Ensuring a Safe Refrigerant Transition

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Xudong WANG
Air-Conditioning, Heating, and Refrigeration Institute
Big Changes are Coming

• High-GWP refrigerants will be phased down on a global scale

• Drivers:
  • Montreal Protocol – Kigali Amendment
  • Europe - F-gas regulations
  • U.S. – EPA, California
  • Canada
  • Japan
  • Australia
Low GWP Refrigerants Evaluation

- AHRI Low-GWP Alternative Refrigerants Evaluation Program
  - Evaluated more than 50 low GWP refrigerant candidates
  - Viable low GWP refrigerants exist
  - Many promising refrigerants are classified as 2L under ASHRAE Standard 34 (mildly flammable)
Flammability - Low-GWP Alternatives

Flammability Properties

- Heat of Combustion, Btu/lb
- Burning Velocity, cm/sec

Classes:
- Class 2
- Class 2L
- Class 3

Fuels:
- Gasoline
- Propane (R-290)
- Isobutane (R-600a)
- Ammonia (R-717)
- R-152a
- R-1234yf
- R-452B
- R-457A
- R-454B
- R-410A
- R-134a
- Dry wood
- Green wood
- R-152a

Increasing Damage Potential
U.S. Path for using flammable refrigerants

ASHRAE Standard 34 Designation and Safety Classification

EPA SNAP Approval Significant New Alternatives Policy Program

In compliance with

Safety Standards
- Refrigeration Systems: ASHRAE Standard 15
- Equipment: relevant UL/EN/ISO Standards

Adopted by

Model Building Codes

State and Local Codes
Jan 2021: Deadline to submit code changes for 2024 code cycle

2024: Model Building Codes fully enable flam. ref. and ready for adoption by local jurisdiction

A2 Countries (Developed)
AHRTI Flammable Refrigerant Research

• A collaborated research program is supported by
  • AHRI ($1 million)
  • ASHRAE ($1.3 million)
  • California Air Resource Board ($0.3 million)
  • US Department of Energy ($3 million)

• The objective is to
  • produce publicly available technical results to support code and standard activities related to the use of flammable refrigerants.
Launched high priority projects

• AHRTI Conducting:
  • AHRTI-9007: Benchmarking Risk by Real Life Leaks and Ignitions Testing
  • AHRTI-9008: Investigation of Hot surface Ignition Temperature (HSIT) for A2L Refrigerants
  • AHRTI-9009: Leak Detection of A2L Refrigerants in HVACR Equipment

• ASHRAE conducting:
  • ASHRAE-1806: Flammable Refrigerants Post-Ignition Simulation and Risk Assessment Update
  • ASHRAE-1807: Guidelines for Flammable Refrigerant Handling, Transporting, Storing and Equipment Servicing, Installation and Dismantling
  • ASHRAE-1808: Servicing and Installing Equipment using Flammable Refrigerants: Assessment of Field-made Mechanical Joints

• DOE funding:
  • ORNL: Investigate the proper basis for setting charge limits of A2L, A2, and A3 for various types of products
  • NIST: Modeling tools for low-GWP refrigerant blends flammability
AHRTI Project 9007 Whole Room Scale Testing

• Both A2L and A3 refrigerant tests are complete
• Designed to understand the ignition event severity not probability of event

<table>
<thead>
<tr>
<th>Equipment</th>
<th>A2Ls</th>
<th>A3 (R290)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTAC</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mini-split</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>RTU</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Residential AC</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Reach-in cooler</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Walk-in</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Service error and elec. feedthrough failure</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
PTAC: A2L vs A3 at m1 charge per UL-60335-2-40

R452B, 1920 grams, 47.4 g/sec
No mitigation
LFL = 11.9% v/v

R290, 114 grams, 21 g/sec
No mitigation
LFL = 2.1% v/v

Small blue flame extinguished right away, no further propagation.

Flame propagates at floor level; two deflagration vents burst and one melted open.
Reach-in cooler testing: R290 at 200g

- Door-opening test per IEC 60335-2-89

<table>
<thead>
<tr>
<th>Start of high speed flame</th>
<th>27 milliseconds after start of high speed flame</th>
</tr>
</thead>
<tbody>
<tr>
<td>The high speed flame has extended 3.5 m from the cooler in 27 milliseconds or 130 m/s.</td>
<td></td>
</tr>
<tr>
<td>The camera view changed due to the pressure wave impacting the camera’s wall.</td>
<td></td>
</tr>
</tbody>
</table>
Where are we now?

• Much better understanding the ignition risk and severity under worst case scenarios that are unlikely to happen.
• Many household ignition sources and hot surfaces cannot ignite A2L refrigerants.
• Development of training materials and guidelines are in progress.
New research projects

- Assess refrigerant detector characteristics for use in HVACR equipment
- ASHRAE: Combustion byproducts risk study
- Assess the effectiveness of mitigation requirements
Industry is focused on...

- Safe transition
- Identifying barriers and removing them
- Meeting phase-down commitments
Barrier: Code Limitations

Regulatory and safety barriers on using A2L and A3 refrigerants in homes and buildings
## Key Standards

<table>
<thead>
<tr>
<th>Regions</th>
<th>General Standard</th>
<th>Product Standard for ACs</th>
<th>Product Standard for Refrigeration</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>ASHRAE-15</td>
<td>UL 60335-2-40</td>
<td>UL 60335-2-89</td>
</tr>
<tr>
<td>International</td>
<td>ISO-5149</td>
<td>IEC 60335-2-40</td>
<td>IEC 60335-2-89</td>
</tr>
<tr>
<td>Canada</td>
<td>CSA B52</td>
<td>CAN/CSA-C22.2 No. 60335-2-40</td>
<td>CAN/CSA-C22.2 No. 60335-2-89</td>
</tr>
<tr>
<td>EU</td>
<td>EN-378</td>
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Status of Key Standards

• ASHRAE-15, 2016
  • Addendum d (published in Oct, 2018): A2Ls for human comfort
  • Addendum h (published in Oct, 2018): A2Ls for machinery room

• Stationary Cooling: UL 60335-2-40, Edition 3: Fully enable A2Ls
  • Ballot approval of the standard passed in Feb, 2019. 160 comments addressed with final vote August 26, 2019.
  • Goal: Ready for publication on or before Sep 24, 2019

  • Edition 2 will be based on IEC 60335-2-89
  • IEC 60335-2-89 Edition 3 (published on June 20, 2019) increased allowable charges to ~500g R290 and 1.2kg A2Ls
  • UL 60335-2-89 may have its deviation and have different charge requirement.
Challenge: Knowledge

Knowledge of new technologies needs to be relayed to most distributors, technicians, engineers, building owners, and consumers.
Communication is Key

We need to stop just talking to ourselves

Key audiences do not know transition is occurring

- Technicians
- Building owners
- Architects and engineers
- Building code officials
- Fire marshals

Ignorance (lack of knowledge or information) creates fear
Questions?

Contact:
Xudong Wang
Email: xwang@ahrinet.org   Tel: 703-600-0305