Refrigerant conversion activities including energy efficiency in Japan

The Japan Refrigeration and Air Conditioning Industry Association
Tetsuji Okada
July. 3. 2019
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1. Market trend
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6. Next Generation Refrigerants
7. Energy Efficiency Improvement
8. JRAIA’s Efforts to Accelerate of Lower GWP Refrigerant
## 1. Market Trend

### 1) Market Volume in each product sector in Japan

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2) World market trend of Residential & Commercial A/Cs

Global sales in 2018: 111.24 M-units

- Share of Residential A/Cs with A2L: xx%
- Share of Commercial A/Cs with A2L: yy%

(in million units)

- Residential air conditioner
- Commercial air conditioner

North America: 14.1, 14.3, 14.6, 15.3, 15.6

Europe: 6.7, 5.6, 5.4, 6.1, 6.6, 6.9

China: 43.3, 42.5, 39.9, 40.6, 45.9, 44.6

Japan: 9.8, 9.3, 8.9, 9.1, 9.7, 10.7

North America: 7.9, 8.5, 7.3, 6.5, 6.8, 6.8

Latin America: 2.6, 2.6, 2.6, 2.6, 3.0

Africa: 13.7, 15.1, 16.4, 17.3, 17.9

Asia (ex. Japan & China): 1.0, 1.1, 1.1, 1.3, 1.3

Oceania: 6.0

Europe: Nearly 100%

North America: 41%

Latin America: 8%

Africa: 20%

Asia (ex. Japan & China): 30%

Oceania: 4%

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### 1. Market Trend

#### 3) Refrigerant transition status

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- **VRF**: No Alternative yet
- **Turbo Chiller**:
  - R245fa ⇒ R1233zd
  - R134a ⇒ R1234ze(E)

- **Air cooling Type**: R32
  - R404A ⇒ R410A
  - R448A, 449A
  - CO₂ (Cascade)
2. Issues in Refrigerant Conversion

- **Technology Development**
  - Environment Performance
    - ODP=0
    - Lower GWP
  - Energy Efficiency
    - High Efficiency (APF)
    - Low Running Cost
  - Safety
    - Flammability
    - Toxicity
    - High Pressure
  - Economic Feasibility
    - Low Price
    - Availability (Parts...)
  - Reliability
    - High Quality
    - Long Life Span

- **S+3Es**
  - Proper Risk Assessment

- **Regulatory compliance**
  - Ozone Layer Protect Act.
  - F-gas Act in Japan
  - Energy Saving Act (Top Runner Program)
  - High Pressure Gas Safety Act

- **Verification of Compatibility with Refrigeration Oil individually required**

- **Commercialization**
Legislation on refrigerants

"Ozone Layer Protection Act" (1988) revised in 2018
- Regulation on production and consumption of CFC and HCFC (abbr. OLP Act)
- Maximum allowance of refrigerant consumption similar to Kigali amendment

"Act on Rational Use and Proper Management of Fluorocarbons" (revised in 2015, 2019)
- Regulation on emission of HFC/HCFC/CFC refrigerants (abbr. Fgas Act)
- Target GWP and year for each product group

"High Pressure Gas Safety Act" (revised in 2016)
- Regulation on safety of flammable (toxic) gas
- Method of safe use of products and refrigerants
- A2L refrigerants are included as “particular inert gas”

"Global Warming Countermeasure Plan" (Cabinet Decision in 2016)
- Regulation on emission of energy origin CO2

"Act on the Rational Use of Energy(Saving Energy Act)" (revised every 3-5 yr)
- Top Runner Program in 32 product categories
3. Regulations and Legislations in Japan

2) Timeline

Global

- Vienna Convention
- Montreal Protocol
- Ozone Layer Protection Law
- Kyoto Protocol (COP3)
- UNFCCC
- Global Warming Countermeasure Plan
- Revised Saving Energy Act
- 1st Top Runner Target

Japan

- Saving Energy Act (1979)
- HCFC produce regulation starts
- HFC introduction
- Home Appliance Recycle Act
- Freon Recovery & Destruction Act
- EoL Automotive Recycle Act
- Freon Recovery & Destruction Act
- 2nd Top Runner Target
- Next Step on going
- Dubai Pathway
- Kigali Amendment
3. Regulations and Legislations in Japan

2) Timeline

- Vienna Convention
- Montreal Protocol
- UNFCCC
- Kyoto Protocol (COP3)
- Dubai Pathway
- Kigali Amendment
- Paris Agreement (COP21)

- Ozone Layer Protection Law
- HCFC production regulation starts
- HFC introduction
- Home Appliance Recycle Act
- Freon Recovery & Destruction Act
- EoL Automotive Recycle Act
- Revised FGas Act

- Revised “OLP” Act

- Revised Saving Energy Act
- 1st Top Runner Target
- 2nd Top Runner Target
- Next Step on going

Global

Japan

3. Regulations and Legislations in Japan
3) Regulation of refrigerant by "designated products"

Regulated by “Act on Rational Use and Proper Management of Fluorocarbons”

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<th>Target GWP (Weighted Average GWP)</th>
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<td>Room A/C (Mini-Split)</td>
<td>750</td>
<td>2018</td>
</tr>
<tr>
<td>Commercial A/C (Split)</td>
<td>750</td>
<td>2020</td>
</tr>
<tr>
<td>Mobile A/C</td>
<td>150</td>
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Commercial A/C Large size (only single type) >> GWP: 750, 2023

Centrifugal (Turbo) Refrigerators >> GWP: 100, 2025

Next Target:
- VRF
- Commercial Refrigerators
- Refrigerants for Service
4. HFC Reduction in Japan

2012 HFC Production/Consumption (57.77M-CO2·t)
- RAC 31%
- PAC 9%
- VRF 20%
- Cond.Unit 14%
- GHP 2%
- Car Aircon 13%
- others 11%

2017 HFC Production/Consumption (47.53M-CO2·t)
- RAC 16%
- VRF 26%
- Cond.Unit 21%
- Car Aircon 16%
- GHP 3%
- others 12%
- PAC 6%
5. Risk Assessment of A3 Refrigerant

1) Direction and Schedule

■ Direction

・In the trend of deregulation of A3 refrigerants, JRAIA will propose air-conditioner be secured.
・Based on RAC's risk assessment method and results for A2L refrigerant, JRAIA also conducts risk assessment for A3 refrigerant and recommended measures to ensure safety from the evaluated result.

■ Schedule

・First year; A3 refrigerant risk assessment
・Second year; Estimation method and make plan for risk reduction
・Last year; Making practical measures and verifying by risk assessment

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<td>Risk assessment</td>
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<td>Hazard estimation (NEDO Project)</td>
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- Risk assessment
- Hazard estimation
- Plan for estimation
- Risk reduction
- Measures verify
- Kobe Symposium
- JRAIA 1st report
## 5. Risk Assessment of A3 refrigerant

### 2) RA step for A3 refrigerant

#### Establishment for safety specification of A3 refrigerant

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| **1: Evaluated product** | • Setting of evaluated product and usage condition  
• Making the risk scenario  
• Manufacturing, Transportation, **Install**, Use, **repair**, disposal |
| **2: Risk assessment** | ◎ Basic items of risk estimation  
• Installation case (leaky space model setting)  
• Refrigerant leak rate and leak speed  
• Ignition source existence probability ← Identification the ignition source  
• Flammable cloud ← CFD, simplified calculation |
| **3: Measures** | • Equipment measures: Air circulation and ventilation fan, shutoff valve, alarm  
• Document correspondence: Instruction manual, warning display  
• Regulatory compliance: regulations, industrial association manual |
| **4: In market**  
(Regulation) | • Regulatory compliance: regulations, industrial association manual  
• Document correspondence: Instruction manual, warning label  
• Maintenance of work procedures manual  
• Improvement of working accuracy in education and training |
6. Next-Generation Refrigerants
Development of Assessment Techniques for Next-Generation Refrigerant with Low GWP Values (NEDO’s Support)

**Project summary**

Device: Mid-to-small size Refrigeration & Air-Conditioning

Refrigerants: “next-generation” low-GWP refrigerant e.g.) HC, HFO and HFO mixture

Objective:
- Establish the standard technique for the safety and risk assessment of low-GWP refrigerant and equipment
- Form the common basis for the development of equipment

**Project term**

2018 FY ~ 2022 FY (5 years)

**Budget**

2018FY 250 M-Yen (2 million USD)

**R & D Contents**

1. Data acquisition and evaluation for basic characteristic of next-generation refrigerants
   - Evaluation test for basic characteristic of next-generation refrigerants
   - Data acquisition and Assessment for test in practical environment

2. Development of Safety & Risk Assessment methods for next-generation refrigerants
   - Establish of Safety & Risk Assessment for flammability

Disseminate information (Internationally)

Industry University Research Institute

opinion exchange

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7. Energy Efficiency Improvement

1) Top Runner Program and Results

**Overview of Top Runner Program**

- **Reference Year**
- **Target Year (3-10yr later)**

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<th>Product</th>
<th>TRP Standard Value</th>
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<tr>
<td>Product A</td>
<td>More than 50%</td>
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<tr>
<td>Product B+</td>
<td>More than 50%</td>
</tr>
<tr>
<td>Product C+</td>
<td>More than 50%</td>
</tr>
<tr>
<td>Product D+</td>
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- Weight average(EE) should be more than standard value.

**Trend of Periodical Power Consumption <Residential ACs>**

- 32 items: 2017
  - Home appliances, Cars, Office appliances etc.

- In case of Domestic ACs, Target values were set twice (2004, 2010)
7. Energy Efficiency Improvement

2) Trend of Energy Efficiency and Price

Japan CPI for Room ACs (1990=100), APF and Number of units

- **1st Target**
- **2nd Target**
8. JRAIA's efforts to accelerate introduction of lower GWP refrigerants

1) Collaboration to UNEP/UNIDO: PRAHA-II Project

2016: The HFC-32 study tour: provided participants with a background on designing and working with A2L refrigerants. Included plants visits, the risk assessment workshop, as well as attending the JRAIA International Symposium on “New Refrigerants and Environmental Technology” - Tokyo, Shizuoka, Shiga, Kobe

2017: International Roundtable Meeting on Risk Assessment Model for use of lo-GWP Refrigerants in High Ambient Temperature Countries – Kuwait

2018: Special Expert Meeting: Risk Assessment Model for the Use of Lower-GWP Refrigerants in High Ambient Temperature Countries – Cairo

2019: Workshop to support Praha-II members for the development of risk assessment model for air-conditioning applications of A2L refrigerants at high ambient temperature countries - Tokyo
8. JRAIA's efforts to accelerate introduction of lower GWP refrigerants

2) ASEAN Workshop

**2018: Workshop on risk assessment and safety measures for RACHP using flammable refrigerants** (workshop supported by NEDO) toward conversion to lower GWPs in ASEAN countries (Indonesia, Malaysia, Philippines, Thailand, Vietnam and Japan).
Ozone officers and members of Industry Association discussed regulations, policies, and urgent challenges for refrigerant conversion and alternative refrigerants in each country. - Kobe, Japan

**2019: Workshop on HFC phasedown for RACHP to meet Kigali Amendment in each countries** (Indonesia, Malaysia, Philippines, Thailand, Vietnam and Japan) TBD - Bangkok, Thailand
Summary

1. The global environment countermeasures (policy, product policy, etc.) in the refrigeration and air conditioning sector in Japan were clarified.

2. In considering future refrigerant conversion, it is necessary to consider the balance of various factors. In particular, verification of the safety of flammable refrigerants is very important.

3. Optimization is required for many parameters, including energy efficiency. (In terms of policy and products)

4. Regarding HFC reduction, not only individual product discussions but also efforts across the refrigeration and air conditioning sectors are required
HVAC&R 2020

Date: 3-6 March, 2020
Place: Makuhari Messe, Chiba, Japan

For further detail: https://www.jraia.or.jp/hvacr/en/index.html
Thank you for your kind attention!!