ENERGY EFFICIENCY IN A/C SECTOR

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Alternative Refrigerants

Compatibility

Environment

Refrigerant Properties

Safety

Performance Level

Financial Gain

Money Stack
KIGALI AMENDMENT AND RELATED DEVELOPMENT ON ENERGY EFFICIENCY

- The Kigali amendment to the Montreal Protocol to phase down the production and consumption of HFCs provides opportunity to realize energy efficiency gains when replacing HFC/HCFC-based equipment.

- CCAC Marrakech Communiqué recognizes that implementation of the Kigali Amendment can avert as much as 0.5 degrees Celsius of warming over the course of the century…with additional climate mitigation possible from improving the energy efficiency of HFC containing refrigeration and air conditioning equipment.

- A group of philanthropist organizations have pledged US$53 million in grants [the Kigali Cooling Efficiency Fund] to support energy efficiency alongside the phase-down of HFCs.

- To complement these funds, the World Bank Group announced it will make available US$1 billion in funding for energy efficiency in urban areas by 2020 that could include support for the development and deployment of high-efficiency cooling technologies using climate-friendly refrigerants.
IMPORTANCE OF ENERGY EFFICIENCY WHEN SELECTING ALTERNATIVE REFRIGERANTS

• A/C industries have concerns about meeting the Montreal Protocol reduction targets -Article 5 countries

• Currently commercially available technologies posses high GWP, and perform less efficiently in high ambient conditions.

• Alternative refrigerants are still being studied -work not completed yet.

• We need to obtain a basic understanding of their properties such as:
  1. burn velocity,
  2. compatibility with lubricants
  3. other system materials and components,
  4. its energy efficiency
• Testing Standards and Codes still do not exist since alternative refrigerants are still being investigated

• Alternative Refrigerant manufacturers are reporting data on energy efficient that need to be verified-Holistic approach and uniformity of

• Introduce safety codes

➢ Conduct Risk Assessments
➢ Provide sustainable and substantial training and certifications
TECHNOLOGY REQUIREMENTS FOR ENERGY EFFICIENCY

• Full system re-design is required to adopt low-GWP refrigerants

• Increased focus on technology transfer

• Remaining countries that have A/C manufacturing operations depend on available technologies-Product and component development is limited to a few countries

• The selection of refrigerant is not the only factor contributing to reduce CO₂ emission
A/C CO2 EMISSIONS

2010 Global GHG Emissions from Air Conditioning

Total = 692 MMTCO₂e

Residential A/C
- Direct Emissions (from HFCs): 19
- Direct Emissions (from HCFCs): 54
- Indirect Emissions (Energy Consumption): 233

Commercial A/C
- Direct Emissions (from HFCs): 27
- Direct Emissions (from HCFCs): 75
- Indirect Emissions: 283


Figure 3-2: Estimated global GHG emissions from A/C systems in 2010
WHY ENERGY EFFICIENCY IS VITAL

• When departing low GWP refrigerants, energy efficiency is essential due to high cooling demand- global trend
  ✓ 15% of global energy consumption per ca is for cooling (7% growth/year until 2050) [IEA]
  ✓ Approx. 40% of energy consumption in urban areas for refrigeration and air conditioning [UNEP]
  ✓ Refrigeration and air conditioning accounts for 40% - 50% of total electricity consumption in developing countries [GIZ, SV Proklima]

• More efficient building envelopes
THE A/C FUTURE NEEDS

FUTURE POWER CONSUMPTION FROM A/C

IND-India
INDO – Indonesia
SAS-PAS – Other Asia
BRA- Brazil
MEA- Middle East
SSA- Sub-Saharan Africa
CPA- Central Asia
NAF- North Africa
LAM- Latin America
MEX- Mexico

Source: 2007, McNeil and Letschert
CURRENT AND FUTURE COOLING ENERGY CONSUMPTION

Current and Projected Space Cooling Site Energy Consumption for OECD and Non-OECD Countries

<table>
<thead>
<tr>
<th>A/C Site Energy Consumption (Exajoules/year)</th>
<th>Residential</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 Consumption (Estimate)</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>2050 Consumption (Business-as-Usual Projection)</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>2010 Consumption (Estimate)</td>
<td>0.5</td>
<td>1.1</td>
</tr>
<tr>
<td>2050 Consumption (Business-as-Usual Projection)</td>
<td>2.7</td>
<td>4.6</td>
</tr>
</tbody>
</table>

OECD

Source: IEA (2013) (Exajoule [EJ] = 10^{18} Joules or 0.95 Quadrillion [10^{15}] Btus)
AMBIENT TEMPERATURE MAP

Source: NASA, July 2016
DEFINITIONS

- Performance ratio = Capacity / power

- IP Units:
  - Energy Efficiency Ratio (EER)
  - \( \text{EER} = \frac{\text{Capacity (BTU/hr)}}{\text{Power (W)}} \) – BTU/Whr

- SI Units:
  - Performance Ratio = \( \frac{\text{Power (kW)}}{\text{Capacity (tons)}} \)-kW/ton

- Dimensionless:
  - Coefficient of Performance (COP)
  - \( \text{COP} = \frac{\text{Capacity (W)}}{\text{Power (W)}} \)
HVAC PERFORMANCE IN HAT

Figure 2.1: Energy efficiency, capacity, and power consumption at different ambient temperatures
QUESTIONS?

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