MAY 2017

ACCELERATE

ADVANCING NATURALLY AMERICA

GAME CHANGER

SMUD's NatRef Incentives For Reducing GHG Emissions

ATMOsphere AMERICA Business Case for Natural Refrigerants June 5-7, 2017 / San Diego

ATMOSPHERE AMERICA 2017 PROGRAM P. 8

Experience the **Full Potential** of **CO_2 Solutions**

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20,000
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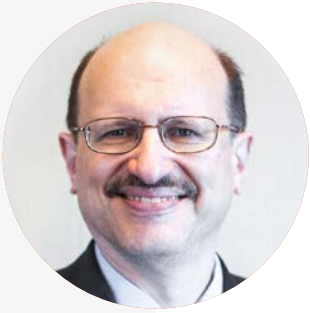


CALIFORNIA

HERE WE COME!

By Michael Garry

As a global company, shecco, publisher of *Accelerate America,* has its eyes trained on natural refrigerant developments throughout the world via this magazine and its three sister *Accelerate* publications in Europe, Japan and Australia, as well as the websites R744.com, Hydrocarbons21.com and Ammonia21.com.

In the two markets where natural refrigerants have gained the most traction – Europe and Japan – the national governments have played a catalytic role. In addition to individual European countries imposing taxes on HFCs while giving tax breaks for natural refrigerant investments, the EU has put into effect an F-Gas Regulation phasing out the use of HFCs. In Japan, the government is phasing down HFCs and providing substantial subsidies for food retail refrigeration systems and display cases using natural refrigerants.

In North America, the U.S. and Canadian governments have contributed through regulations to the uptake of natural refrigerants, but the measures have not been as sweeping as in Europe and Japan (though Canada has proposed a phase-down plan similar to that of Japan and the EU).

Of course, the new Trump administration has shown no interest so far in advancing refrigerant regulations (while deregulating just about everything else), and has yet to voice an opinion on the Kigali amendment to the Montreal Protocol calling for a global phase-down of HFCs.

Fortunately, the most populous state in the U.S., California, is continuing to move forward aggressively with its greenhouse gas reduction plans, as detailed in the January 2017 issue of *Accelerate America*; these efforts will have national implications. The plans include the implementation of a Short-Lived Climate Pollutant (SLCP) Reduction Strategy, which includes a 40% HFC reduction target and a ban on refrigerants with a global warming potential (GWP) of 150 or more.

At shecco's ATMOsphere America conference June 5-7 in San Diego, the California Air Resources Board (CARB) will be holding a special SLCP discussion giving attendees an opportunity to learn about the plan and provide feedback to CARB officials.

Another vehicle for promoting the adoption of natural refrigerant technologies are energy-efficiency incentives from utilities. As a technology that reduces energy consumption compared to legacy equipment, natural refrigerant systems are beginning to earn these incentives. And one utility, the Sacramento Municipal Utility District SMUD), is going a step further. As outlined in our cover story beginning on page 34, SMUD has launched an incentive program that, in addition to funding energy efficiency, also provides dollars for direct greenhouse gas (GHG) emissions reduction.

If SMUD's GHG-reduction incentive program does well in California and catches on with other public and even private utilities, it could be a game-changer, giving natural refrigerant systems, with their zero or near-zero GWPs, the boost they have needed in the U.S. market. A representative of SMUD will be on hand at ATMOsphere America, participating in a panel discussion with other utilities to talk about their incentive programs.

I hope to see many of *Accelerate America's* readers at ATMOsphere America in June. Another way to connect will be through a new letters-to-the editor page we are launching in the next issue. If you'd like to share your views on any of the articles in this issue, please drop me a line at michael.garry@shecco.com. I will be picking a letter of the month, whose author will receive a special prize. I look forward to hearing from you! ■ MG

VOLUME 3, ISSUE #25, MAY 2017

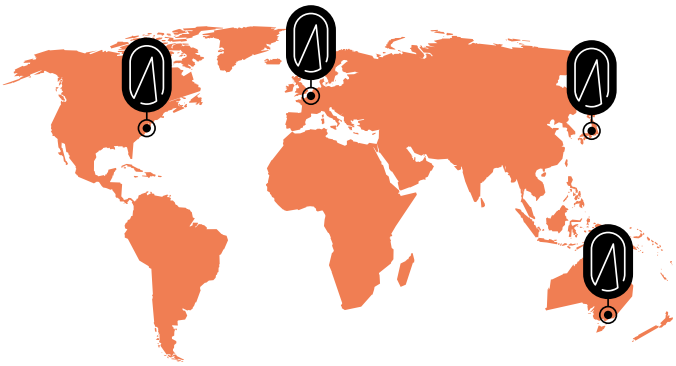
ACCELERATE

ADVANCING HVAC&R NATURALLY AMERICA

About *Accelerate America*

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

http://acceleratena.com



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TRENDS

POLICY

END USER

EVENTS

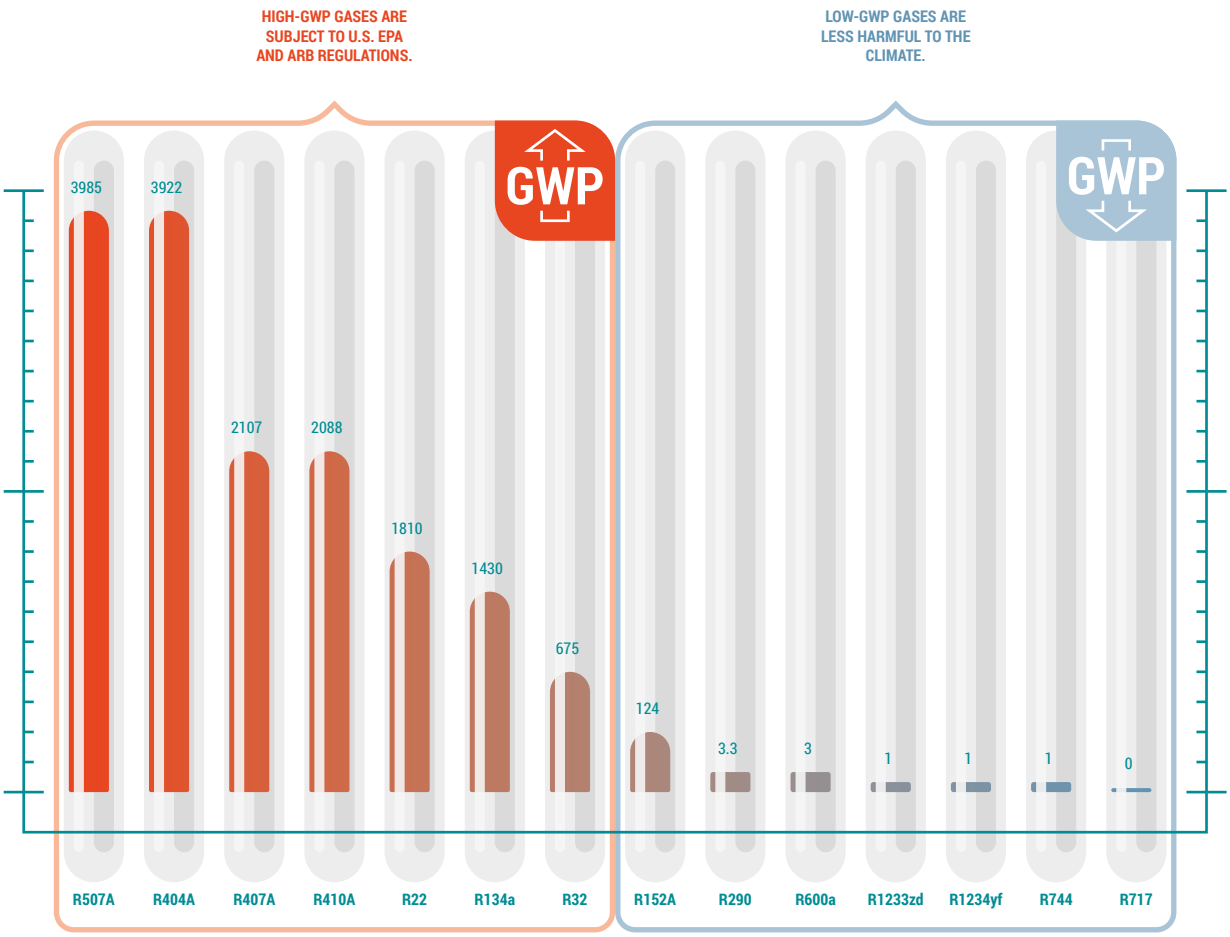
TECHNOLOGY

ABOUT ACCELERATE AMERICA

R22 EQUIPMENT RETROFITS & REPLACEMENTS

R22 production is being phased out by the U.S. EPA. Beginning in 2020, there will be no new production or import of virgin R22 permitted in the United States. HFC replacements for R22 are potent climate-forcing agents and thus increasingly subject to regulations, including national bans.[1]

GLOBAL WARMING POTENTIAL (GWP)[2]



PREPARING FOR THE FUTURE

New low-GWP technologies are advancing rapidly and are available today. In some applications, low-GWP technologies can provide higher energy efficiency.

[1] Certain HFCs are being banned for both retrofits and replacements, but can still be used for maintenance. www.epa.gov/snap

[2] GWP values here indicate climate-forcing impact over a 100-year period relative to that of carbon dioxide, as found in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007), except for R1233zd and R1234yf, obtained from the Fifth Assessment Report.

Visit www.arb.ca.gov/rmp for more information on low-GWP options.

ATMOsphere AMERICA

Business Case for Natural Refrigerants

June 5-7, 2017 / San Diego

MONDAY JUNE 5, 2017

PRE-EVENT WORKSHOPS

9:00 AM Building a Foundation for LongTerm Operational Success with Iternative Systems
1— hour workshop by Heatcraft

10:00 AM Strategies for Expanding Transcritical CO_2 Booster Adoption
2— hour workshop by Emerson

12:00 PM Harness the Full Potential of CO_2 Solutions
1— hour training and Q&A by Danfoss

REGISTRATION AND WELCOME LUNCH

12:30 PM Registration & welcome lunch served in the sponsor exhibition area.

THOUGHT LEADERS PANEL

2:00 PM HVAC&R industry thought leaders discuss their future plans, including their technology needs and the opportunities for natural refrigerant technologies across various applications in North America.

Co-Chairs: Marc Chasserot & Derek Hamilton, shecco

Fernando Campos, Walmart Mexico
Tristam Coffin, Whole Foods Market
Antoine Azar, Sustainable Solutions (Former Coca Cola)
Gerard von Dohlen, Newark Refrigerated Warehouse
Ricardo García, Frialsa
Bryan Beitler, Source Refrigeration
Scott Martin, Hillphoenix
Marc Chasserot, shecco

3:30 PM Networking coffee break

REGULATIONS AND STANDARDS PANEL

4:00 PM Presentations by government representatives and other organizations on the latest regulatory issues and standards regarding natural refrigerants in North America.

Chair: Marc Chasserot, shecco

Glenn Gallagher, CARB
Marek Zgliczynski, Embraco, on behalf of International Electrotechnical Commission
Mark Skierkiewicz, Underwriters Laboratories (UL)
Dave Rule, IIAR
Marc Chasserot, shecco

6:00 PM Drinks and light dinner will be served in the exhibition area, sponsored by Heatcraft.

TUESDAY JUNE 6, 2017

7:30 AM Continental breakfast will be served in the exhibition area.

MARKET TRENDS & OPPORTUNITIES PANEL

8:30 AM Leading North American suppliers will give brief strategic and visionary presentations sharing their latest success stories, lessons learned, challenges and next steps regarding natural refrigerantbased technologies.

Chair: Alvaro de Oña, shecco

Scott Martin, Hillphoenix
Michael Lehtinen, Heatcraft
André Patenaude, Emerson
Jerry Lozano, Güntner
Peter Dee, Danfoss
Giacomo Pisano, Dorin
Alvaro de Oña, shecco

10:00 AM Networking coffee break

PARALLEL SESSIONS

10:30 AM Participants will be able to choose one of the following sessions:

FOOD RETAIL PANEL

Chair: Michael Garry, shecco

Peter Savage, AAA Refrigeration Service

Harrison Horning, Hannaford Supermarkets

John Stuit, Defense Commissary Agency (DeCA), DeCA's progress with transcritical CO_2 commissaries and an update on its ammonia/CO_2 commissary

Tristam Coffin, Whole Foods Market

Paul Anderson, Target

Paul Alway, AB Group (Former Marks & Spencer), Experience of retailer challenges in adoption of naturals: "How we made it happen"

CASE STUDIES: INNOVATION

Chair: Jan Dusek, shecco

Jim Knudsen, Danfoss, Ejector technology – The next generation in transcritical CO_2

Yoram Shabtay, Heat Transfer Technologies, Select case studies of Copper heat exchanger coils for natural refrigerants

Andy Baker, YourCleanEnergy, A year on innovative transcritical CO_2 heat pump system providing lower cost hydronic heat than oil boilers

Chris Vallis, AB Group, A European journey in pursuit of sustainable retail

Hayato Sakamoto, Kawasaki Heavy Industries, Kawasaki centrifugal chiller using water as a refrigerant

12:30 PM Networking lunch

PARALLEL SESSIONS

2:00 PM Participants will be able to choose one of the following sessions:

INDUSTRIAL REFRIGERATION PANEL

Chair: Michael Garry, shecco

Steve Jackson, PermaCold Engineering, Environmentally sound engineering and refrigerants as the future of industrial engineering

Michael Lynch, United States Cold Storage, CO_2/NH_3 cascade refrigeration

Gerard von Dohlen, Newark Refrigerated Warehouse, No good refrigerant leaks

Pete Lepschat, Henningsen Cold Storage, Ammonia charge… Less > More

David Bornemeier, Western Gateway Storage

TRAINING PANEL

Chair: Alvaro de Oña, shecco

André Patenaude, Emerson, Addressing the challenges facing the refrigeration industry

Johari Gregorio, Embraco, How to simplify the process of converting to HCs

Lori Schiavo & Art Miller, RSES, Why is training important?

Scott Melton, ASTI, Demystifying ammonia through training to preserve and protect our industries and our world

Alvaro de Oña, shecco, The GUIDE to Natural Refrigerants Training in Europe

CASE STUDIES: COMMERCIAL REFRIGERATION

Chair: Jan Dusek, shecco

John Prall, Embraco, EMC compressor achieves unprecedented levels of energy efficiency

Giacomo Pisano, Dorin, The use of ejectors in CO_2 technology: How to boost efficiency in warm climates. A real example from Italy

Tristam Coffin and Tom D. Wolgamot, Whole Foods and DC Engineering, A case study in the CO_2 systems in Whole Foods Market's Northern California region

Nicola Pieretti, CAREL, CAREL's solution for managing the latest transcritical booster rack

Jeff Newel, Hillphoenix, Lab study of a transcritical CO_2 system with parallel compression and a gas ejector system – measured performance applied to bin analysis

Vicente Guilabert, Huayi Compressor Barcelona, R290 LBP variable speed compressor in a plug-in ice cream conserver

4:30 PM Networking coffee break

PARALLEL SESSIONS

4:30 PM Participants will be able to choose one of the following sessions:

ROUNDTABLE: THE FUTURE OF FOOD SERVICE

Chair: Antoine Azar, Sustainable Solutions (Former of Coca Cola)

Francisco Jorge Zavala and **Cecilia Garza**, 7-Eleven

Charles Hon, True Manufacturing, True Manufacturing's low GWP journey

Eoin Lennon, NOVUM, NUVUM's natural refrigerant choice

Howell Feig, AHT Cooling Systems USA

Vicente Guilabert, Huayi Compressor Barcelona

CASE STUDIES: HVAC

Chair: Alvaro de Oña, shecco
Chair: Jan Dusek, shecco

Klaas Visser, KAV Consulting, CO_2 evaporative condensers/ gas coolers (ECGCs)

Mike Kallas, Azane, Linking low-charge ammonia packaged systems to HVAC applications

John Miles, SANDEN, Adventures in water heating

Jan Dusek, shecco

Kelly Sasaki, Mayekawa, NHVAC in action

Dave Pearson, Star Renewable Energy

CASE STUDIES: INDUSTRIAL REFRIGERATION

Chair: Derek Hamilton, shecco

Kurt Liebendorfer, Evapco, Applying low-charge ammonia systems to an operating dairy

Javier Atencia, Tewis and **Eloy Espinosa**, Bohn de Mexico, Cold-storage distribution center design with natural refrigerants

Benoit Rodier, CIMCO, Various approaches using natural refrigerants for a cold-storage project construction

Caleb Nelson, AZANE, Diverse applications for low-charge ammonia

Jürgen Süss, efficient energy, Process cooling with a low-capacity centrifugal chiller, with water as the refrigerant

John Scherer, NXTCOLD, General Cold Storage in South Gate, Calif., is replacing an R22 facility with ultra-low-charge-ammonia ERIC Technology refrigeration units

7:00 PM Dinner reception at the Prado in Balboa Park. Shuttle buses will be available to take participants to the reception venue and back to the hotel. Buses will be leaving from 6:30 PM onwards. Sponsored by Platinum Sponsor Hillphoenix.

WEDNESDAY JUNE 7, 2017

ACCELERATE AMERICA AWARDS CEREMONY & BREAKFAST

8:00 AM **Michael Garry**, shecco, editor of *Accelerate America*, and **Marc Chasserot**, shecco, publisher of *Accelerate America*, will present the 2nd edition of the *Accelerate America* Awards, recognizing companies and individuals leading the transition to natural refrigerant-based technologies.

CEO INTERVIEW

9:00 AM Steven Trulaske of True Manufacturing, one of the most successful CEOs in the industry, will be interviewed by Michael Garry and Marc Chasserot of shecco in this brand new panel.

UTILITIES PANEL

9:30 AM Hosted by the Electric Power Research Institute (EPRI), this panel will discuss utility energy efficiency programs and their role in speeding up the adoption of NatRef technologies.

Chair: Ammi Amarnath, Electric Power Research Institute, New opportunities for natural refrigerants

Paul Delaney, Southern California Edison (SCE)

Tim Kidman, WSP/Sacramento Municipal Utility District (SMUD), SMUD's pilot natural refrigerant incentive program

Chris Roman, San Diego Gas & Electric, SDG&E accelerating the adoption of energy efficient refrigeration technologies

Jamie Anthony, Bonneville Power Administration

Patrick Moore, Pacific Gas & Electric (PG&E)

Aaron Daly, Whole Foods Market

Leigha Joyal, Hillphoenix, Incentives for natural refrigerants

11:00 AM Networking coffee break

CARB SLCP DISCUSSION

11:30 AM This session, hosted by the Californian Air Resources Board (CARB), will be an opportunity for natural refrigerant technology stakeholders to provide input on the Short-lived Climate Pollutant Reduction Strategy, known as the SLCP Plan. This meeting will be a unique opportunity for participants to engage with CARB officials on the details of California's Refrigerant Management Plan, which will be updated to reflect this new strategy once the rule-making process begins. Opportunities for natural refrigerant based technologies to replace HFCs will be the key discussion topic in this informal and interactive session.

Pamela Gupta, CARB

Glenn Gallagher, CARB

1:30 PM Conclusions and farewell lunch

POST-EVENT WORKSHOP

2:30 PM Harness the Full Potential of CO_2 Solutions
1— hour training and Q&A by Danfoss

EVENTS GUIDE

May 2017 / June 2017

01 May 30, Exeter, RI
Exeter, RI Ammonia Regulatory Training
www: https://www.eventbrite.com/e/exeter-ri-ammonia-regulatory-training-tickets-34017847297?aff=website

02 May 31, Exeter, RI
Exeter RI Ammonia Safety Day
www: https://www.eventbrite.com/e/exeter-ri-ammonia-safety-day-tickets-21510426264?aff=website

03 June 1, Kansas City, Kan.
GCAP's Kansas City 9th Annual Ammonia Safety Day
www: http://www.ammoniatraining.com/kansas-city-ammonia-safety-day

04 June 1, 2pm Eastern, Online
NASRC Webinar - Quarterly Policy Update
www: http://nasrc.org/blog/2017/5/11/nasrc-webinar-quarterly-policy-update

05 June 2-6, Anaheim, Calif.
Int'l Dairy Deli Bakery Association Seminar Expo '17
www: http://www.ammoniatraining.com/kansas-city-ammonia-safety-day
@myIDDBA #IDDBA17

06 June 4-6, Incline Village, Nev.
American Frozen Food Institute (AFFI), Food Logistics Forum
www: http://www.affi.org/event/food-logistics-forum-0
@AFFI

07 June 5-7, San Diego, Calif.
6th ATMOsphere America
www: www.atmo.org/America2017
@ATMOEvents #ATMOAmerica

08 June 7-8, Long Beach, Calif.
35th West Coast Energy Management Congress (EMC)
www: http://www.energyevent.com
#EMCexpo

09 June 8-9, Dalhart, Tex.
ASTI 8-Hour Refresher Safety & 24 Hour Technician Training
www: https://ammonia-safety.com/events

10 June 12-16, Montreal, Canada
ASTI 8-Hour Refresher Safety Training
www: https://ammonia-safety.com/events

11 June 12-15, Garden City, Kans.
GCAP CO_2 Technician Training Course

12 June 13-15, Chicago, Ill
Global Cold Chain Expo
www: http://www.globalcoldchainexpo.org
@coldchainexpo #GCCE

13 June 13-15, Chicago, Ill
United Fresh 2017
www: http://www.unitedfreshshow.org
@UnitedFresh

14 June 14-15, Boston, Mass.
Northeast Buildings & Facilities Management Show & Conference 2017
www: http://proexpos.com/NEBFM
@NEBFM

15 June 22, Augusta, Maine
Augusta ME Ammonia Safety Day
www: https://www.eventbrite.com/e/augusta-me-ammonia-safety-day-tickets-21510428270?aff=web

16 June 24-28, Long Beach, Calif.
ASHRAE Annual Conference
www: https://www.ashrae.org/membership--conferences/conferences/2017-ashrae-annual-conference

17 June 25-27, New York, N.Y.
Summer Fancy Food Show
www: www.specialtyfood.com
@craftcarejoy

18 June 25-28, Las Vegas, Nev.
IFT17 - Institute of Food Technologists
www: https://www.iftevent.org
@IFT

19 June 26-29, Scottsdale, Ariz.
IDEA 2017, 108th Annual Conference & Trade Show
www: http://www.cvent.com/events/idea2017/event-summary-fdf093839b6d4984ac8eb1da14a411a8.aspx
@districtenergy

20 June 27, 2 pm Eastern, Online
GreenChill Webinar: Using Trace Gases in Testing Refrigeration Systems
www: http://epawebconferencing.acms.com/tracegases

EVENTS GUIDE

July 2017 / August 2017

01 July 3-5, Ottawa, Canada
iWise 2017 Conference
www: https://www.sciencetarget.com/iwise2017
@iwiseconference

02 July 9-12, Tampa, Fla.
IAFP2017
www: http://www.foodprotection.org/annualmeeting
@IAFPFood #IAFP2017

03 July 10-13, San Francisco, Calif.
Intersolar North America
www: https://www.intersolar.us/en/home.html
@intersolar #intersolar

04 July 10- 13, Garden City, Kans.
GCAP Implementation of Process Safety Management for Industrial Ammonia Course
www: http://www.ammoniatrainingonline.com/111-2/

05 July 12-13, Atlanta, Ga.
Build Expo Atlanta
www: http://buildexpousa.com
@BuildExpoUSA

06 July 18, 2 pm Eastern, Online
GreenChill Webinar: ASHRAE-Coordinated Research on Alternative Refrigerants
www: http://epawebconferencing.acms.com/ashrae

07 July 20-22, Lexington, Ky.
2017 AAMP Convention
www: http://www.aamp.com/event-calendar/aamp-convention

08 July 22- 23, Dalhart, Tex.
ASTI 8-Hour Refresher Safety & 24 Hour Technician Training
www: http://fs4.formsite.com/ammoniapldcom/form2/index.html

09 July 28-30, Monterey, Calif.
PMA Foodservice Conference & Expo
www: http://www.pma.com/events/foodservice

10 July 31- August 2, Washington, D.C.
2017 GCCA Assembly of Committees
www: http://www.gcca.org/events/2017-gcca-assembly-committees

11 August 1, Vallejo, Calif.
Bay Area Chemical Safety Day
www: https://www.eventbrite.com/e/bay-area-chemical-safety-day-tickets-31497856938?ref=ecal

12 August 8, 2PM Eastern, Online
GreenChill Webinar: ORNL's Experiences Conducting Life-Cycle Climate Performance Tests on Commercial Refrigeration Systems
www: http://epawebconferencing.acms.com/life-cycle-climate

13 August 9-11, Nashville, Tenn.
Global Sustainability Summit
www: http://www.fmi.org/sustainabilitysummit/About

14 August 15-17, Tampa, Fla.
Energy Exchange 2017
www: http://www.2017energyexchange.com

15 August 15-18, Denver, Colo.
2017 ACEEE Summer Study on Energy Efficiency in Industry
www: http://aceee.org/conferences/2017/ssi
@ACEEEdc #SummerStudy17

16 August 16-17, Houston, Tex.
Build Expo Houston
www: http://buildexpousa.com/
@BuildExpoUSA

17 August 16-18, Québec City, Canada
HRAI's 49th Annual Meeting
www: http://www.hrai.ca/agm

18 August 22, 2PM Eastern, Online
GreenChill Webinar: Overall Costs of Management: Leakage, Usage, and Performance
www: http://epawebconferencing.acms.com/mgmtcosts/

19 August 24-26, Guadalajara, Mexico
IIAR Natural Refrigeration Seminar XV and Safety Day
@GCAP

20 August 26, Storm Lake, Iowa
Storm Lake IA Ammonia Safety Day
www: https://www.eventbrite.com/e/storm-lake-ia-ammonia-safety-day-tickets-33171306270?aff=ASTIwebsite

21 August 27-29, Los Angeles, Calif.
The 2017 Western Foodservice & Hospitality Expo
www: http://www.westernfoodexpo.com/
@TheFoodShows #TheFoodShows

22 August 30-31, Oklahoma City, Okla.
2017 Oklahoma Restaurant Convention & Expo
www: https://www.okrestaurants.com/oklahoma_restaurant_convention.php
#ORAShow2017

IN BRIEF

AMMONIA

EVAPCO'S EVAPORATORS LOWEST IN CHARGE

TANEYTOWN, Md. – While Evapco has garnered considerable attention for its packaged low-charge-ammonia Evapcold units, the company has also been active in developing ammonia evaporators that lower charge in central systems, including two new ones introduced this year that offer its lowest charge to date. The new evaporators, the SSTSB series and SSTEB low-profile series, both utilize 3/8-inch-diameter internally enhanced stainless steel tubes, which lower the charge compared to 5/8-inch-diameter tube models; their recirculation rate is 1.2:1.

More information at:
http://bit.ly/2qYc4oI

CO_2

DANFOSS'S MOBILE CO_2 TRAINING UNIT AT ATMO

BALTIMORE, Md. – To improve understanding of natural refrigerant systems, Danfoss will deploy its mobile training unit for CO_2 applications in the western United States for the first time this summer. Its first stop is the ATMOsphere America conference in San Diego June 5-7. Danfoss will hold "open house" sessions in the container classroom to showcase equipment and components for CO_2 solutions. Other western stops include: Source Refrigeration & HVAC Training Center in Anaheim, Calif., June 14-29; and DC Engineering in Meridian, Idaho, July 10-20.

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

HYDROCARBONS

RED BULL VIDEO EXPLAINS HC COOLER RECYCLING

FUSCHLSEE, Austria – Energy drink giant Red Bull, which has deployed about 780,000 ECO-Coolers using isobutane refrigerant globally (more than 70% of its fleet), has published a video showing what happens to its natural refrigerant-based coolers at the end of their lifetimes in preparation for recycling. The video was produced in partnership with the Refrigerants, Naturally! initiative, which brings together international companies to take action against global warming and ozone layer depletion. The video can be viewed at www.refrigerantsnaturally.com. In the U.S., the company has installed more than 200,000 ECO-Coolers.

More information at:
http://bit.ly/2qnGou0

AMMONIA

HOW LOW CAN AMMONIA CHARGE GO?

OHRID, Macedonia – With the development of innovative low-charge ammonia cooling systems heralding a renaissance of this natural refrigerant worldwide, charges could eventually reach as low as 18 g/kW, leading expert Professor Hrnjak told participants at the 7th IIR Conference on Ammonia and CO_2 Refrigeration Technologies in Ohrid. The definition of low-charge ammonia emerged as a key topic of discussion during the conference of refrigeration experts. Traditionally associated with high refrigerant charges, ammonia charges can in fact be reduced significantly, according to case studies.

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

CO_2

DAIMLER R134a RECALL MAY LEAD TO CO_2

STUTTGART, Germany – Germany's Federal Motor Transport Authority has asked Daimler to recall 134,000 cars using R134a in violation of the EU's Mobile Air Conditioning (MAC) Directive, according to reports in the German press. The Federal Environment Agency (UBA) is urging the manufacturer to turn to natural refrigerant CO_2 as an alternative. "The introduction of CO_2 air-conditioning systems for passenger cars, which was launched by Daimler, is an environmentally sound and safe solution that must be continued," the UBA told the *Frankfurter Rundschau*.

More information at:
http://bit.ly/2pAY3MR

HYDROCARBONS

R290 AIR CONDITIONERS INSTALLED AT CHINESE TECHNICAL COLLEGE

JIAXING, China – As China proceeds with its phase-out of R22, Chinese manufacturer Midea recently installed some 1,060 propane-based mobile air conditioners in the dormitories at the Nanyang Vocational and Technical College in Jiaxing, in the country's northern Zhejiang province. Hydrocarbons21.com was invited to the technical university to see the installation during the "International Workshop on Designing, Production and Installation with R290 in Air-Conditioning Industry" in Ningbo, China, in April. Delegations from the Middle East and Vietnam also attended the event.

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

A Sea Change in ***Small-Format Refrigeration***

Regulations bring natural refrigerants' viability to the forefront

By André Patenaude

André Patenaude *is director - CO_2 business development, Emerson Commercial and Residential Solutions (which now incorporates Emerson Climate Technologies). He was selected last year as one of Accelerate America's 25 Movers & Shakers driving adoption of natural refrigerants.*

Of all the commercial refrigeration sectors impacted by President Obama-era regulatory activities, the small-format retail and foodservice markets have arguably been hit the hardest.

Comprised of small grocers, convenience stores and restaurants, these markets not only utilize the widest variety of equipment and system architectures, they are also faced with understanding new refrigerant requirements in each equipment class. The net result is a sea change to refrigeration architectures in these segments — one where natural refrigerants propane (R290) and CO_2 (R744) play an increasingly vital role.

With so many factors impacting these markets, it's easy to see why there's an unusually high degree of confusion and uncertainty. Making sense of it all is not easy, but many owner/operators are tasked with selecting the refrigeration platforms that will accomplish their short- and long-term operational objectives. And with numerous regulatory deadlines from both the Environmental Protection Agency (EPA) and the Department of Energy (DOE) approaching, these decisions must be made quickly.

In recent years, the industry has made tremendous progress in developing equipment that is more environmentally friendly and energy efficient than their predecessors. While recent actions from the Trump administration suggest that deregulation measures may yet be on the horizon, the specific extent of these changes is still largely unknown. As things currently stand, environmental regulations introduced by the previous administration remain in place, and the transition to equipment that utilizes refrigerants with lower global warming potential (GWP) is still underway.

New equipment and system architectures

Because of this convergence of regulatory activity, operators can expect new equipment options and architectures from original equipment manufacturers (OEMs). It's also becoming more common for retailers and restaurant chains to state sustainability objectives — from the selection of eco-friendly refrigerants to lowering their overall carbon dioxide equivalency.

In response, many OEMs have taken the approach of integrating both EPA and DOE requirements in the same design cycle. This entails selecting a refrigerant that offers both lower-GWP levels and performance efficiencies to meet the new energy targets.

Among these OEMs, some are developing new units in hopes of achieving compliance for future, potentially lower-GWP requirements. For those taking this "end game" approach and attempting to clear these regulatory hurdles once and for all, natural refrigerants are currently the only options for achieving this objective.

Here's a look at some of the new equipment and system architectures for R290 and R744.

R290

Overview

As a viable replacement to R404A and R134a, R290 delivers well-documented performance efficiencies and superior thermodynamic properties, without compromising capacity. And in Emerson's independent test labs, R290 consistently outperforms R404A by delivering energy efficiency gains of more than 20%.

The caveats for R290 use come down to its flammability (class A3), serviceability concerns and charge limits. While there are currently no certification requirements to service R290 systems, operators may have difficulty finding technicians who are comfortable handling and servicing the equipment. In many instances, serviceability concerns are largely offset by equipment design — as many systems are self-contained and factory-sealed to enable "plug and play" installation and servicing.

The 150 g charge limit currently restricts R290 use to smaller systems that utilize fractional horsepower compressors or condensing units. ▶

Understanding EPA and DOE deadlines

Throughout the next five years, there will be several Environmental Protection Agency (EPA) and Department of Energy (DOE) regulatory hurdles that stakeholders in these markets must clear. (See chart, page 20.)

The EPA has set a phase-out schedule for the use of hydrofluorocarbon (HFC) refrigerants with a high GWP, while the DOE has established new energy consumption guidelines for specific classes of refrigeration equipment. Unfortunately, compliance dates from each agency aren't necessarily in sync.

For original equipment manufacturers (OEMs), understanding the overlap of these regulations presents an opportunity to comply with both regulatory initiatives in one design cycle.

It's important to note that the EPA has listed R290 acceptable for use in new stand-alone units and ice machines, while R744 is allowable in all the classes in the chart. R290 has a GWP of three; R744 has a GWP of one.

Other synthetic refrigerant options are available, but none deliver the ultra-low GWP levels, i.e., below 150 GWP, which are considered the hypothetical threshold for exemption from future regulatory action.

Applications

Stand-alone: R290 is most commonly found in self-contained display cases that feature a built-in condensing unit in each refrigeration fixture. These cases have been in service for more than a decade in Europe and have become increasingly popular in the U.S. in recent years.

Integrated cases: Deployed as an alternative to centralized systems, these large refrigeration cases integrate multiple R290 compressors on individual 150 g circuits. And each compressor has its own supporting system components (e.g., fans, valves, piping, etc.). This is an instance where larger charge limits would greatly simplify equipment design and expand application potential.

Micro-distributed architecture: Like stand-alone cases, each fixture is designed with its own condensing unit. The difference is, micro-distributed systems are designed to remove exhaust heat from the building through a shared heat rejection/water loop system that extracts the heat from each unit and diverts it to a condenser/cooler on the roof. While store comfort is optimized, operators may expect higher first costs and a slight energy penalty due to the secondary heat exchange design. However, in warmer climates, the removal of exhaust heat from facility — and the load reduction on the HVAC system — may offset this penalty.

Ice machines: The EPA recently listed R290 as acceptable for use in ice machines. The type of ice machine (cuber or flaker) is a key design consideration for OEMs, but component manufacturers are offering fractional horsepower compressors to integrate with both types and help with evaporator design.

EPA Refrigerant and DOE Energy-Reduction Regulations

Supermarket (rack)	**EPA 1/1/17** Phase out: R404A, R507A				
Walk-in cooler and freezers (remote condensing units)	**DOE 6/26/17** OEM deadline for certification of medium-temperature condensing units.	**EPA 1/1/18** Phase out: R404A, R507A		**DOE 1/1/20*** 20%–40% (cooler) energy reductions 20%–30% (freezer) energy reductions	
Stand-alone coolers with < 2,200 BTU	**DOE 3/27/17** 30%–50% energy reductions		**EPA 1/1/19** Phase out: R404A, R507A, R410A, R407A/C/F, HFC-134a		
Stand-alone coolers with > 2,200 BTU	**DOE 3/27/17** 30%–50% energy reductions			**EPA 1/1/20** Phase out R404A, R507A, R410A, R407A/C/F, R134a	
Stand-alone freezers	**DOE 3/27/17** 30%–50% energy reductions			EPA 1/1/20 Phase out R404A, R507A, R410A, R407A/C/F	
Ice machines		**DOE 1/1/18** 5%–15% energy reductions			
Dispensing units					**EPA 1/1/21** Phase out R404A/R507A, R410A, R407A/C/F

*These regulations have been recently withdrawn from publication in the federal Register and are currently under review by the DOE.

R744

Overview

R744 systems have been deployed in Europe for nearly two decades, and have proved to be a very effective alternative to hydrofluorocarbons (HFCs) in both low- and medium-temperature applications. Only in recent years has the U.S. seen wider R744 adoption in commercial refrigeration. Because R744 has a high operating pressure (around 1,300 psig or 90 bar) and low critical point, refrigeration strategies must be designed to account for its unique characteristics.

While CO_2 is more common in large-format grocery stores, OEMs have begun manufacturing systems and components sized for smaller equipment. Current trends show that system costs proportionately rise with the development of smaller equipment and condensing units. However, these R744 systems are considered "future proof" to global regulations and directives.

Applications

Small, centralized CO_2 systems: Appropriately sized for small-format applications, these systems are based on existing CO_2 architectures (such as cascade and transcritical booster). A typical small system relies on four compressors to supply the complete refrigeration needs of the retailer.

Remote condensing units: Many OEMs are manufacturing CO_2 condensing units that can serve small-format needs, such as walk-in freezers and coolers. These recently developed solutions will likely become increasingly used in applications in the coming years.

Stay informed

While there are still a lot of unanswered questions in the small refrigerated equipment space, natural refrigerants currently offer viable options for today's operators selecting new refrigeration platforms.

Over the next several years, regulatory agencies and governing bodies will hopefully bring additional clarity about refrigerant use in available equipment architectures. As OEMs continue to design, test and certify these new equipment offerings, operators must stay informed of any changes in the marketplace to help them make decisions that align best with their business objectives ■ AP

A3s and A2Ls: Safety Standards and Charge Limits

In addition to natural refrigerants, the industry is also looking at the promise of synthetic A2Ls (mildly flammable) as ultra-low-GWP alternatives to HFCs.

Today, there are global efforts underway to evaluate the refrigerant classifications, safety standards and charge limits of A2Ls and A3 (R290), with flammability studies of both in order to determine their behavior in real-world applications.

Here's a summary of these activities:

Review A2L safety standards:

» U.S.: UL 1995, ASHRAE 15; target date is late 2017
» International: ISO 5149, IEC 60335, EN378; target date is late 2017

Update building codes:

» Building codes for A2Ls are under review for adoption in the 2021 code cycle.

Evaluate charge limits:

» Raising the A3 charge limit from 150g to 300g–500g in the U.S.
» Raising the A2L charge limit from 500g to 1 kg in the U.S.

Flammable refrigerant study:

» $5.2M partnership by AHRI, ASHRAE, DOE and others to study flammable refrigerant behavior in real-world applications

The first key point from this activity is this: If the safety standards activities conclude in 2017 and the governing bodies ratify them in 2018, the soonest these standards could be effective in the building codes is 2021.

Second, the potential to increase R290's charge limits up to 500g and A2Ls to 1 kg has broad implications for the applications discussed herein. It would allow larger-horsepower compressors and systems to carry higher refrigerant charges, thus simplifying system design and expanding their applicability.

Finally, it's important to note that the EPA has yet to list any of the ultra-low GWP A2Ls (or those with less than 150 GWP) as acceptable for use in commercial refrigeration.

Raising the ***Propane Charge Limit***

The IEC's proposed 500 g charge cap for R290 is moving toward a resolution

By Marek Zgliczynski

Last year's Kigali Amendment to the Montreal Protocol, calling for a phase-down of HFCs, saw the global community take another important step towards reducing greenhouse gas emissions from human activity in order to preserve our planet for future generations.

In the refrigeration sector, the global phase-down of HFCs is making an important contribution to this international mitigation effort.

To that end, recent regulations in different parts of the world (the EU F-Gas Regulation, the U.S. EPA SNAP rules and California Air Resources Board actions, etc.) will impose bans on high-GWP refrigerants in the next few years in several refrigeration and air conditioning segments, including different categories of light commercial refrigeration.

Today, light commercial refrigeration appliances follow IEC (International Electrotechnical Commission) safety standards. IEC standards are the reference for regional and national legislation (e.g. EN and UL standards, EPA rules, etc.).

The present IEC standard used for hermetically sealed applications, IEC60335-2-89, limits to 150 g the charge of any flammable refrigerant. This makes the full application of the Kigali Amendment for transitioning to low-GWP refrigerants more difficult – notwithstanding the fact that by using multiple independent circuits, the problem of charge limits in bigger cabinets can be solved with the existing standard.

How to allow more change

In the IEC SC61C/WG4 working group, the industry is trying to define specific additional measures needed to allow higher charge levels without increasing risks above the existing standard.

The activity, led by Werner Schwaiger from the Austrian National Committee, started in 2015. Recently, during a meeting held in Turin, Italy, at the end of April, the working group addressed comments received on the last draft of the amendment to IEC standard 60335-2-89.

The main factor used to minimize the creation of a flammable mixture around an appliance is the airflow. Its effectiveness must be certified using a special leak test, which was developed with the help of specialized laboratories in Great Britain and in Germany.

Additionally, the working group will take into consideration the outcomes of an Air Conditioning, Heating and Refrigeration Institute (AHRI) project, currently in progress in the U.S., to assess the severity of negative events due to flammable refrigerants (both A3 and A2Ls).

Meanwhile, a new Draft for Comments (DC) document that considers a 500 g limit for propane charges, and will also allow the use of slightly flammable A2L refrigerant alternatives, will be circulated in June. If positively commented upon, and if a consensus is reached, the document will be submitted to the SC61C committee and go to the first official vote as a Committee Draft (CDV) during the Plenary Meeting of the SC61C in October in Vladivostok, Russia.

During 2018, in the event of a positive CDV and FDIS (Final Draft of International Standard) vote – a 66.7% majority of P (participating)-members is required – the final standard amendment would be published.

It is important to note that the majority of experts participating in WG4 working group activity are from leading U.S. companies. Therefore there is a good chance that UL and the EPA will also adopt the approved IEC standard into American legislation quite soon. The European version of the IEC standard will be voted in parallel and other regions, like China, Japan, etc., should follow as well ■ MZ

Marek Zgliczynski *is chair of IEC SC61C and manager of commercial refrigeration product engineering for Brazilian compressor manufacturer Embraco.*

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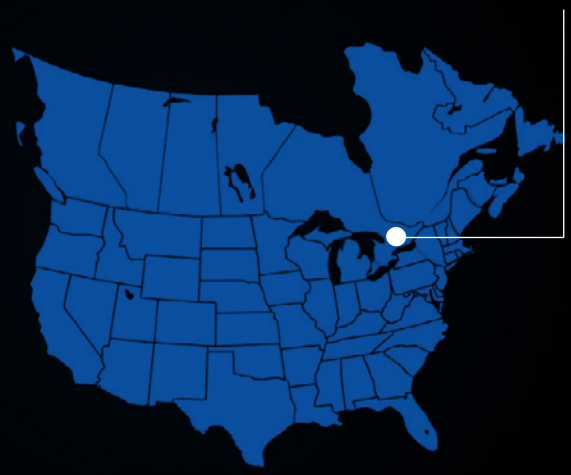

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The Choice **Conundrum**

How do end users choose the right low-GWP solution when there are so many options that aren't wrong?

By Chris Vallis and Paul Alway


Chris Vallis, AB Group
Paul Alway, AB Group

Over 250 years ago, in 1758, Benjamin Franklin studied the science of refrigeration in Cambridge, England.

Today, the refrigeration cycle is earmarked as a solution to heating and cooling challenges on a global scale.

For example, heat pumps are heralded as having the potential to address the world's heating and cooling needs while operating with almost no carbon emissions, if powered by renewable energy.

As reported in the April 2017 issue of *Accelerate America*, refrigerant management has been identified by Project Drawdown as the No. 1 climate-change mitigation approach for atmospheric CO_2-equivalent reductions. Under a plausible scenario, refrigerant management is estimated to cut almost 90 gigatons of greenhouse gas GHG) emissions over a 30-year period. That is the equivalent of eliminating the GHG emissions from over 750 coal-fired power plants each year.

It's a sobering and motivating thought that our sector can play such a significant role in the future of our planet and its climate.

The importance of GHG reduction was underscored by Elon Musk in a particularly memorable talk on carbon and the climate crisis at the Paris Climate talks in December 2015. He pointed out that CO_2 in parts per million (ppm) in our atmosphere had been around the 300 level for 400,000 years (see chart, page 27). But carbon levels now top 400 ppm following a continued vertical climb since 1950.

Musk explained how this change can have a major impact, given the high sensitivity of our climate. New York City, for example, would be under ice if the average global temperature dropped by 5°C, but it would be under water with a gain of 5°C. This is a plus/minus 2% change (compared to absolute zero), demonstrating that small changes can have huge effects. ▶

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> *The future is already here — it's just not very evenly distributed.*
> —William Gibson

▶ Given this new reality, there is now the inevitability that we will eventually exit the fossil fuels era. At the same time, there is now the inevitability that we will exit the HFC era.

At the time of writing my previous guest column in September 2016, the Kigali amendment was pending. The following month, despite challenging global politics, 170 countries met to reach a remarkable agreement. Through this amendment to the Montreal Protocol, the world will begin phasing out HFCs in 2019 – a clear message that our industry is set for positive change.

There are three significant factors at play that together will create a solid platform for this movement away from HFCs: First, this is a fantastic time for progress and innovation; next, energy incentives and funding are becoming available (see page 34); and third, California is becoming more ambitious than Europe in HFC phase-down goals as part of its Short-Lived Climate Pollutant (SLCP) Reduction Strategy, and many hope this will pave the way for other states.

Choice overload

This landscape establishes the fundamental need to innovate, which is defined as "to introduce something new; make changes in anything established." Of course, making changes is rarely easy on a large scale.

This is where making hard choices comes in. With so many "right things" when it comes to low-GWP solutions, the psychology of choice overload can reduce engagement, decision quality and satisfaction.

To take an extreme example, look at the vast product choices in a retail food store. One of our clients recently explained the challenge of stocking 75 types of olive oil and 348 kinds of jam.

One method to combat choice overload is to follow these steps:

» CUT: Less is more.
» CONCRETIZE: Make it real.
» CATEGORIZE: More categories, but fewer choices.
» CONDITION FOR COMPLEXITY: Increase the complexity, but gradually.

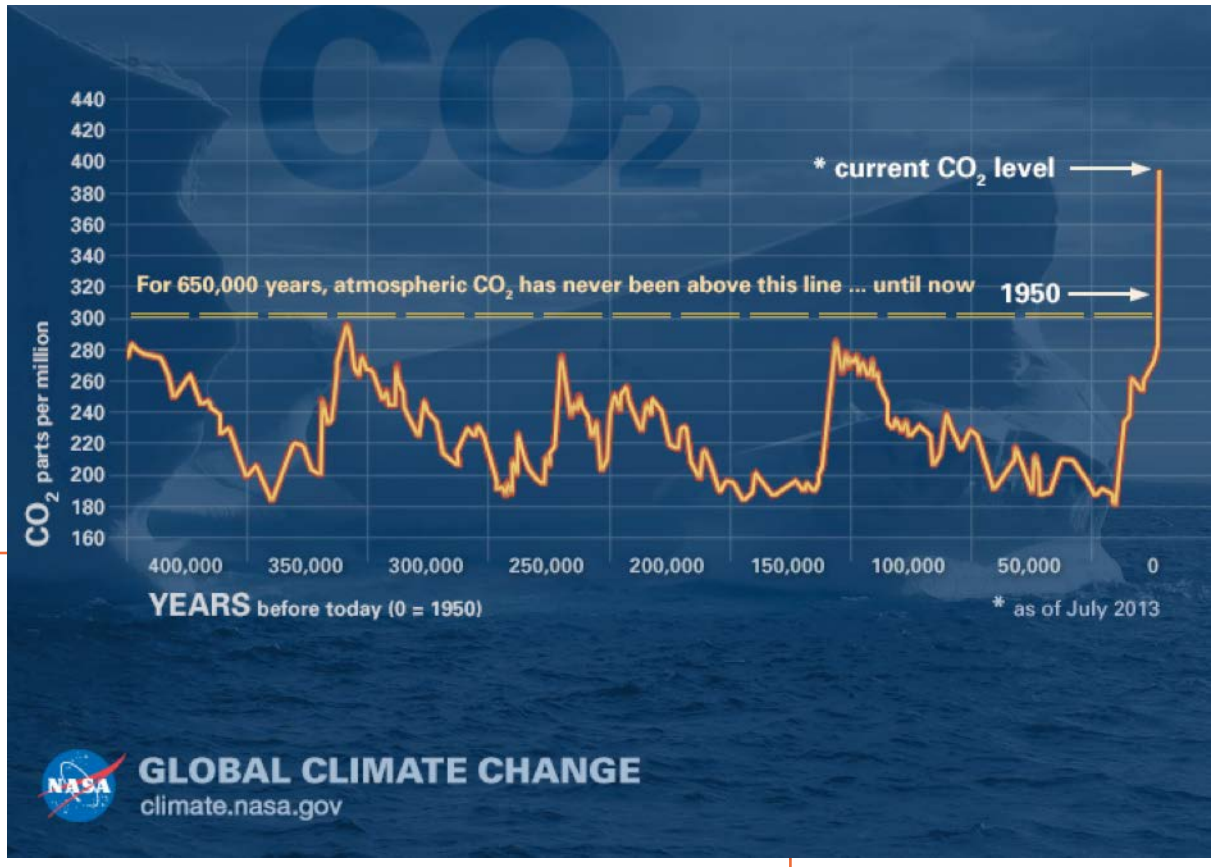
We have found the math of comparing and contrasting options can be very complex, but essential, albeit different for each end user.

One mistake is comparing with the past instead of with the possible. This means making peace with the fact that systems that run on natural refrigerants can cost more than those using HFCs, at a component and system level.

But HFCs are, in a sense, no longer a viable comparison. After all, they are being phased out, so they are not part of the long-term landscape, and are thus a flawed benchmark. The inevitability of their demise means a choice is required.

What makes this choice hard is the way alternatives relate. In an easy choice, one alternative is clearly better than the other. But in a hard choice, one alternative is better in some ways, while another is better in other ways, and neither is better than the other, overall.

Even small choices can be hard. Imagine you are deciding what to have for breakfast – a high-fiber cereal or a chocolate donut. Healthiness and tastiness are the things that matter. One is better for you, one tastes way better. Neither is better overall.



Hard choices mean we often take the safest option – what feels easiest, with less fear of the unknown attached. On the other hand, having the courage of one's convictions can make all the difference.

Our clients have found that proper governance, sound trials and strong data analysis can help bolster confidence in these conviction, and aid in making decisions. Since hard choices aren't between equally good options, what really counts is the variety of things that matter in such a decision.

So trials, testing, governance, simulations, detailed analysis and collaboration can make all the difference. The only thing more important is data, data and more data. Only then can you feel secure when making hard choices. It's also a learning curve, sometimes a very steep one, and by no means directly proportional to effort. To use one final cliché, it's a marathon not a sprint.

I can't sum it up better than Franklin D Roosevelt famously did: "Above all, try something" ■ CV & PA

Chris Vallis is technical director at AB Group Inc. (www.abgroup.com), a U.K. consultancy with a specialization in refrigeration. He is leading the firm's entry to the U.S. market.

Paul Alway is design director at AB Group Inc. He previously worked for U.K. retailers Tesco and Marks & Spencer on the roll out of transcritical CO_2 systems, among other projects.

IIAR Developing ***Safety Standard for CO_2***

Venturing beyond its traditional ammonia systems, the group is targeting CO_2, low-charge ammonia and commercial applications.

By Michael Garry

As it continues to branch out from its focus on traditional large-charge ammonia systems, the International Institute of Ammonia Refrigeration (IIAR) is developing a standard for CO_2 that will specify criteria for the safe design and operation of CO_2 refrigeration systems like cascade and transcritical.

"We hope to complete it a year from now," said Eric Smith, vice president and technical director of IIAR, during a webinar on May 2 hosted by the Environmental Protection Agency's GreenChill Partnership.

IIAR is also developing guidelines for low-charge-ammonia systems that will enable end users "to be compliant with the [EPA's] General Duty Clause" for safety, added Smith, who expects the guidelines to be ready in six months. IIAR is based in Alexandria, Va.

In an update last year to its IIAR-2 operational and safety standard, IIAR aimed to promote the use of ammonia in the commercial industry, offering new information on low-charge packaged systems and how equipment can be used outside the machine room, Smith said.

Smith acknowledged that while IIAR has traditionally served the industrial refrigeration industry, it "has a real interest in using natural refrigerants for commercial systems." To that end, the group is "hoping to gain interest from more people in the commercial world." That was reflected in the host of the webinar, GreenChill, which works with food retailers to reduce leaks and adopt advanced refrigeration systems.

Safety study

In positioning ammonia for commercial uses, he pointed out IIAR's emphasis on the safe use of the refrigerant. In a recent study, 5,000 lbs. of ammonia, which is lighter than air, were released in an hour from a relief valve located at 15 and 30 ft. above the ground. The study found a one in 100,000 chance of a toxic level of the ammonia reaching the ground from 15 ft., and a one in one million chance from 30 ft. Smith described this as "telling about the perceived dangers of ammonia release."

IIAR has been helping to establish ammonia safety standards in developing countries that have so safety codes specifically for ammonia refrigeration. "Safety is important not just in the U.S. but everywhere," Smith said. "When there's an ammonia release on some part of the world, it's known everywhere because of the worldwide web."

He pointed out that many modern refrigerants like HFO blends are not always available in developing countries like India and some in South America. By contrast, ammonia and CO_2, which are commonly produced and used in industry, "would serve those countries well" as refrigerants.

Even if HFO blends were available, they may suffer from "fractionation" in large systems, he said. "Part of the blend could leak out of the system and you would end up with a refrigerant that does not have the same composition as it did when charged."

Moreover, he said, the presence of fluorine in HFOs continues to raise concerns. "There are some studies in Europe about its long-term effect on the environment. We don't know 10 to 20 years from now what the effect of fluorine might be."

On the training front, IIAR's year-old education program, Academy of Natural Refrigerants, has certified about 100 people who have taken a course on the updated IIAR-2 standard for ammonia refrigeration. IIAR will add classes on IIAR standards 4, 5 and 8 on installation, start-up and decommissioning, and will introduce courses on CO_2 next year, Smith noted.

IIAR's Ammonia Refrigeration Foundation (ARF) is partnering with the U.S. Department of Defense and RETA (Refrigeration Engineers and Technicians Association) to help military veterans find jobs in the HVAC&R industry. IIAR is also working with Praxair on a diversity grant that would offer opportunities to low-income individuals to "be exposed to our industry," he said ■ MG

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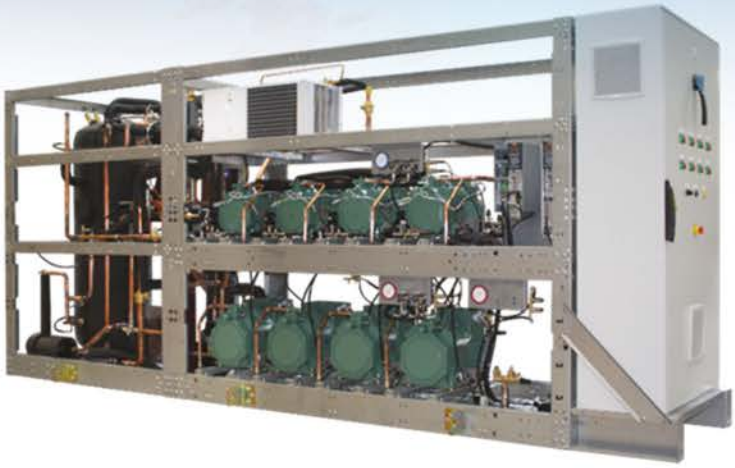

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Further Delay Sought for ***EPA's Amended Safety Rule***

The EPA wants to put off until 2019 implementation of the Obama administration's rule amending the Risk Management Program

By Michael Garry

The effective date of the U.S. Environmental Protection Agency's amended Risk Management Program (RMP) rule, originally set for March 14 and then reset for March 21, has been extended to June 19th as the Trump administration seeks to further delay the rule's implementation until February 19, 2019.

The 25-year-old RMP as originally constituted imposes safety requirements on U.S. cold storage and food processing facilities using at least 10,000 lbs. of ammonia in refrigeration processes. The amended RMP rule, Issued by the Obama administration in late December 2016, changes the RMP in three areas: ensuring that local responders and community residents are prepared for an accident, preventing catastrophic accidents, and requiring independent third-party audits following an accident.

To delay the effective date of the RMP rule until 2019, the EPA recently published a proposed rule, for which it held a public hearing on April 19 seeking comments. The hearing attracted a range of organizations, including industry groups such as Global Cold Chain Alliance (GCCA) and the Agricultural Retailers Association, as well as NGOs like the Union of Concerned Scientists and the BlueGreen Alliance.

Representing the GCCA, Lowell Randel, its vice president, government and legal affairs, spoke in support of the delay. "The additional time [would] give the new policy officials at EPA time to review the issues and potentially propose revisions to the final rule," said Randel. However, he added, any revisions would have to go through the "notice and comment rulemaking process" before they could take effect.

Industry groups have also sought to vacate the amended RMP rule through the Congressional Review Act (CRA), which allows Congress, with the President's signature, to void rules issued late in the Obama administration. But "with all of the actions by EPA, it is not expected that there will be any further movement of the CRA resolutions that have been introduced," including House Joint Resolution 59, Randel said.

Third-party audits targeted

In the industrial refrigeration industry, the most controversial part of the new RMP rule involves the third-party audits. The rule requires industrial refrigeration operators to secure an independent third party – rather than use its own internal resources – to conduct a compliance audit within a year following a reportable accident. The industry also believes that "the EPA didn't meet its burden on the cost-benefit of the rule," said Randel. "And there are some security concerns on public information sharing."

The final rule also increases coordination between facilities using hazardous chemicals like ammonia and Local Emergency Planning Committees (LEPCs).

The expansion of the RMP, as well as greater enforcement of the program, has led many U.S. operators to implement low-charge ammonia systems that use far less than 10,000 lbs. of ammonia; low-charge quantities invoke the EPA's less restrictive General Duty Clause.

The BlueGreen Alliance, an NGO focused on labor and environmental issues, strongly opposed changes in or delay of the new RMP rule in testimony at the April 19th hearing. "These rules have already gone through an extensive multi-agency stakeholder and comment process, and workers and communities cannot wait another two years for these rules to be implemented," wrote Jessica Eckdish, senior policy advisor with the BlueGreen Alliance, in a post on April 18 on dailykos.com, a progressive website ■ MG

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EIA Praises ***UL Move on HC Charge***

UL increases the charge allowed in domestic fridges in the U.S. to 150 g from 57 g, but EPA approval still needed.

By Michael Garry

The Environmental Investigation Agency (EIA), a Washington, D.C.-based NGO, praised the move in late April by Underwriters Laboratories (UL) to adopt a new safety standard, UL 60335-2-24 Edition 2, which will boost the hydrocarbon charge allowed in U.S. domestic refrigerators to 150 g from 57 g, the amount allowed under UL 250.

"This is great news that brings us closer to mainstreaming hydrocarbon fridges in the U.S. market as the previous 57 g limit was a considerable barrier," said Christina Starr, climate policy analyst for EIA, in an email message to *Accelerate America.*

The new standard is in line with the IEC's international standard that allows 150 g of hydrocarbon refrigerants propane and isobutane in domestic refrigerators, supporting adoption of these appliances around the world.

However, for manufacturers to be able to sell these appliances in the U.S., the Environmental Protection Agency would need to update its existing regulations – which allow only 57 g of hydrocarbon refrigerant in domestic refrigerators – to incorporate the new UL standard.
"Since the UL 250 standard will be retired and replaced next year with UL 60335-2-24, the EPA must act quickly to prioritize a review of the new standard," wrote Starr. on EIA's website, eia-global.org.

Current EPA regulations will phase out the currently dominant refrigerant in domestic refrigerators, R134a, in 2021, but the current 57 g charge limit for hydrocarbons "is too small to allow cost-effective and energy-efficient manufacturing," she wrote.

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

"For over a decade, other countries have been using household refrigeration appliances that contain hydrocarbon refrigerants, which have almost no climate impact and are significantly more energy efficient than HFC technology," wrote Starr.

Each year U.S. consumers purchase about 12 million new household refrigerators and freezers. Replacing R134a in new purchases with a climate-friendly refrigerant can avoid emissions of up to 3.7 million metric tons of direct CO_2 equivalent, according to the EIA.

Efforts are also underway globally and in the U.S. to increase the allowable hydrocarbon charge in commercial refrigerators above 150 g. The IEC is considering raising the limit for flammable A3 refrigerants to 500 g. (See page 22.) ■ MG

Domestic Refrigerators Using HCs Outside the U.S.

AB Electrolux of Sweden	Pacific/SE Asia	R600a
	EU	R290
	US	R134a
Samsung Electronics America	EU/Intl.	R600a
	US	R134a
LG Electronics	UK, India	R600a
	US	R22
Haier	Pacific, EU	R600a
	US	R134a

GAME CHANGER

Kathleen Ave and Ryan Hammond, SMUD

The Sacramento Municipal Utility District breaks the mold by offering greenhouse-gas-reduction incentives – on top of energy-efficiency incentives – for natural refrigerant systems

By Michael Garry
Photography by Talia Herman

SMUD'S INCENTIVES FOR NATURAL REFRIGERANT SYSTEMS

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200
$200/kW of demand reduction

30%
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Limit: 30% of project cost or $150,000, whichever is less

Direct GHG Emissions from Refrigerants

25
$25/Mt$CO_2$e reduction over system lifetime

30%
$150,000
Limit: 30% of project cost or $150,000, whichever is less

Projects in disadvantaged communities receive a **25% GHG incentive bonus.** Combined incentive limited to **50% of project cost or $250,000, whichever is less**.

One of the key impediments to the uptake of almost any new technology is its higher initial cost compared to the technology it is replacing. And that has certainly been true of natural refrigerant systems.

Even when evidence is proffered about the energy savings made possible by natural refrigerant equipment – which over the lifetime of the equipment would lead to an advantageous total cost of ownership (TCO) – many commercial and industrial end users remain reluctant to invest in the new technology because of its higher initial cost.

For example, at last year's ATMOsphere America conference in Chicago, attendees were polled on the "biggest challenge facing the adoption of natural refrigerant technology in food retail in North America." By far the No. 1 response (from 83 respondents) was initial cost (46%), followed by perception of safety risk (28%).

Apart from the rising sales of natural refrigerant equipment in North America, which are beginning to bring first costs down, there are a few factors that can change the cost equation for end users. One is regulation, such as the Environmental Protection Agency's SNAP (Significant New Alternative Policy) program, which has started delisting HFC refrigerants with a high GWP (global warming potential), and the Department of Energy's energy-efficiency requirements. The European Union's F-Gas Regulation has also compelled many end users to start investing in environmentally friendly systems.

Another way to move past the cost hurdle is to receive financial help from a government or utility. In Japan, subsidies from the Ministry of the Environment have led to a massive deployment of transcritical CO_2 systems between 2014 and 2016. (See "Will CO_2 Continue to Surge in Japan?" *Accelerate America*, March 2017.) While that sort of assistance is not available from the U.S. government, a growing number of U.S. utilities have begun providing funding for natural refrigerant systems that are more energy efficient than legacy equipment. (See "Utility Incentives: A Work in Progress," *Accelerate America*, June 2016.)

For example, in California, the most environmentally proactive state in the U.S., several utilities have started offering efficiency and demand-response incentives for natural refrigerant equipment, including Southern California Edison (SCE), Pacific Gas & Electric (PG&E) and the Sacramento Municipal Utility District (SMUD). ▶

SMUD headquarters, Sacramento, Calif.

▶ SMUD has now taken its incentive offering a significant step further.

On March 30, at a meeting at SMUD headquarters in Sacramento of the North American Sustainable Refrigeration Council (NASRC), SMUD announced a new pilot incentive program specifically aimed at natural refrigerant systems used mostly by supermarkets, convenience stores, cold-storage warehouses and food processors. These systems include everything from transcritical CO_2, low-charge-ammonia packaged equipment, ammonia/CO_2, and self-contained propane or isobutane cases. SMUD worked with consulting firms WSP USA and KW Refrigerant Management Strategy in developing the natural refrigerants program.

SMUD sees the program as an opportunity to expand its knowledge of natural refrigerant systems and support future low-GWP refrigerant policy development.

But what distinguishes SMUD's new program from any other utility incentive scheme in the U.S. – and possibly the world – is that it rewards end users for not only energy efficiency but also for direct greenhouse gas (GHG) emissions reduction.

The GHG part could be a game changer.

Refrigeration equipment such as LED lights, anti-sweat controls and ECM motors reduce a facility's energy consumption – an indirect contributor to climate change as well as a cost of doing business. Natural refrigerant technologies, with their zero or near-zero global warming potentials (GWPs), not only save energy but also replace high-GWP refrigerants like HFCs whose emissions are a significant direct contributor to climate change. So even if 100 lbs. of a natural refrigerant like CO_2 escapes from a transcritical system into the atmosphere during start-up, maintenance, leakage or end-of-life disposal, the global warming impact would be thousands of times less than that of HFCs.

In practical terms, this environmental benefit means end users of natural refrigerant systems don't have to worry about regulations forcing them to move to a new type of refrigerant.

SMUD originally planned to include HFOs and HFO blends in the program, requiring a GWP of less than 150 for new systems and a GWP less than 1,000 for retrofits of existing equipment. But after receiving feedback and upon "further reflection," the utility decided to "go exclusively with natural refrigerants," said Kathleen Ave, climate program manager for SMUD's Energy Research & Development (ER&D) group. "We have limited incentive dollars and we want to achieve the best possible GHG reductions with those dollars."

A ripple effect

On the one hand, SMUD's natural refrigerant incentive program is limited, given its modest budget and the utility's relatively small service territory (900 square miles). Yet the program, because of its GHG component, is "a big deal," said Aaron Daly, energy manager for Whole Foods Market, and head of NASRC's Utility Incentives and Energy Efficiency Progress Group.

U.S. utilities are typically reluctant to depart from the norm with incentives for natural refrigerant systems, Daly said. "Everyone is 'racing to be second.'" But SMUD's natural refrigerant program is sending a strong signal that will have "a ripple effect across North America," he said. "To the extent that other utilities can point to the SMUD program and adopt one like it, that's going to completely change the game for us."

Whole Foods Market, Sacramento, Calif., that received an efficiency incentive from SMUD, in part for installing a CO_2 cascade system in a retrofit project.

Daly distinguished between what's realistic to expect from public utilities like SMUD and private, investor-owned utilities. "In the short term, what SMUD has done can be directly adopted by other public utilities," he said. Private utilities are limited to offering incentives based on energy efficiency, and would need to convince regulators – the Public Utilities Commission in California – to allow them to implement a program like SMUD's, with its GHG component.

However, Daly noted, energy efficiency projects are becoming increasingly expensive, opening up the possibility that private utilities will want to invest in both efficiency and GHG reduction.

Moreover, in California utilities are required to buy carbon offsets for the GHG emissions their plants produce, and Daly thinks they could make a case for buying offsets through their incentive programs with customers. "If regulators would allow them to do it, they could implement it very quickly and easily because they have all the program infrastructure in place."

SMUD plans to share its experience with natural refrigerant incentives with other utilities, both public and investor-owned, at a variety of venues, including a Department of Energy partnership for energy sector climate resilience, and the California Municipal Utilities Association.

Ryan Hammond, SMUD's senior energy advisor, commercial services, sees GHG reduction becoming a bigger driver of utility value. "It's still a long-term proposition, but this [program] is a good way to test the waters and begin structuring a whole program around it."

At least one private utility, SCE, is working on incorporating "water and GHG incentive values" to go along with energy incentives, said Paul Delaney, senior engineer for SCE. "Including water and GHG reduction calculations would be really good in my opinion."

Even on the energy efficiency side, utilities still need help in identifying the energy-saving capacity of natural refrigerant systems, Daly said. "One of the big issues – and hopefully SMUD is going to help us with this – is clearly delineating the efficiency benefits of implementing [natural refrigerant] technology."

Along with other major chains, Whole Foods has a small number of outlets in the SMUD territory. Though Whole Foods is not planning a major overhaul in those stores, Daly is interested in leveraging the SMUD incentives to replace self-contained display cases with propane cases, which the chain has installed throughout the U.S.

Whole Foods has already received incentives for natural refrigerant projects from SMUD (through its legacy programs) and other utilities like Southern California Edison and Consolidated Edison in New York. "I see natural refrigerants as the way forward," said Daly. And he sees incentives as a way to "help clear the road ahead so that we can get there quicker and easier."

Red Bull, which has installed more than 200,000 Eco-Coolers containing isobutane in the U.S. (and about 780,000 globally), regards the SMUD program as "a great opportunity," said Shira Norman, sustainability specialist for the Austrian beverage giant. "If we qualify for incentives through this program, we will certainly go after them. It's very exciting from a sustainability standpoint to have as one of the utility incentives the use of low-GWP refrigerants."

Norman also hopes that Red Bull will be able to "work with other utilities to create incentive programs similar to that of SMUD." ▶

▸ SMUD's incentive options

SMUD, a municipal utility governed by a seven-member board of directors serving four-year terms, has long offered a range of incentives for energy-efficient refrigeration equipment. These includes Custom and Savings By Design (SBD) incentives as well as prescriptive (deemed) after-installation rebates from the Express Energy Solutions program for low-cost (under $5,000) investments in refrigeration efficiency. In rare cases, incentives for innovative cooling technology are available from the ER&D group, whose mission is to study technology that has not been widely implemented in the Sacramento area.

In 2014, Whole Foods received a "whole building" custom and ER&D efficiency incentive from SMUD for retrofitting an existing Sacramento store with a CO_2 cascade system and other energy-saving components; the cascade system contributed about 20% of the energy savings. (See "Getting an Energy Rebate, the Whole Foods Way," *Accelerate America*, June 2015.)

SMUD's natural refrigerant program works with its existing Custom Incentive and SBD programs to provide funding for energy efficiency; the former supports retrofits in an existing building, such as replacing a high-GWP-refrigerant system with a natural refrigerant system; and the latter provide funds for installing a natural refrigerant equipment in a new facility or one undergoing extensive renovation.

At least at the outset, the natural refrigerant program will not offer prescriptive rebates for equipment like display cases that use propane. "For now, [propane cases] will go through the custom program," said SMUD's Ryan. "But as more and more come online, we might make a determination that they go through the rebate program. And they would be eligible for the GHG emission component as well."

For energy savings under the Custom Incentive Program, SMUD will offer an incentive of 10 cents per kWh of energy reduction, and $200 per kW of demand reduction. The total incentive is limited to 30% of the project's cost or $150,000, whichever is less. (For the incentive structure under the SBD program, customers would contact SMUD.)

Separately, the program taps SMUD's ER&D group to reward natural refrigerant installations for their direct GHG emissions reduction. SMUD will offer an incentive of $25 per metric ton of CO_2-equivalent emissions reduction. This incentive is also limited to 30% of the project's cost or $150,000, whichever is less.

All projects located in communities designated as disadvantaged (with preference to those in the top 10%) and implemented by small businesses will receive an incentive bonus equal to 25% of their GHG reduction incentive. To identify those communities, SMUD employs CalEnviroScreen, a mapping tool that helps identify California communities that are most affected by pollution, and where people are often especially vulnerable to pollution's effects.

The combined energy and GHG incentives will be limited to 50% of the project's cost or $250,000, whichever is less.

End users receiving incentives must agree to allow SMUD (or designated contractors) to collect energy consumption data from the natural refrigerant equipment with sub-metering devices over a three-year period to vet the accuracy of efficiency forecasts. They will also be asked to share annual refrigerant leak data for three years.

The GHG component of the program will enable SMUD to "test the waters in the region" for natural refrigerants, said SMUD's Ave, adding, "It's designed to help grow the market, mainstream the technology to the extent possible, and observe it." However, she expects the GHG incentive offer to have a limited lifetime. "That's typical for research programs; they're generally shorter term. I'd like to have a good few years of participation." ▸

NATREFS PART OF NEW ENERGY PLAN

The California Energy Commission (CEC), the state's primary energy policy and planning agency, has adopted a three-year strategic investment plan that for the first time includes an initiative to test and evaluate natural refrigerants for commercial and industrial applications.

The plan, known as "The Electric Program Investment Charge (EPIC): 2018-2020 Proposed Triennial Investment Plan," is a strategy for administering research and development funds. CEC invests more than $120 million annually through EPIC.

The California Public Utilities Commission, which launched EPIC in 2011 and oversees it, began conducting a formal proceeding to consider CEC's plan this month, with approval anticipated in December 2017; after that eligible projects could begin submitting applications for funding.

One of the initiatives under the plan – Initiative 1.7.1, entitled "Optimize Refrigeration Compressor Efficiency and Test and Evaluate Alternative Refrigerants" – will "test and evaluate alternative refrigerants, such as propane, CO_2 and others, for both small and large refrigeration units in commercial/industrial applications in various climate zones."

Whole Foods Markets is one company that has been involved in EPIC-funded projects. "It allows us the invest in emerging technology," said Aaron Daly, energy manager for Whole Foods. In natural refrigerants systems, he noted, emerging technology includes parallel compressors and ejectors used in transcritical CO_2 systems. The EPIC program "gives retailers an opportunity to help move the market forward."

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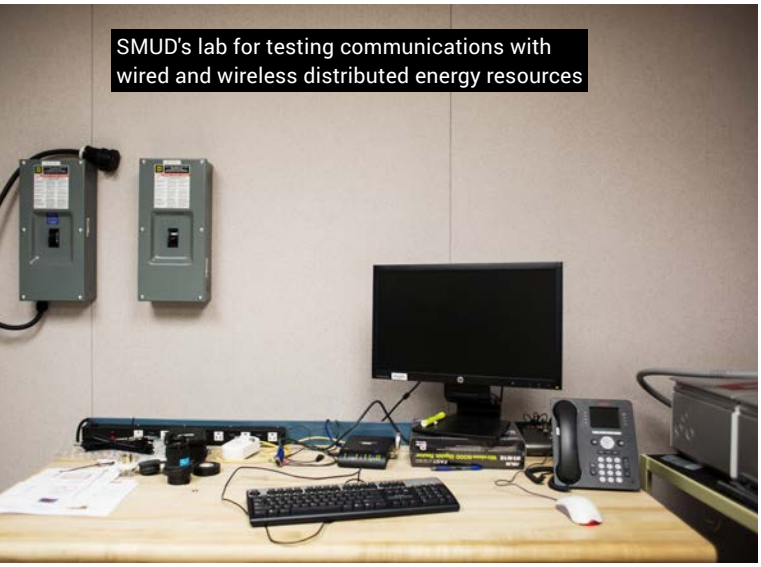
HFC emissions data and CARB report at SMUD headquarters


SMUD's lab for testing communications with wired and wireless distributed energy resources


Substation near SMUD headquarters

▶ The program limits participation to one incentive per company, noted Hammond. "It's a seed to get the idea out there." After a retail chain uses the incentive to successfully implement a natural refrigerant system in one store, the expectation is that "they would apply it to other stores," he said.

The incentive budget for the GHG reduction part of the program is between $500,000 and $600,000 for the first two years, said Ave, acknowledging its modest size. "We may exhaust the budget and just be in monitoring mode." On the other hand, "we could augment [the budget] if we get a good response and positive initial results." Ave would like to have a mix of natural refrigerant systems to study, including systems employed in disadvantaged neighborhoods.

The Custom Incentive and SBD budgets covering the energy efficiency side of the program "are a lot larger," said Hammond, who declined to be specific. "They can dry up, but in five years I haven't seen it yet."

Setting the baseline

As with any incentive program, an essential element is the establishment of a baseline against which performance of the new system is measured. In the SMUD's Natural Refrigerant Incentive Program, the energy efficiency baseline for custom incentives is the efficiency of an existing system when it was new; if the system is non-operational, then the baseline reverts to the California Energy Code or an industry standard, which are also used as the efficiency baseline for SBD incentives.

The GHG emissions baseline – as well as the GHG emissions for the natural refrigerant system – is the product of three factors: refrigerant GWP, refrigerant charge, and annual refrigerant leak rate. The difference in GHG emissions between the baseline system and the natural refrigerant system, multiplied by the default lifetime of the natural refrigerant system (15 years), produces the total estimated GHG emissions reduction used to award the incentive ($25/MtCO2-e).

For retrofits, the GHG emissions baseline uses the legacy refrigerant GWP and charge, while for new systems the GHG emissions baseline uses a default refrigerant GWP (2,107 for remote commercial systems and 2,676 for stand-alone systems) and a default charge (2.56 lbs. per MBTU/hr. of cooling capacity of the new system or 0.5 kg for a stand-alone system). A default annual refrigerant leak rate of 20% (or 8% for stand-alone systems) is

SMUD's sub-metering equipment

used for both GHG emissions baselines, while engineering leak-rate estimates are used for the natural refrigerant system.

"SMUD will calculate the estimated emission reduction for customers, and information on the defaults and calculation methodology will be provided in program documentation," said Hammond. SMUD will also consider a customer's own estimate of GHG savings, as well as its estimate of energy and demand savings.

While securing utility incentives can often be a lengthy process but the SMUD program is offering relatively quick delivery. "To get an estimated incentive to a customer, we usually allow about a two-to-three-week turnaround," said Hammond. "The final incentive is issued within about two weeks from when the project is installed and operational."

Reducing SLCPs

SMUD's decision to offer GHG-reduction incentives for natural refrigerant systems stems from its presence in California, which has legislatively set a goal to reduce GHG emissions to 40% below 1990 levels by 2030. One of the six pillars of the state's climate strategy is the reduction of short-lived climate pollutants (SLCPs), including HFCs, which are "super pollutants" that remain in the atmosphere for a relatively brief time but pack a powerful warming punch.

The California Air Resources Board (CARB) has prepared an SLCP Reduction Strategy that includes a ban on refrigerants like HFCs that have GWPs of 150 or more in new stationary non-residential refrigeration equipment and new residential refrigerator-freezers. (See "California: A Bridge to the Future," *Accelerate America*, January 2017.)

In its SLCP strategy, CARB included a $20 million low-GWP refrigerant incentive program, funded by cap-and-trade proceeds, and geared to GHG emission reduction. It was expected to launch in 2016, pending approval of the California state budget. But the legislature ultimately chose not to fund the program last year. "We hope [the program] will come back," said Ave. The efficiency data collected by SMUD's natural refrigerant program could support the return of CARB's incentive plan, noted Hammond.

CARB is required to complete the SLCP plan by January 1, 2018, after which it will begin the rulemaking process. End users in SMUD's region will be able to leverage the SMUD natural refrigerant incentive program to meet CARB's GWP requirements for refrigerants.

"SMUD has a history of being involved with super-pollutant reduction," noted Hammond. "Our earlier work was the installation of dairy digesters in our community in conjunction with dairy farmers." The new program identified refrigeration and HFC emissions reduction as "the biggest [SLCP] opportunity for us to bite off," said Ave.

SMUD's efforts in this area are also driven by its status as a public entity governed by an elected board, which requires the utility to focus on not just its own GHG production through power generation but also GHG emissions in the community. "That gives us the flexibility to do programs like [the natural refrigerant incentive program]," said Hammond.

At press time, SMUD had not yet started receiving applications for incentives under the program. But there is a lot of interest, including several "strategic accounts" (supermarkets ▶

NXTCOLD UNITS TARGETED FOR INCENTIVES

Among the natural refrigerant technologies being measured for energy incentives in California are packaged ultra-low-charge ammonia units from NXTCOLD.

Based in Los Angeles, NXTCOLD is one of a handful of companies marketing packaged systems that require far less ammonia than the conventional pumped or gravity-fed overfeed systems traditionally used by cold-storage facilities and food processors. For example, a facility operated by Lineage Logistics in Oxnard, Calif., has an ammonia charge of only 0.5 lb./TR.

NXTCOLD is working with Southern California Edison (SCE) and others to track the energy efficiency and demand response of its packaged units in support of incentive funding. The Oxnard installation has already received incentives of $0.08/kWh for energy savings, and $150/kW for demand reduction from SCE.

Next on the agenda will be studies of energy efficiency and demand response at two Southern California facilities – a Baker Cold Storage warehouse (operated by Lineage Logistics) in Long Beach using 46 rooftop NXTCOLD units; and a General Cold Storage warehouse in South Gate employing eight NXTCOLD units. The studies are being conducted on behalf of SCE's Emerging Technology group by Cypress, Ltd., an energy consulting firm based in Coto de Caza, Calif. Incentives may be rewarded based on the results of the studies.

"We will identify a few strategies for flexible demand response to add or subtract load, depending on conditions, and conduct detailed monitoring of the results," said Tom Smolarek, president of Cypress.

Refrigerated warehouses offer a "prime-time opportunity for demand response/load management" using precisely controlled low-charge-ammonia packaged units, noted Paul Delaney, senior engineer for SCE.

Cypress will also engage later this year in an in-depth demand-response study of the Baker facility on behalf of the Electric Power Research Institute (EPRI), which received a $2 million grant for the project from the California Energy Commission's EPIC (Electric Program Investment Charge) program.

▶ and refrigerated warehouses) from which SMUD has received "positive response" to outreach efforts, said Ave.

SMUD is also working with CARB and Sacramento's local air district (responsible for controlling air pollution from stationary sources) to publicize the program. The Sacramento area, Ave noted, lends itself to serving as a test market for pilot programs. "It's a small enough region – and isolated enough from the Bay Area – to get your arms around."

Even with the availability of financial incentives, the biggest challenge facing the natural refrigerants incentive program, said Ave, will be persuading end users to break out of their comfort zone when it comes to refrigeration technology. "It's getting people to consider these alternatives that may not be as well-known, and to trust that there's an ecosystem – particularly design and maintenance – to support them. You can't accomplish that overnight and just with incentives."

Ave is hopeful that local community colleges and other organizations with HVAC&R technical programs will get involved "to help broaden awareness and make the market transformation happen."

Daly of Whole Foods agreed that a key barrier to natural refrigerant adoption remains the attitude of an organization toward developing new technologies. "Many organizations say 'if it ain't broke don't fix it,'" he said. "So unless we have a clear signal in the marketplace suggesting a reason to do otherwise, there's just the inertia of what's always been done.

"That's why I think what SMUD's done is such as big deal." ■ MG

Montage at SMUD's customer service center

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NYC-Area Utilities ***Eye NatRef Incentives***

PSEG Long Island is processing an energy incentive for a CO_2 cascade system, while ConEd is looking at incentives for transcritical systems.

By Michael Garry

Two New York City-area utilities that have robust prescriptive energy-efficiency rebate programs for food retailers are starting to consider natural refrigerant systems for energy incentives through their custom programs.

"We're starting to see applications come in for natural refrigerant-based systems with energy savings and demand peak savings," said Steve Orman, senior energy consultant, commercial efficiency program, PSEG Long Island, Melville, N.Y., "We have not rebated any yet, but are processing a couple right now." One of those is a CO_2 cascade system, he added. Orman described PSEG's incentive program at a symposium in late March hosted by AAA Refrigeration Service and Hillphoenix in Tarrytown, N.Y.

Under the custom program, which issues incentive funds based on an energy efficiency analysis of the proposed system vs. a baseline system, a food retailer "has to make the case for it," said Orman. PSEG employs a team of engineers who are responsible for validating a food retailer's energy analysis and models. PSEG also does a thorough pre-inspection. "Don't do anything until we document existing conditions," he advised.

"It takes a few weeks to go through the review cycle," he said. "We place heavy emphasis on being as accurate as possible with potential energy savings."

Typically, the custom incentives awarded for natural refrigerant systems are around $1 per W saved and $1,000 per peak kW saved.

Consolidated Edison of New York (ConEd), has not started providing incentives for natural refrigerant systems "but we should be able to evaluate future CO_2 installations; they should in concept be in the incentive program," said Michael Gilbert, ConEd's business development manager, C&I energy efficiency, demand management & sustainability, who also spoke at the AAA/Hillphoenix symposium. ConEd serves New York City and some northern suburbs.

DeCicco & Sons, a seven-store food retailer based in Pelham, N.Y., that is a ConEd customer, saved $74,000 in energy consumption and power demand over a 12-month period as a result of using a transcritical CO_2 booster refrigeration rather than a traditional HFC system. (See "Transcritical Cuts Energy Costs by $74,000 for DeCicco & Sons, *Accelerate America*, April 2017.)

DeCicco's president, John DeCicco, Jr., another symposium speaker, based the energy-savings calculation on a comparison of his store in Larchmont, N.Y., which has operated a transcritical system from Hillphoenix for 15 months, with another DeCicco store in Ardsley, N.Y., which has a conventional R404A system. His utility rate is 18.8 cents/kWh.

ConEd has awarded DeCicco $678,000 in incentives for a variety of efficiency measures, though not for the transcritical system. However, he expects to leverage those savings to earn incentives for future transcritical installations at a new store in Somers, N.Y., and an existing store, in Harrison, N.Y. ▶

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> *We're starting to see applications come in for natural refrigerant-based systems.*
>
> – Steve Orman, PSEG Long Island

Impact of $1 in energy savings

Refrigeration and lighting account for over half of total energy use in a supermarket, "making these systems the best places to start looking for energy-efficiency opportunities," said Orman He strongly urged food retailers to take measures to reduce their electricity consumption, pointing out that $1 in energy savings is equivalent to $59 in grocery sales. "That's a staggering statistic," he said.

And PSEG is willing to pay grocers to install a wide array of energy-saving refrigeration equipment in existing facilities and new construction through its prescriptive commercial program, including LED refrigerated case lighting, evaporator fan controls, EC motors, and case door heater controls. PSEG will also finance an energy study for a retrofit project to identify sources of savings.

Under its custom program, PSEG will consider incentivizing floating head controls on racks, variable speed drives (VFDs) on condenser fans, combined heat and power systems, and thermal energy storage that offers peak demand savings, as well as natural refrigerant systems.

"Rebates on Long Island are currently significant, but may change in the future," Orman noted.

In 2014, PSEG paid an East Northport, N.Y., supermarket a rebate of $47,000 for a retrofit that included the installation of LED lighting, floating head controls and VFDs on rooftop condensers. The equipment cut the store's annual energy consumption by 340 kWh and its peak demand by 37 kW for an annual savings of $61,000. The payback for the equipment was just over one year.

PSEG is willing to help retailers publicize their energy efficiency program, which can be a good "PR opportunity," said Orman.

ConEd, which like PSEG charges among the highest rates for electricity in the U.S., is starting to install "smart meters" throughout its territory as part of a $1.5 billion investment to collect "granular data on how we use energy," said Gilbert. It will allow end users to "do smarter things than they are doing right now."

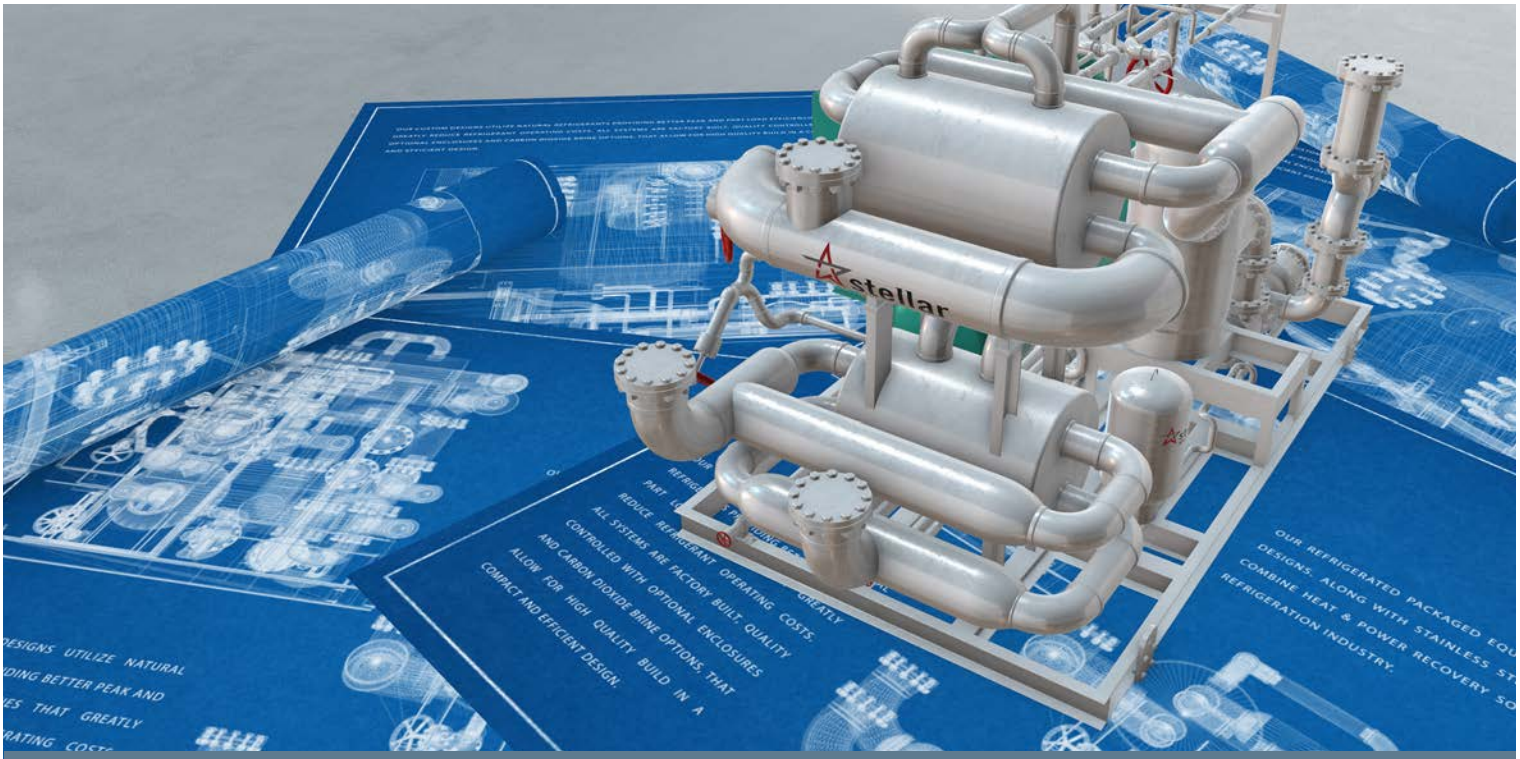
ConEd also offers prescriptive rebates for energy-efficient refrigeration components as well as custom incentives under its commercial and industrial program. Most refrigeration systems fall under the custom program, which offers 16 cents/kWh in energy reduction incentives. "We've got free money and we want to get it out," said Gilbert.

The utility also offers funding to supermarkets with back-up generators (subsidized in part by ConEd) who participate in its demand response program and are willing to drop demand with 21 hours' notice.

Gilbert acknowledged that ConEd's incentives come in rebates after the end user makes the initial investment. "If you have a $100,000 project, and you get a $40,000 rebate, you have to come up with the $100,000," he said. "It's one of the big holes in our program." There are, however, municipal financing sources, such as the New York City Energy and Economics Corporation, that finance energy efficiency projects.

ConEd does offer a Commercial Direct Install program for smaller end users (using less than 300 kW of average peak demand) that provides subsidies rather than rebates, paying up to 70% of project costs for LED lighting, ECMs, night covers and evaporator fan controls.

Both Orman and Gilbert noted that New York State has adopted an aggressive energy strategy called Reforming the Energy Vision (REV) under which the state seeks a 40% reduction in greenhouse gas emissions from 1990 levels by 2030. By that year, the state wants 50% of energy to be generated from renewable sources as well as a 23% reduction in energy consumption in buildings from 2012 levels ■ MG



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Nestlé's ***Natural Refrigerants*** *Journey*

The food and beverage giant has pioneered the use of ammonia, CO_2 and hydrocarbons in its production facilities, and hydrocarbons in its retail foodservice cases, throughout the world, and it's not done yet

By Andrew Williams

From left: Dirk Lilie, Vincent Grass, Nathalie Gingras-Fleuti and Javiera Charad Wilckens, Nestlé

In 1986, as the world was starting to grapple with refrigerants that depleted the ozone layer via the Montreal Protocol, Nestlé began turning to environmentally friendly natural refrigerants.

That year – a year before the Montreal Protocol was signed and three years before it entered into force – Nestlé decided to replace CFC and HCFC at its food processing plants with ammonia.

Thus began a journey that has put Nestlé, a Swiss food and beverage manufacturing giant responsible for more than 2,000 brands, in the forefront of the adoption of ammonia, CO_2 and hydrocarbon systems in manufacturing plants and hydrocarbon freezers in foodservice venues. (Its brands include such iconic names as Nescafé, Perrier & San Pellegrino water, Häagen-Dazs ice-cream, Nesquik cereal, and Kit-Kat chocolate.)

Along with an emphasis on renewable energy, natural refrigerants have played a central role in supporting Nestlé's overall environmental goals, which include a 35% reduction in greenhouse gas emissions from its manufacturing operations between 2010 and 2020. Since 1992, Nestlé has invested 299 million Swiss francs ($307 million) on replacing HFC systems with natural refriger-

ant-based alternatives for industrial refrigeration. In 2016 alone, it installed 47 new industrial refrigeration systems based on natural refrigerants.

For the past seven years, the rollout of natural refrigerants has been led by Vincent Grass, Nestlé's refrigeration team leader, corporate operations – engineering services, who spoke to *Accelerate Europe* at the company's picturesque headquarters in Vevey, Switzerland, alongside Lake Geneva, with a backdrop of snow-capped Alpine mountains. (*Accelerate Europe* is a sister publication to *Accelerate America*.)

The rollout continues under the direction of the 40-year-old Grass, who commutes from his home in nearby Evian, France. "We are expanding the use of natural refrigerants across the company," he said.

About 90% of Nestlé's refrigerant charge – and potential risk in terms of direct refrigerant emissions – is in manufacturing. Commercial applications account for the remaining 10%.

"We're focusing on industrial because that's where we can make the biggest impact," said Grass. "It's where we have the biggest risk of leakage and the highest electricity consumption."

On the industrial side, 90% of Nestlé's refrigerant needs are served by natural refrigerants. While Nestlé continues to expand its natural refrigerant footprint – transitioning away from HFC systems in recently acquired sites – it's hard to predict when the company will use only naturals in its plants, said Grass.

"The thing is," he explained, "we have many different applications in our factories, on different scales and at different temperatures. We also have different geographies, with different climates. The cooling demand is different. We need to look at it product-by-product and application-by-application." Other factors include the lack of available technology in some countries, and restrictive charge limits in some jurisdictions.

"We strive to hit 100%, but we can't say when we'll be there," he said. "Achieving the last 10% is very difficult."

Peter Jaggy, head of engineering at Nestlé, stressed the need to ensure that staff at headquarters, and throughout the 119 countries in which Nestlé operates, are on the same page. "On the fringes, there is a lot of activity which we don't necessarily see from here in headquarters," he said. "This is why it's not so easy to get from 90% to 100%." But he expressed pride at the pioneering role that Nestlé has played in bringing natural refrigerants to so many different countries.

Nestle's Major Natural Refrigerant Milestones

1986: Begins replacing CFCs and HCFCs with ammonia.

2000: First NH_3/CO_2 system

2001: First NH_3/CO_2 system with CO_2 compressors

2005: First hydrocarbon chillers

2006: First CO_2 ice cream freezer

2011: First hydrocarbon ice cream freezer

2016: All ice cream freezer worldwide use hydrocarbons

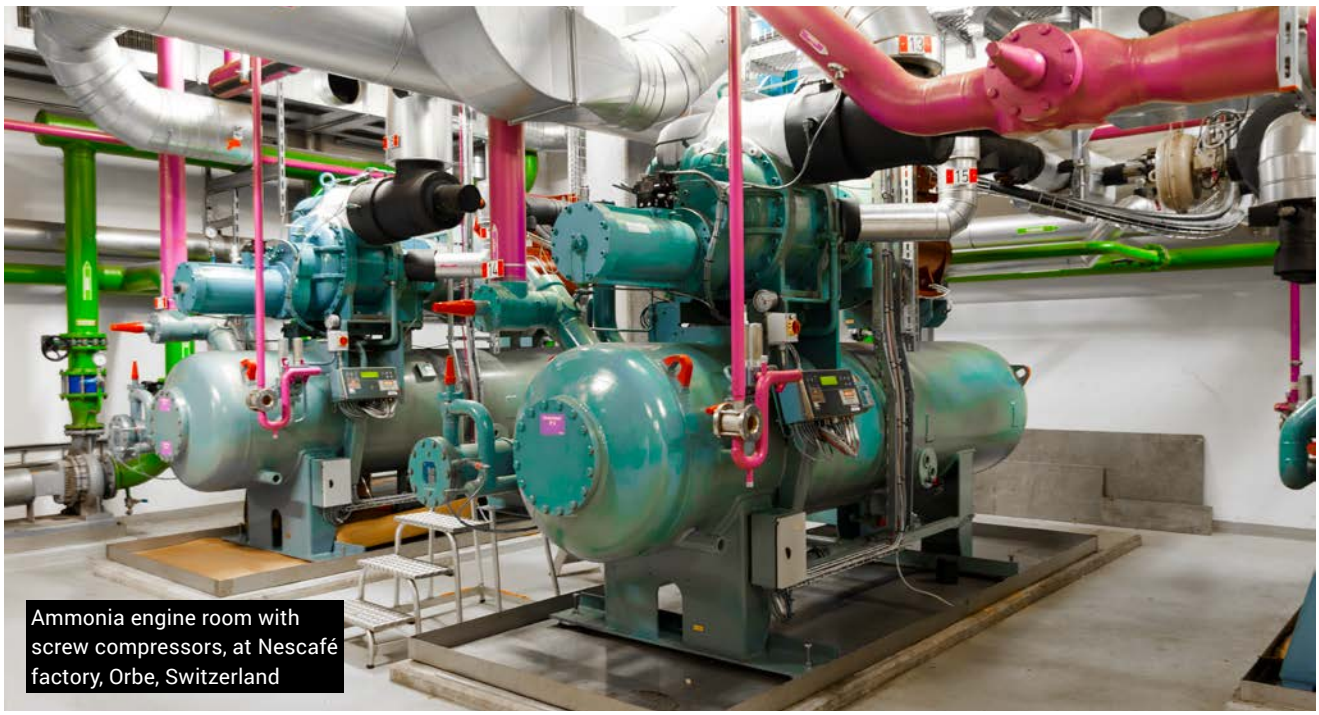
Nestlé is a member of the Consumer Goods Forum (CGF), which brings together over 400 consumer goods manufacturers and retailers seeking to pursue more sustainable business practices. In October 2016, the CGF Board passed a resolution committing its members to deploying natural refrigerants wherever possible. "In markets where barriers to deployment currently exist, CGF members committed to moving to natural refrigerants in new equipment as soon as possible and by no later than 2025," Grass said.

One of the people instrumental in Nestlé's adoption of natural refrigerants is its former chief refrigeration engineer, Holm Gebhardt. Gebhardt, as one of the founders of natural refrigerants advocacy group Eurammon in 1996, helped to convince not just Nestlé but the wider world that natural refrigerants are viable alternatives to F-gases.

In 2000, Gebhardt co-founded the now-defunct Carbon Dioxide Interest Group, which raised awareness of CO_2 technology's potential. "This is why Nestlé is already above 90% natural refrigerants in industrial," said Grass. "We started this journey a long time ago. We've always been convinced that natural refrigerants are the right way to go."

Adding CO_2

Nestlé's original move from CFCs directly to ammonia was initially focused on its largest plants. "Later, we extended our use of natural refrigerants to the replacement of HFCs in smaller systems," said Grass. ▶



Ammonia engine room with screw compressors, at Nescafé factory, Orbe, Switzerland

▶ In 2000, Nestlé added CO_2 to its industrial operations, becoming one of the first food processors to employ that refrigerant. At a factory in Beauvais, France, it replaced 15 tons of CFC R13 installed in the 1970s with an ammonia/CO_2 cascade system in which the CO_2 circulates without compression. "This was a renaissance of CO_2," said Grass. "It had been used at the turn of the century, but for over 50 years it had not been used at all."

A year later, Nestlé opened the world's first large NH_3/CO_2 cascade system to use compressed CO_2, built in cooperation with Star Refrigeration. It replaced an R22 system at Nestlé's coffee factory in Hayes, U.K.

"The valves for CO_2 did not exist at that time," said Grass. "HERL was a valve manufacturer in Germany back then, and they developed the valves for us."

For most big plants, ammonia is the most efficient option, Grass said. But in combination with CO_2, "you can address safety issues and still deliver low temperatures. By adding CO_2, you need more components but the compressors are smaller, so you're reducing your footprint too."

Also in 2001, Nestlé's also issued its first official position paper on industrial refrigeration, pledging to replace its few remaining CFC and HCFC systems with natural refrigerants.

In 2003, Nestlé built its first NH_3/CO_2 system using compressed CO_2 in the U.S., in a Prepared Food Factory in Jonesboro, Ark. The factory includes the first automatic horizontal plate freezers using CO_2 as the refrigerant.

At its Nescafé factory in Orbe, Switzerland, near its headquarters, Nestlé operates an NH_3/CO_2 system that can produce a temperature of -65°F to freeze-dry coffee, as well as hydrocarbon chillers for indirect air conditioning of production areas.

Working for Cofely Axima in 2003, Grass was in charge of the CO_2 side of the installation. "The ammonia is confined to [the] machine room and on the roof in evaporative condensers that reject the heat," he said. "The CO_2 is distributed to all the end uses we have on site across the different floors of production."

Other milestones continued to be reached. In 2005, Nestlé commissioned its first chillers using a hydrocarbon (R290) as the refrigerant in a confectionery factory in York, U.K. "We couldn't hook everything up to the same system, so this is where we started to use hydrocarbon chillers – using water or glycol for the end uses," Grass said.

In 2006, Nestlé installed the world's first CO_2 ice cream freezer in its factory in Bangchan, Thailand. "When you manufacture ice cream in a factory, you use a freezer in which you start to freeze the mixture," Grass said. "In 2006, this equipment did not exist for CO_2. We worked with suppliers to develop the first one."

Nestlé reiterated its commitment to natural refrigerant In 2008, stating that HFCs such as R134a were wrongly presented by their backers as long-term alternatives to CFCs and HCFCs. ▶

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SWISS SYSTEMS

Throughout Nestlé's myriad facilities in Switzerland, it has employed a variety of natural refrigerant systems. Here are some examples.

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» Free cooling effect: when the ambient temperature falls below 52°F, the water that circulates in the data center begins to be cooled in a water-side economiser.

The Nest, Vevey

» Nestlé's discovery center.

» Ammonia-based heat pump provides heating, cooling and sanitary hot water.

» Water circulates in 29,528 ft. of underground and internal piping.

» 36 vertical-loop pipes source heat from the ground.

Nestlé headquarters, Vevey

» During the summer, the building is air-conditioned by the water from nearby Lake Geneva through radiant cooling panels attached to the ceiling.

» By 2020, two ammonia heat pumps for heating and cooling will be added and will save an estimated 1,500 metric tons of CO_2-equivalent emissions per year.

» A small subcritical CO_2 system serves a restaurant.

CO_2 engine room with reciprocating compressors, at Nescafé factory, Orbe, Switzerland

Hydrocarbon ice cream freezers

After a prototype CO_2 ice cream chest freezer for retail and foodservice applications failed to meet efficiency requirements, Nestlé introduced a hydrocarbon-based ice-cream chest freezer in 2011. Since 2014, all the company's new ice-cream chest freezers in Europe have been HFC-free. This policy was extended worldwide in 2015. Since 2016, all of its new ice-cream chest, upright and island freezers have used hydrocarbons, either propane or isobutane, worldwide.

"We see good efficiency with hydrocarbons compared to HFCs," said Grass. "It's a significant difference."

Ice-cream freezers in stores represent one area where the company is trying to tell customers about natural refrigerants. "We're working with our ice-cream business to put a logo on our freezers featuring a QR code that customers can scan to access information about natural refrigerants and their benefits," said Javiera Charad, project manager – environmental sustainability at Nestlé.

By 2020, all new proprietary cold beverage dispensers made by Nestlé Professional will use hydrocarbons.

The availability of service technicians to maintain Nestlé's systems is good in developed countries, but elsewhere in the world, training can be a big issue, said Grass. "In a number of developing countries, if you want to install an ammonia chiller, then finding technicians and operators who already have experience with ammonia is a challenge. You have to train them."

Nestlé pushes manufacturers to open service centers in remote areas. "We're not ready to pay for overseas assistance every time," Grass said. "For component manufacturers, offering training is potentially a big opportunity for their business model. There is a huge shortage of training facilities."

Another obstacle to wider use of natural refrigerant-based technologies is the cost gap with HFCs. "Non-natural systems often tend to be cheaper to acquire," said Jaggy. "This is one of the biggest challenges today. We have to continuously fight the battle of convincing our people that it still makes sense to do this, even if it would be cheaper to do something else."

One consideration is that an industrial ammonia plant usually lasts for 30-40 years. "When we opt for ammonia, we know there won't be any deadlines to phase out or replace it later," Jaggy said.

Having worked on the supplier side, where he dealt with some end users who preferred to take a short-term approach to refrigeration, Grass is glad to be at Nestlé.

"This job gives me an opportunity, as a human being, to take action," he said. "Now I'm on the customer side, and I can make change happen. In the seven years I've been here, we've done a lot. I've had a lot of fun. And we still have a lot to do." ■ AW

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True's New Cases ***Far Surpass Energy Regs***

The expanded line of propane refrigerated cabinets use up to 60% less energy than the DOE's mandated level

By Michael Garry

True Manufacturing showcased its expanded line of propane-based refrigerated merchandising display cases – many of them far exceeding the U.S. Department of Energy's latest energy efficiency requirements – at the National Restaurant Association (NRA) Show May 20-23 at McCormick Place in Chicago.

"Our display cabinets have amazing efficiency numbers," said Todd Washburn, director of sales & marketing, retail division, for O'Fallon, Mo.-based True, adding that the cabinets were completely redesigned as a "ground-up new product."

The refrigerated and "dual-zone" cabinets (split between refrigerated and room temperature) each come in glass and mirror ends, between 36-in. and 77-in in width, for a total of 14 models. The four glass-end refrigerated cabinets are each at least 50% lower in energy consumption (kWh/day) than the maximum allowable value set by the DOE as of March 27, 2017. For example, the DOE maximum for the TDM-R-48-GE model is 13.64 kWh/day, while True has designed the unit to consume 5.53 kWh/day, or 59.5% less.

The energy savings comes from the use of propane refrigerant, as well as LED lighting, ECM motors, and proper "balancing of the refrigeration system," said Washburn.

True introduced the self-contained, air-cooled display cases a year ago, but has expanded to "a full product line this year," he said. They are suited for large and small supermarkets in departments like bakery and deli.

The cases are also designed to keep the temperature of products within a tight range by managing the air flow. "It stabilizes the product at the right temperature," said Washburn. "That's what the retailer cares about."

Many of True's self-contained units not only exceed the DOE energy requirements, but also meet the EPA's more stringent Energy Star 4.0 standard. True is now reviewing some of the equipment on the edge of meeting Energy Star to see if "we can squeeze any more efficiency out of it for Energy Star," he said.

Energy-efficient R290 display cases at the NRA Show

Washburn noted that more retailers are installing self-contained propane cases, in part because they offer more flexibility. "It's easier to add units – you don't have to plug them into a rack," Washburn said. "And they're efficient." It's possible to now equip an entire supermarket with only self-contained cases, and some retailers are doing so while others are moving in that direction, he said.

Helping enforcement

True has been a leader in the conversion of stand-alone display cases from HFCs to propane, with about 80% of its foodservice and food retail coolers now using R290. Many other OEMs, including Beverage Air, Traulsen and Welbilt, have followed True's lead and begun offering propane-based cases, which were also on display at the NRA Show. (See "OEMs Flock to Hydrocarbons," *Accelerate America*, March 2017.)

Most of the movement to hydrocarbon refrigerants has been prompted by the DOE's new efficiency requirements and by the impending delisting of HFCs like R404A and R134a in stand-alone commercial equipment in 2019 and 2020, per the Environmental Protection Agency's SNAP (Significant New Alternative Policy) program.

Given the Trump administration's anti-regulatory posture, it remains to be seen how strictly the DOE will enforce its new efficiency requirements. "The industry will try to help enforcement," said Washburn. "If you are complying and someone else isn't, make a phone call to DOE and ask why this company is not listed [on the DOE website] as complying. Those of us that invested in compliance want everyone to take it seriously." ■ MG

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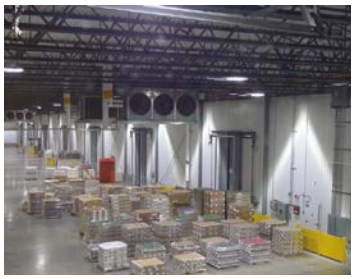

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From left: Hayato Sakamoto and Takahiro Hirao, KHI

H_2O As a Refrigerant

Kawasaki Heavy Industries (KHI) is ready to launch the world's first commercially available water-refrigerant centrifugal chiller for use in air-conditioning applications.

By Devin Yoshimoto & Jan Dusek

Is there an "ultimate refrigerant" that does not heat the planet, deplete the ozone layer, or present the risk of combustion or toxicity?

That's the question posed by Hayato Sakamoto, assistant manager in the Machinery Division of Kawasaki Heavy Industries (KHI), and his team as they observed the global shift towards more environmentally friendly refrigerants.

The answer, they found, is yes there is – and it's water.

After several years of development and testing, KHI is now ready to market the world's first commercially available water-refrigerant centrifugal chiller for use in air-conditioning applications.

"For the air-conditioning industry, systems using water as a refrigerant have been an eternal theme," said Takahiro Hirao, senior manager in the Aerodynamic ▶

KHI water-refrigerant turbo chiller

▶ Machinery Department, Machinery Division, at KHI. "Although there were other manufacturers who worked on development, no one could invent a feasible product, because their solutions were several times larger than existing systems with the same refrigeration capacity,"

KHI, however, has never been the type of company to shy away from an engineering challenge – especially if the work leads to a breakthrough that has the potential to change the world.

Matrix management

KHI has, in fact, had a long history of solving technical challenges by leveraging knowledge across different technical fields.

The Tokyo-based company does this through what it calls matrix management – a corporate manufacturing philosophy that encourages researchers to internally share issues with experts in other fields to look for the best technical solutions, rather than having departments work independently from one another.

One of the most recent examples of this is the release of Kawasaki's new Ninja H2R/H2 motorcycle. The motorcycle has been able to achieve the company's highest performance benchmarks to date. This was achieved by incorporating industrial technology – from KHI's work with gas turbines – in the motorcycle's research and development process.

Why is this important? Because the gas turbine knowledge was the same source of inspiration that led to overcoming the challenges of working with water as a refrigerant. Hayato Sakamoto told *Accelerate Japan* how KHI overcame those challenges. (*Accelerate Japan* is a sister publication to *Accelerate America*.)

Water's challenges

Using water as a refrigerant presents two main challenges. First, water requires the achievement of a significantly higher pressure ratio between the condenser and the evaporator, compared with standard HFC chillers.

"Unlike HFCs, which exist in the form of a gas under normal atmospheric conditions, water is a liquid, and its pressure needs to be reduced in order to change phases from liquid to gas," Sakamoto explained.

Second, because water exists as a liquid in normal atmospheric conditions, it has a much larger volume than HFC gases. This means that, in addition to increasing the performance of the compressor, its size would also have to increase.

"Using water as a refrigerant," Sakamoto says, "multiplies the volumetric flow rate 100-fold, necessitating the use of a large compressor, which inevitably makes the chiller larger."

To improve the compressor performance while minimizing its size, KHI developed a high-speed motor and a two-stage compressor, leveraging knowledge gained from fluid analysis technology in the development of KHI's gas turbines and steam compressors.

The proprietary high-speed motor achieves a high rotation speed by using the fine control of magnetic force. ▶

▶ The motor is integrated with the compressor, explained Sakamoto. "Therefore, the motor's coil is coated with resin for insulation and to make it waterproof. Because the motor is connected directly with the compressor, there is no need for a speed-increasing gear or oil."

In addition to the high-speed motor, KHI adjusted the number and shape of the impeller blades. And the company developed a two-stage compressor by placing an intermediate cooler in between the two-stage compression process to keep the temperature low inside the compressor.

These compressor enhancements allowed the system to achieve a seven-fold pressure ratio between the evaporator and the condenser. In addition, it allowed the compressor to remain small yet perform well enough to overcome water's large volumetric flow rate when used as a refrigerant.

Optimal component arrangement

The final touch came from arranging all the components inside a single enclosure before vacuum sealing it, which further enhanced the system's performance and efficiency.

This, however, was no easy task.

"At the beginning of the development process, we made a prototype with just a quarter of the current capacity to examine if water refrigerant is even viable for turbo chillers," recalled Sakamoto. "Back then we had difficulties just making the inside of the system a vacuum, causing us to fail to achieve expected results.

"To make it smaller," he added, "we needed to lay out the components in a very complicated manner, just like putting together the pieces of a jigsaw puzzle. And the complex structure caused another challenge: internal energy loss,"

In order to increase the efficiency of the system, KHI had to minimize the air leaking from the motor. This was done by "enclosing the motor inside the entire system and connecting it directly with the compressor."

This means that the evaporator, compressor, motor, and other primary components are all packaged within the vacuum container.

Once the optimal arrangement of the components had been found, KHI was finally ready to put the system into action and measure its operating performance.

Kobe operation

In 2013, KHI installed the chiller at its Kobe Works facility in Kobe, Japan. The chiller powers the six-story office building's centralized air-conditioning system – providing cooling for 53,820 square feet.


Cooling towers

The water-refrigerant chiller, along with secondary absorption chillers, supplies air conditioning for a canteen on the first floor and offices from the second to the fifth floors. The sixth floor has meeting rooms, which are air conditioned by packaged systems.

Sakamoto detailed the water-refrigerant chiller's typical operational day.

1. Before 6 am, the chilled water and the cooling water are saturated at the ambient temperature. At 6 am, the system controller starts the chilled water pump, the cooling water pump, the cooling tower fan, and finally, the turbo chiller.
2. The compressor gradually increases rotational speed to the set value to avoid surge phenomena. After the compressor reaches the set value, the chiller starts to control the chilled water temperature.
3. During stable load conditions, the chiller controls the chilled water temperature at 7±0.3°C (44.6±0.9°F).
4. The system then supplies chilled water at 7°C (44.6°F) to air handling units on each floor.
5. The entire system is operated on a daily start-and-stop basis, with chilled water stored every morning automatically before the load starts to increase.
6. The load then begins to increase around 8 am and peaks in the mid-afternoon, when the first-floor canteen runs from 11:30 am to 2 pm.
7. If the load exceeds 352 kW (100.1 TR), one of the absorption chillers starts to operate. In this case, the number of system units changes from one to two and the required load for the water-refrigerant chiller itself drops sharply from 352 kW to 176 kW (50 TR).
8. Finally, the chiller stops operating at 9 pm and the cycle starts again the next morning.

Before testing the system, one of the major operational concerns of Sakamoto and his team was how the chiller would handle sudden load changes. ▶


Cooling water inlet and outlet piping

The turbo chiller has been used for air-conditioning in Kawasaki's Kobe Works office since 2013. Here are the specifications of the system currently in use:

Turbo chiller capacity: 352 kW (100 TR)
High-speed motor rating: 110 kW (31.3 TR)
Secondary absorption chiller capacity: 422 kW (120 TR)
Stand-by absorption chiller capacity: 422 kW
Chilled water inlet temperature: 12°C (53.6°F)
Chilled water outlet temperature: 7°C (44.6°F)
Cooling water inlet temperature: 30°C (86°F)
Cooling water outlet temperature: 35°C (95°F)
Size: 8.2 ft. x 8.2 ft. x 8.5 ft.
Net weight: 8.0 t
Coefficient of Performance: 5.1
No. of cooling towers: 3
No. of buffer tanks: 1

▶ "We were concerned about whether or not the chiller would be able to keep up and maintain the chilled water's required temperature," said Sakamoto. That's because "the inertia of the compressor rotor is much larger than HFC chillers due to the compressor's large size."

However, the team observed that the chiller was able to maintain the chilled water temperature at 7±0.5°C even if the load required for the chiller changes sharply.

Results

As of June of last year, the chiller had operated for a total of 4,260 hours and the team had confirmed the chiller's ability to handle temperature and load fluctuations as well as the compressor's ability to avoid surge phenomena.

The water-refrigerant turbo chiller is "performing well, just like our initial estimation, delivering COP of 5.1, which is comparable to existing HFC systems, throughout three years of operation," said Sakamoto. "Assuming a service life of 15 years, the amount of HFC reduction would be 575 tons of CO_2-equivalent."

Why water?

Looking to the future, there is no doubt that the speed of technological development with respect to natural refrigerants will only accelerate. But the question is, does the industry want to use this opportunity to come up with mere stop-gap solutions, or seize the chance to find a long-term solution?

"We regard water as the ultimate refrigerant, because it has no ozone depletion potential or greenhouse gas effect," said Hirao. "Also, it is neither combustible nor poisonous. So, we hope to promote it globally in the future,"

Market awareness and adoption of natural refrigerant technology is a must for the water-refrigerant turbo chiller to succeed. Kawasaki has a long-term vision, but at the end of the day, there needs to be an overall awareness and willingness to choose natural refrigerant technology.

Asked what must still be done to create these conditions, Sakamoto replied: "Improving efficiency and reducing product costs by manufacturers is important. In addition, since GWP regulation is less strict in the air-conditioning market, I believe a favorable environment for natural refrigerants will be formed if more strict regulations are imposed on HFCs in that sector."

Pioneer's pride

Challenges undoubtedly remain for the introduction of the water chiller.

Nevertheless, as one of a few pioneers who work on natural refrigerant technology in the air-conditioning market, Sakamoto and his team show strong dedication to their product.

"Our system is as small as existing systems while delivering a comparable performance," he said. "This is a breakthrough. We hope our customers recognize this and consider using our product."

"Don't be afraid. Let us make it prevail together."

If innovative companies like Kawasaki are able to overcome the challenges of using water as a refrigerant through technology and innovative engineering, it only serves to show the possibilities for natural refrigerants ■ **DY & JD**

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February 2017
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Issue #23
March 2017
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Issue #24
April 2017
Focus: Industrial Refrigeration (low-charge ammonia and CO_2)

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Focus: Utility Incentives

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Publisher	Marc Chasserot marc.chasserot@shecco.com @marcchasserot
Editor	Michael Garry michael.garry@shecco.com @mgarrywriter
VP-Business Development; Technical Editor	Derek Hamilton derek.hamilton@shecco.com.
Contributing Writers	Jan Dusek Eda Isaksson Charlotte McLaughlin Andrew Williams Devin Yoshimoto
Ad Coordinator	Silvia Scaldaferri
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Graphic Designers	Juliana Gómez Anna Salhofer
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