Refrigeration and Refrigerants

Examples of EPRI Projects

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Overview: Refrigeration & Refrigerants

- Many HVAC&R categories face pressing changes
  - U.S. EPA, California ARB
  - Some applications have major changes happening very soon

- Near term alternatives?
  - Retrofits, “drop-ins”, and near-term new equipment
  - Nearly all new alternatives require some compromise
    - Efficiency, capacity, safety

- EPRI Work:
  - Summary of extensive third party tests
    - Key information to understand requirements, safety etc
  - Completed and ongoing field work
    - Project using low-charge ammonia/CO₂ at Imuraya (SCE)
    - Project using ultra low-charge ammonia at Takara (CEC EPIC)
  - Project on heat pumps at residential sites in California (CEC EPIC)
Refrigerant Multi-funder Supplemental Project

Alternative Refrigerants for Enhancing Customer Value (Refrigerant Collaborative)

- Multi-Funder Collaborative
  - Funders – SCE, BPA, SDG&E, and Southern Co.
- How will refrigerant changes impact the industry?
  - Summarize the changes, the options, and the impacts/opportunities
- For tech(s) of interest:
  - In-depth review and laboratory/field evaluation
- Low-Charge Ammonia Refrigeration
  - Opportunities for refrigerated warehouse
  - Also industrial applications

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Low Charge Ammonia/CO₂ Refrigeration Project at Imuraya

• Project Partners
Low Charge Ammonia/CO₂ Replacing R507A Refrigerant

• 2,100 square foot freezer at -20°F
• NewTon 3000 from Mayekawa
  - Low charge ammonia primary, CO₂ secondary
  - 2 stage compact screw compressor
  - VFD speed control
  - Double economizer
• First U.S. installation
• 30% premium in first cost
• Installation similar to standard
• Total energy savings = ~30%

Source: ASHRAE Journal Article February 2017
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CEC EPIC Project: Ultra-Low Charge Ammonia Refrigeration System

Big Picture
• Advancing new ultra-low charge ammonia chiller in industrial sector
• Highly efficient, zero GHG, air source (water savings)
• Applications in food processing, walk-in coolers, supermarkets etc.

Primary Objective
• Pilot an advanced natural refrigerant based process cooling system

Potential Benefits
• Annual energy savings of 4,703 GWh
• Annual water savings of 8,467 million gallons of water

Partners
• CEC, EPRI, Mayekawa, EdF Innovation Labs, Takara

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CEC EPC-16-048: Project Partners

- Funder:
  - California Energy Commission

- Prime:
  - EPRI

- Technology Provider & Subcontractor:
  - Mayekawa
  - Mycom
  - EDF

- Cost share/ co-funding:
  - EPRI
  - Takara

- Demonstration Site:

- Support and Tech Transfer
  - Edison
Chiller Performance (70-80% capacity) with Chilled Water Supply Temperature

<table>
<thead>
<tr>
<th>COP</th>
<th>R-507A</th>
<th>R-717</th>
</tr>
</thead>
<tbody>
<tr>
<td>43°F</td>
<td>3.11</td>
<td>4.45</td>
</tr>
<tr>
<td>44°F</td>
<td>3.19</td>
<td>4.40</td>
</tr>
<tr>
<td>45°F</td>
<td>3.19</td>
<td>4.50</td>
</tr>
<tr>
<td>46°F</td>
<td>3.21</td>
<td>4.51</td>
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</tbody>
</table>

Filters:
- Ambient Dry Bulb 65-70 °F
- Chiller Capacity 70-80%
- Compressor power 5+ kW

Ammonia chiller show ~40% efficiency improvement.
The R-507A chiller’s COP averaged 3.17. The R-717 chiller’s COP averaged 4.46.

Note: This is work in progress; final results may vary
Some Thoughts

- Low GWP refrigerant technology is here today
- Higher efficiency observed while using certain refrigerants
- Low charge ammonia and CO$_2$ refrigerants have good opportunity
- Higher first costs, but savings through the life of the project
Thank you!

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