Blowing Agent – Regulatory Environment

Workshop on Management of HFCs: Technical Issues

BASF Corporation

April 21\textsuperscript{st}, 2015
Evolution of Blowing Agents

1\textsuperscript{st} Generation
- High ODP
- High GWP
- CFC-11
- CFC-12

2\textsuperscript{nd} Generation
- Low ODP
- High GWP
- HCFC 141b
- HCFC R-22

3\textsuperscript{rd} Generation
- Zero ODP
- HC Cyclopentane
- HFC 134a
- HFC 245fa

4\textsuperscript{th} Generation
- Low GWP
- HC Cyclopentane
- HFO
- Formacel 1100
- Forane® 1233zd
- Solstice™ 1233zd(E)
Is Insulation Critical?

R-Value Importance

Yes

- HFC-245fa
  - $$$$
- HFC-134a
  - $$
- Hydrocarbon
  - $

NO

- HFO’s
  - $$$$$$
- Water
- Formic Acid

- Hydrocarbon
  - $
- HFO’s
  - $$$$$$
- Water
- Formic Acid
Blowing Agent Evolution
Thermal Effectiveness

- R-22 banned in U.S. 2008
- R-11 banned in U.S. 1993
- 141b banned in U.S. 2003
- R-22 banned in U.S. 2008

134a
K-factor = 0.150

R-22
K-factor = 0.145

CP
K-factor = 0.140

245fa
K-factor = 0.135

141b
K-factor = 0.130

HFO
# HFO Blowing Agents

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Name</th>
<th>Structure</th>
<th>MW</th>
<th>Phys. State</th>
<th>BP (°F)</th>
<th>λ</th>
<th>ODP</th>
<th>GWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dupont</td>
<td>FEA 1100</td>
<td><img src="image" alt="Structure of FEA 1100" /></td>
<td>164</td>
<td>Liquid</td>
<td>90</td>
<td>10.7</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Arkema</td>
<td>Forane 1233zd</td>
<td><img src="image" alt="Structure of Forane 1233zd" /></td>
<td>131</td>
<td>Liquid</td>
<td>66</td>
<td>10</td>
<td>0.0005</td>
<td>&lt;5</td>
</tr>
<tr>
<td></td>
<td>AFA-L1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeywell</td>
<td>Solstice 1233zd(E)</td>
<td><img src="image" alt="Structure of Solstice 1233zd(E)" /></td>
<td>131</td>
<td>Liquid</td>
<td>66</td>
<td>10</td>
<td>0.0005</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>HBA-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeywell</td>
<td>HBA1 /</td>
<td><img src="image" alt="Structure of HBA1 / HFO1234ze" /></td>
<td>114</td>
<td>Gas</td>
<td>&lt; 5</td>
<td>13</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>HFO1234ze</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeywell /</td>
<td>Solstice</td>
<td><img src="image" alt="Structure of Solstice HFO 1234yf" /></td>
<td>114</td>
<td>Gas</td>
<td>-20</td>
<td>13</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Dupont</td>
<td>HFO 1234yf</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeywell</td>
<td>HFC-245fa</td>
<td><img src="image" alt="Structure of HFC-245fa" /></td>
<td>134</td>
<td>Liquid</td>
<td>59</td>
<td>12.7</td>
<td>0</td>
<td>1030</td>
</tr>
<tr>
<td>Exxon</td>
<td>Cyclopentane</td>
<td><img src="image" alt="Structure of Cyclopentane" /></td>
<td>70</td>
<td>Liquid</td>
<td>120</td>
<td>13</td>
<td>0</td>
<td>11</td>
</tr>
</tbody>
</table>
Global Blowing Agent Technology
Appliances (Refrigerator/Freezers)
HFC Regulations in the USA

- US EPA is looking at SNAP to regulate blowing agents
  - Federal Register released on August 6, 2014
  - Proposal to delist most HFCs in all foam blowing sectors except spray foam on January 1, 2017
  - Public Hearing was on August 27, 2014
  - Comments were due to the EPA on October 20, 2014

- BASF comments
  - US EPA needs to look at each industry area
    - Some industries will be able to convert earlier than others
    - January 1, 2020 or longer is a more reasonable timeframe to convert customers to new technologies

- Waiting for final ruling
BASF New Offerings

- HFOs
  - Currently working with all three manufacturers
    - Received enough material to optimize systems
      - New system ready and commercialized with Honeywell Solsticce blowing agent
  - Cooperative work with Asia and Europe
Developments in the phase-in of low-GWP chemicals in various PU sectors

- Most foams used for refrigeration have already converted to low-GWP blowing agents. This includes Whirlpool, Electrolux, and GE in the USA. They have not completed the conversions but are the farthest along. Commercial refrigeration accounts that make ice makers, display cases for supermarkets, and reach in coolers are also converting away from HFC blowing agents now. These two markets will change first.

- Any industry that requires outside agency approvals such as fire rated panels or marine will need more time. These tests are very expensive and time consuming. We are working on non HFC systems but the amount of time required to convert all of the customers will be longer than 2020. This is why we feel we need at least until 2020 to complete this work.

- Water heater customers have already changed over to cyclopentane.