Challenges in manufacturing A/C with alternatives in A5 countries
Las Vegas, February 1, 2017
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OUTLINE

• A/C alternatives within MP framework

• MP Industry interventions

• Findings and challenges
Overall picture

• Industries are moving away from R-22; and towards especially R-410;
• A5 still mainly R-22;
• R-410 products are being optimized – R-22 to less extent (if at all);
• Some depends on CKD/SKD kits from especially China.
### A/C Refrigerant Options

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>GWP</th>
<th>Pe (bar)</th>
<th>Pc (bar)</th>
<th>Vol. cap. (kJ/m³)</th>
<th>Flammability</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-22</td>
<td>1,810</td>
<td>7.9</td>
<td>15.3</td>
<td>6,419</td>
<td>No</td>
</tr>
<tr>
<td>R-410</td>
<td>2,088</td>
<td>12.5</td>
<td>24.8</td>
<td>9,267</td>
<td>No</td>
</tr>
<tr>
<td>R-290</td>
<td>3</td>
<td>7.3</td>
<td>13.7</td>
<td>5,564</td>
<td>Yes (A3)</td>
</tr>
<tr>
<td>R-32</td>
<td>675</td>
<td>12.8</td>
<td>24.8</td>
<td>10,209</td>
<td>Yes (A2L)</td>
</tr>
<tr>
<td>HFO/HFC 1</td>
<td>150-1,000</td>
<td>Like R-22</td>
<td></td>
<td></td>
<td>Yes (A2L)</td>
</tr>
<tr>
<td>HFO/HFC 2</td>
<td>150-1,000</td>
<td>Like R-410</td>
<td></td>
<td></td>
<td>Yes (A2L)</td>
</tr>
<tr>
<td>R-744 (CO₂)</td>
<td>1</td>
<td>50.8</td>
<td>121.8</td>
<td>28,371</td>
<td>No</td>
</tr>
</tbody>
</table>
**Kigali amendment**

![Graph showing HFC consumption phase down for art.5 and non-art.5 countries](image)

- Developed countries (non-A5) are divided into two groups (non A5-1; non A5-2)
- Developing countries (A5) are divided into two groups (A5-1; A5-2)
- The EU is shown separately and is as expected more stringent than the MP phase down
- Baselines are composed of HFC and HCFC (mainly R22). The EU F-Gas regulation does not account for R22. Specific regions or countries may decide to have more stringent measures.

**Source:** Danfoss
TECHNICAL FEASIBILITY OF ALTERNATIVES

- A number of test programs (PRAHA, EGYPRA, AREP, US DoE) confirms that potential alternatives are available;
- Requirements for product re-design;
- Low-GWP alternatives are flammable - A2L or A3
INTERVENTION - MANUFACTURING

Eligible actions:

• No capacity upgrade
  – One-to-one replacement;

• Only processes affected by change of refrigerant;

• Cost effectiveness (US$/kg)
  – In relation to ODS phase-out
A/C Assy line – non flammable
IDU Helium leak test
ODU Helium leak test
Inclusive and Sustainable Industrial Development

ODU Evacuation
Inclusive and Sustainable Industrial Development

ODU Refrigerant charging
ODU Process tube sealing
Inclusive and Sustainable Industrial Development

ODU leak test
ODU performance test – 100%
ODU extended performance test
Flammability - ATEX

• Zone 0 - An atmosphere where a mixture of air and flammable substances in the form of gas, vapor or mist is present frequently, continuously or for long periods.

• Zone 1 - An atmosphere where a mixture of air and flammable substances in the form of gas, vapor or mist is likely to occur in normal operation occasionally.

• Zone 2 - An atmosphere where a mixture of air and flammable substances in the form of gas, vapor or mist is not likely to occur in normal operation but, if it does occur, will persist for only a short period.
Safety measures

- Ventilation;
- Sensors;
- Physical barriers;
- Other ???
A/C Assy line – intervention - flammable
A/C Assy line – flammable - recovery
A/C ODU Assy line – R-290
Inclusive and Sustainable Industrial Development

Development
FINDINGS - MANUFACTURING

• Factory conversions for flammable - relatively unproblematic;

• Safety concepts may have opportunities for revision;

• Post production requires attention:
  – Installation, maintenance and de-commissioning;
  – Applicable safety standards.

• SME – conversion costs;

• Limited technical capacity.
OTHER CHALLENGES

• Components/refrigerant availability:
  – Still no mass production;
  – Liability issues due to flammability.

• Cost impact on final product price:
  – Unknown due to above;
  – Indications that they could be substantial.
Thank You!