Ammonia Cascade Systems

November 15, 2012
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- Raise your hand during Q&A (hand button is on the upper right part of the screen)
Sending Questions via Chat
Sending Questions via Chat

Chat (Everyone)

Presenter: Welcome to today's session.
Presenter: We'll get started shortly.
Presenter: If you have questions feel free to raise them now.
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Options:
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Everyone  Hosts
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Today’s speakers…
George Ronn is the Senior Manager of Refrigerant Compliance and Control Systems at SUPERVALU. He manages refrigerant compliance activities for SUPERVALU, which includes training in-house service technicians and outside contractors on the company’s expectations regarding leak repair and refrigerant use in 1,500 stores across the country. In his role, he is also responsible for leak reduction measures, including the R-22 Initiative referenced in this presentation.
Richard Heath and his team in Boise work with OEMs, design engineering firms, and government agencies to develop and validate technologies needed to meet enterprise and industry sustainability goals and requirements. His team also manages all energy efficiency projects and is responsible for meeting corporate energy reduction goals.
Caleb Nelson is a Mechanical Engineer and one of CTA’s group managers specializing in refrigeration systems for commercial applications. One of the main goals of his group at CTA is to lead the industry in providing unique solutions for end-users to meet their own efficiency and stewardship goals. The use of natural refrigerants has played an essential role in meeting those goals and has been a primary focus for Caleb for the past several years. Caleb is an active member of the IIAR and continues to seek out ways to fine tune the use of NH3 and other natural refrigerants for commercial use.
SUPERVALU and Natural Refrigeration

Journey to Net-Zero
• Superior Goal Achievement – 2008, 2009, 2010
• Distinguished Supermarket Partner – 2009, 2011
• Best of the Best Award
  – Shaw’s/Star Market Chestnut Hill, MA – 2010
  – Albertsons Carpinteria, CA – 2012
• First GreenChill Certified Store - Gold
  – Cub Foods Phalen – December 2008

• First GreenChill Platinum Certified Store
  – Shaw’s/Star Market – Chestnut Hill, MA - September 2009

• First Natural Refrigerant Store
  – Albertson’s – Carpinteria, CA - July 2012
• Reducing refrigerant use year-over-year is one of our facility team’s 3 key metrics; and our individual and collective annual performance is measured against it within SUPERVALU!

• Re-enforced after joining GreenChill, but part of our corporate culture since 2003.
Options for the Upper Cascade System:

- Low-charge **Synthetic** Refrigerant  *(Existing Assets)*
- **Natural** Ammonia (NH3) Chiller. *(NEW Assets)*
- **Natural** Hydrocarbon  *(NEW Assets)*
- Future ???

Using CO2 as the in-store refrigerant eliminates 90% of the non-natural refrigerants:

- This is a feasible and proven technology available for all supermarket projects now.
Ammonia has been used as a refrigerant far longer than any of the Synthetic Refrigerants. We do not need to prove that it works; we need to prove that we can apply the technology to Supermarkets, validate the benefits, and determine the feasibility point.
NH3 System Design Development

Why NH3?

Why Reciprocating Compressors?
- Proven, work-horse of Industrial systems for decades.
  - Simple, Cheap & Familiar
  - Full and part load efficiency

Why Open-Drive?
- Efficiency
- Recip. application range (high discharge temps with NH3)
- Small leakage through shaft seal is insignificant and not an issue.

Why Flooded Evaporator?
- Efficiency
  - No “Hot Spots”
  - Practically no superheat at compressor suction
- Allowed use of standard Non-miscible, Mineral Oil.
  - Able to use and Automatic Oil Return System.
Why NH₃?

NH₃ System Design Development

• Challenges with Dry Expansion and Miscible Oil
  – Evaporator loses efficiency
  – Miscible Oils such as PAG are very Hygroscopic! …So is NH₃.
  – Need superheat to separate miscible oil and NH₃.
    – Compressor Efficiency
    – Reciprocating Application Range
  – Specific Volume of NH₃—approximately 6 times R-22 or R404a

*A Dry Expansion System boasts many attractive benefits, but not without concerns that must be addressed.*
Real vs. Perceived Obstacles

- Regulations ➔ Keep Charge below 500 pounds
- Safety ➔ Standard OSHA Requirements
- Energy Use ➔ > 25% Increase in Efficiency
- Design Complexity ➔ Use Dedicated System Engineering vs. Equipment OEM
- Operational Complexity ➔ Very similar to standard DX Racks
- Controls Complexity ➔ Need to work with Control OEMs to develop canned packages similar to existing refrigeration controls.
- Service Contract Cost ➔ Here’s our Hurdles: Costs are prohibitive at this point for large scale roll-out.
- First Cost Premium
The Carpinteria refrigeration system is a Cascade design with CO2 as the in-store refrigerant:

The CO2 is cooled by the Upper Cascade located on the roof.

- For the Upper Cascade on this project we have (2) independent technologies; Ammonia (NH3) and R-407A.
- NH3 cascaded with CO2 provides us with a 100% natural solution. This is the first application for NH3 in supermarket commercial refrigeration in the U.S.
- The overall feasibility and lifecycle environmental benefits of NH3 will be evaluated with this project.
- The R-407A system is installed for the sole purpose of direct comparison and real-time validation of the expected benefits of the NH3 system.

Working with the DOE and EPA through GreenChill and NREL, we will conduct a complete comparative analysis of the two options. The result will be a validated Total Equivalent Warming Impact (TEWI) for both options and the results will be shared with the industry.
Additional System Information

• Charges:
  – R717: 300#
  – R407a: 350#
  – R744: 1600#

• Capacities:
  – C02 Combined System: Approx. 70 TR (Low and Med Temp)
  – R407A & NH3 Systems: Approx. 85 TR (+13 evap)
Use of All-natural Refrigerants Reduces TEWI both Directly and Indirectly!

The all-natural refrigeration solution deployed at the Carpinteria store reduces the primary refrigeration energy by >25%. And eliminates all Direct Emissions.
NH3 vs 407A Daily Energy Use Comparison
(Actual Data to-date as of 11/14/2012)