor efficiency (energy savings) by 1.5%.

However, there are constraints when raising suction or lowering condensing pressures. On the suction side, the suction temperature has to remain lower than the load temperature. Also, when evaporators underperform – because of insufficient pump-out, poor defrost or dirty coils – that will lower the suction pressure.

On the condensing side, the condensing temperature has to be higher than the wet- bulb temperature (for an evaporative condenser) "to make liquid useful for refrigeration," said Bachman.

The use of hot-gas defrost limits the ability to lower condensing pressure, he noted. And as with evaporators, poor condenser performance is also a barrier to lowering condensing pressure. "Condensers usually look worse than evaporators because condensers are usually 'out of sight, out of mind,'" Bachman said. He recommends going up on the roof and checking out the condenser. A thickness of 1/16th of an inch of scale on the coil will reduce a condenser's capacity by 50%, he said.

DOUG SCOTT
VACOM TECHNOLOGIES

THE MAGIC FORMULAE

In ammonia refrigeration:

- 1°F increase in suction temperature = 2% savings in compressor energy usage
- 1°F decrease in condensing temperature = 1.5% savings in compressor energy usage

Fan speed has an especially great impact on power usage because power varies not directly but with the cube of fan speed. As a result, using variable speed on fans can save considerable energy. "If you cut the fan speed in half, you use 1/8 the power," noted Bachman.

Scott uses modeling to determine optimum efficiency conditions in refrigeration components like fans. In one example, a blast freezer used nine evaporator fans operating at 100% capacity along with two compressors, one at 100%, the other at rest.

After a retrofit, the fans were equipped with variable speed, and "we figured out what fan speed would still do freezing for a typical load," said Scott. He found the fans could operate at 70% of their maximum speed – which brought the compressors down to 70% of capacity – and still achieve the needed freezing. But that reduction in speed reduced fan power consumption by 62% and overall power use by 38%.

"A little reduction in fan speed can save a lot of power," said Scott.

A produce plant found that – based on having light average loads and high fan power – that it could run its condenser fans at 45% to gain optimum power usage. "You wouldn't think it could be that low but that's the reason for modeling." said Scott, who also cautioned that modeling should not be considered infallible. "You still have to understand refrigeration."

Scott advised using energy modeling early in the equipment/project decision-making process "when it can optimize capital investment as well as operating cost."

JOSH BACHMAN
CASCADE ENERGY

PART-LOAD OPTIONS

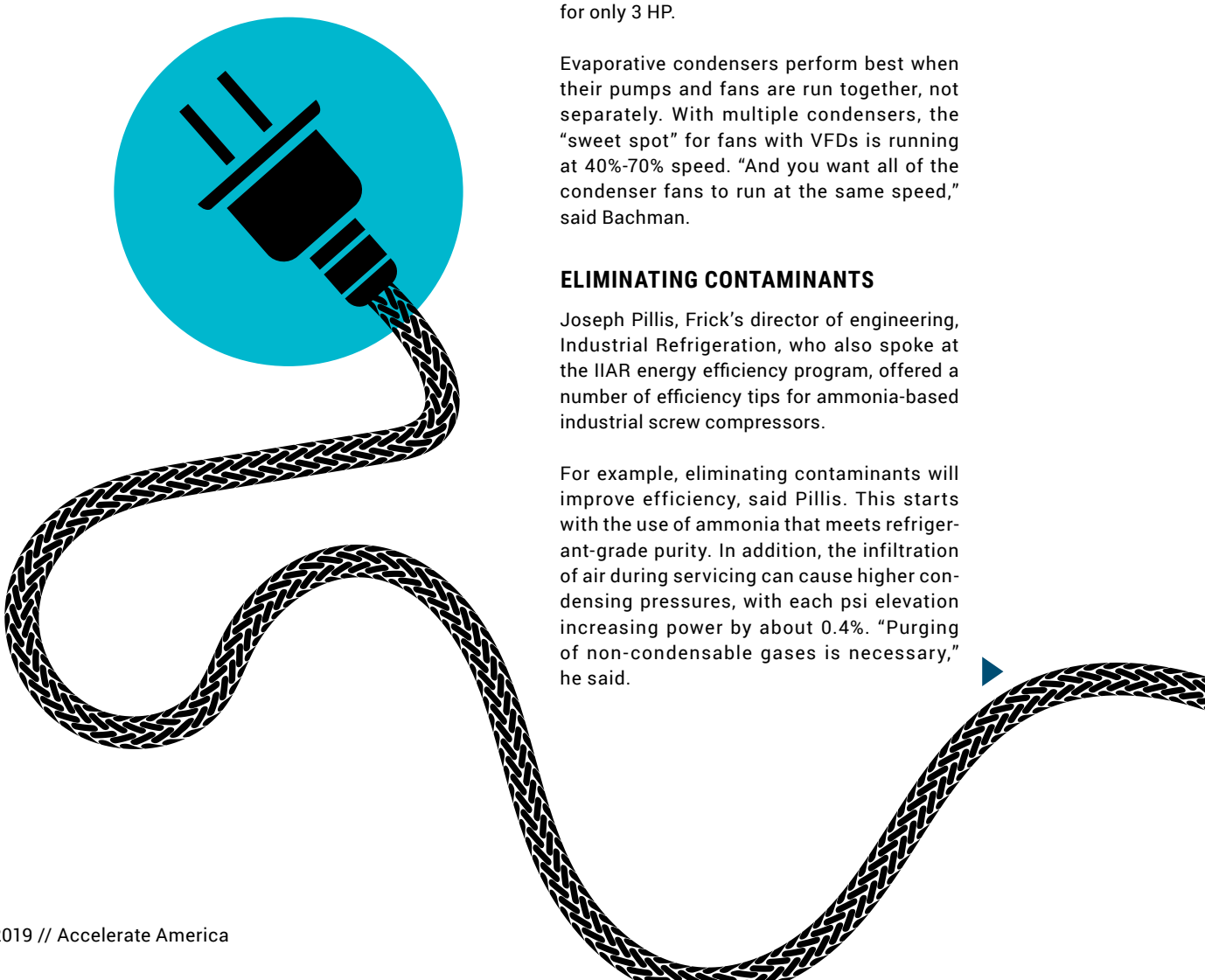
Compressors operate most efficiently at full load. However, full loads are designed for the hottest day of the year so more often compressors will work in part-load conditions.

Running at part loads rather than the less common full load "has major energy implications," Bachman said. He advocates using "your best part-load option."

For a screw compressor, VFD speed control is the most efficient way to operate at part load, said Bachman; slide valves, which are more common, are moderately inefficient. For reciprocating compressors, "cylinder unloading" – from 8 cylinders to 6 or 4 – "is not precise but very efficient," he said. "It's more efficient than screw compressor VFDs."

When running two evaporators at part load, it is more efficient to run them each at 50% capacity than one at 100% and the other at zero, Bachman noted. If the 100%/zero scenario requires 10 HP, the 50%/50% would call for only 3 HP.

Evaporative condensers perform best when their pumps and fans are run together, not separately. With multiple condensers, the "sweet spot" for fans with VFDs is running at 40%-70% speed. "And you want all of the condenser fans to run at the same speed," said Bachman.



ELIMINATING CONTAMINANTS

Joseph Pillis, Frick's director of engineering, Industrial Refrigeration, who also spoke at the IIAR energy efficiency program, offered a number of efficiency tips for ammonia-based industrial screw compressors.

For example, eliminating contaminants will improve efficiency, said Pillis. This starts with the use of ammonia that meets refrigerant-grade purity. In addition, the infiltration of air during servicing can cause higher condensing pressures, with each psi elevation increasing power by about 0.4%. "Purging of non-condensable gases is necessary," he said.

ENERGY-EFFICIENCY TOOLKIT

- Reduce compressor lift
- Cut fan speed
- Optimize part-load conditions
- Eliminate contaminants
- Economize screw compressors

Meanwhile, the ingress of water into the system's low-side vessels may depress suction pressure, Pillis added. "An ammonia regenerator is needed to remove water." The impact of water is greater in DX systems, which are being used more in low-charge ammonia systems, he noted.

Another efficiency factor is superheat's impact on the suction line, Pillis said. Every 10°F of superheat causes a 2.5% drop in efficiency. Conversely, on the liquid side, every 10°F of liquid subcooling improves efficiency by 2.5%. "There's energy saving there if you reject more heat from condensed liquid," he said.

Pillis recommended avoiding oil pumps when possible, observing that a 5-HP pump running for a year at 10 cents/kWh would cost $3,300. "The most efficient oil pump is the one not running," he said.

A significant amount of energy can be saved via heat reclaim in industrial systems. Pillis suggested using a glycol oil cooler for heat reclaim and a thermosyphon oil cooler when not reclaiming heat. The latter, however, adds ammonia charge, and is therefore not being employed in low-charge systems.

One of the advantages of a screw compressor over a reciprocating compressor is that the former is equipped with a secondary suction port for economizing and sideloads.

In economizing, additional gas resulting from subcooling of the condenser liquid flows into the secondary suction port. A sideload is a gas coming from a secondary evaporator at a temperature higher than that of the primary evaporator.

The compression efficiency for the gas coming through the secondary suction port is high "as additional frictional power is small," Pillis said. "It's like a 'frictionless' compressor."

In one example, Pillis said that an economizer resulted in a 19% increase in evaporator capacity compared to a standard single-stage compressor, while using only 9% more power – the "magic part," said Pillis. A two-stage ammonia compressor system is a little more efficient than an economized single-stage compressor, but is more expensive and should be used only for a very low temperature application, he said.

In general, economizing "is a very good way to save energy," said Pillis. ■ MG

JOSEPH PILLIS
FRICK

HOW EFFICIENT IS CO_2?

In June of 2018, Henningsen Cold Storage, Hillsboro, Ore., installed its first transcritical CO_2 system – and one of the first industrial transcritical systems in the U.S. – at a 111,000-sq-ft plant in Grandview, Wash. (See "Taking on Transcritical in Cold Storage," *Accelerate America*, October 2018.)

At the IIAR Natural Refrigeration Conference & Expo, held March 4-6 in Phoenix, Ariz., Pete Lepschat, director of engineering for Henningsen, offered an update on the system's performance so far. He was joined by Chris Herzog, principal, Industrial Refrigeration Equipment Partners.

He provided an energy comparison between the transcritical CO_2 system in Grandview and a very efficient low-charge ammonia system installed at a plant in Salem, Ore., in 2017.

Henningsen's highly efficient facilities average 0.48 kW/cu ft/yr, compared to an IARW industry average of 1.21. The Salem plant is its most efficient, at 0.26, and one of the most efficient in the cold-storage industry.

On a first-cost basis, adjusted for facility size, Henningsen found the cost of construction and refrigeration to be about 6% less at the CO_2 facility, which required 5-6 weeks less construction time.

On an energy basis, the CO_2 facility initially had much higher energy costs than the ammonia facility, owing to the high ambient temperatures experienced from June to August. However, Herzog attributed that also to the late start the Grandview plant got on commissioning, which took place September- October. "Many energy-efficiency measures were not used the first few months," he said.

The efficiency measures ultimately employed at Grandview include: dock dehumidification, evaporator/condenser fan control, hot-gas defrost, gas cooler optimization (with fan controls, floating head pressure and adiabatic cooling), compressor VFDs and a glycol pump VFD. The low humidity in Grandview, Wash., helps the adiabatic process keep the transcritical system under the critical point for CO_2 "almost all of the time," Herzog noted.

In the commissioning of the system, the low-temperature suction setpoint was changed from -25F to -16F. In addition, evaporator fan and gas cooler fan speeds were changed from fixed to modulating.

The projected energy consumption of the CO_2 system, based on "what we're seeing now" with the improvements should be about 20% higher than the Salem low-charge system, said Herzog.

Herzog noted that the Grandview facility uses much less water than the Salem plant. Combining that with energy, the Grandview's plant's operating costs from June through December were about 6% higher than Salem's. This does not yet reflect favorable results for CO_2 during the winter and "a full year of commissioning," said Herzog.

Herzog concluded that "CO_2 efficiency can approach [a very high level of] NH_3 efficiency with proper design features." CO_2 also has greater opportunities for heat recovery, he added.

CO_2 CAVEATS

Meanwhile, in the industrial refrigeration industry at large, a debate has emerged as to which refrigerant – ammonia or CO_2 – is preferable in industrial applications. Following the Henningsen presentation at IIAR, Eric Smith, vice president and technical director for IIAR, commented that the "equation changes" for CO_2 in warmer weather and larger warehouses.

Stefan Jensen, managing director for Australian OEM Scantec Refrigeration Technologies, who attended the IIAR Conference in March, points to the energy performance of a transcritical CO_2 system at a small warehouse in Australia that has been operating for a year. According to Jensen, the specific energy consumption of the system in kWh/cu-m/yr is twice that of an equivalent central low-charge ammonia system located in the same neighborhood.

Scantec has started installing transcritical CO_2 systems, and Jensen said he plans to measure their efficiency.

He acknowledged that for smaller warehouses – lower than 5,000-10,000 cu m – the additional cost of a centralized low-charge ammonia system compared to a transcritical CO_2 system would require "too long a return on investment."

Overall, Jensen believes that system design, more than refrigerant choice, has the greatest impact on energy efficiency. For example, he thinks speed-controlled two-stage reciprocating compressors are more efficient than economized screw compressors. In one example comparing two identical plants, the reciprocating units were 2.5 times as efficient, he said.

MRBRAZ TO INSTALL SIX MORE LOW-CHARGE AMMONIA AC CHILLERS IN 2019

Replacing R22 AC units, the energy-saving NH_3/glycol chillers will cool office space for a major retailer, which is already using 10 of the chillers.

– By Michael Garry

MRBraz ammonia/glycol chiller

MRBraz & Associates, a supplier of industrial refrigeration and air-conditioning (AC) equipment, said that in 2019 it will install low-charge packaged ammonia/glycol DX chillers providing AC for offices at six warehouses operated by a major U.S. retailer.

The company has previously supplied this AC chiller to 10 of the retailer's warehouses since 2012.

"As [the retailer] sees an ROI, they are putting in more in 2019," said Daniel Braz, vice president of operations for MRBraz. (He declined to name the retailer without their permission.) The AC chillers are replacement units for R22 systems that use 180-220 lbs of refrigerant.

Braz spoke about the AC units at the IIAR Natural Refrigeration Conference & Expo, held in Phoenix March 4-6. In 2017, MRBraz displayed the AC unit at the IIAR Conference in San Antonio, Texas.

MRBraz also has two more [low-charge AC chillers] in the manufacturing stage that will be installed the following fiscal year at the retailer's warehouses. "One is in California, and we're excited to see how it goes there," he said, pointing out the new HFC-reduction legislation the state is implementing.

In addition, MRBraz is working with a school district in Houston, Texas, on a plan for a new high school that would use the AC units rather than a synthetic-refrigerant system. A mobile trailer unit is also available.

Low-charge ammonia AC chillers are relatively rare in the U.S. "It's gaining ground, but it takes time to cultivate it and show it works," Braz said. "But legislation and technology are making a fertile ground for natural refrigerants to come into the HVAC space."

Campbell Soup uses a similar AC chiller (from Azane) at a facility in Napoleon, Ohio. (See, "NatRefs for AC," *Accelerate America*, October 2017.)

About 1 lb/TR

MRBraz's skid-mounted AC chiller, stationed in the parking lot outside the retailer's warehouses, is designed with only about 1 lb/TR of ammonia, which is confined to the unit; it pumps a chilled glycol solution as a secondary coolant to an air handling unit, which delivers cool air to the office space.

The typical chiller contains about 100 lbs. of ammonia for 100 TR of capacity, cooling 25,000 sq ft of space. It employs a VFD screw compressor, ECM fan motors, an air-cooled condenser, food grade oil, and an ammonia/glycol heat exchanger with a temperature approach of only 3°F-5°F. The units, available in capacities ranging from 30-110 TR, require a single 180-V power feed.

Braz presented data showing the efficiency benefits of the AC units. He pointed out that ammonia has a lower HP/TR (1.3) than R22 (1.5) and HFCs like R410A (1.7) and R134a (1.5). In one example, the MRBraz AC chiller uses 1.99 HP/TR compared to 2.15 HP/TR for a pre-existing R22 chiller; the COP's were 2.37 and 2.20, respectively. In its first year of operation, the low-charge chiller saved the warehouse about $100,000, which produced a "healthy ROI," said Braz.

MRBraz handles the manufacturing, installation and maintenance of the units – from "cradle to grave," said Braz. It also does performance monitoring for preventive maintenance.

To enhance the safety of the AC units, leaked ammonia is dispersed vertically by fans several hundred ft into the air "where it is not harmful," said Braz. Permits to use the units have been obtained without difficulty from local municipalities, he added.

The company reports no complaints about ammonia leaks in the retailer's parking lots. ■ MG

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