Transitioning to Alternatives and Challenges in Japan

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JRAIA
18 November 2017
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1. Who is JRAIA?

The Japan Refrigeration and Air conditioning Industry Association

- Established in 1949.
- 170 member companies including the associate members. (as of 1st of October 2017)
- The business fields of the member companies are:
  - Air conditioning (residential, commercial, automotive)
  - Refrigeration (commercial, industrial, transport)
  - Ventilation
  - Heat pump system (HP water heaters)
  - Refrigerants
  - Parts
2. Strategies to be taken as Japan

1) JRAIA’s Vision and Activities on Environmental Conservation

**EQUIPMENT**

Energy Saving
Emission control on a CO2 basis

**REFRIGERANTS**

Direct Emission Control
- Promotion of recovery
- Measures against leakage (proper management of refrigerants)
- Reduction of amount charged into equipment

**ALTERNATE REFRIERGENTS**

Acceleration to shift to new refrigerants
- Research of low GWP refrigerants
- Risk Assessment

- Top Runner Program
- Act on Rational Use & Proper Management of Fluorocarbons
- Home Appliances Recycling Act
- EoL Automotie Recycling Act
- High Pressure Gas Safety Act

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2. Strategies to be taken as Japan

2) Points for Refrigerants Conversion

Actions to phase-down HFCs have been started sector by sector in Japan by considering not only "environment performance" but also "safety", "energy efficiency" and "economic feasibility".

**S+3Es**

**Safety (precondition)**
- Low Toxicity
- Low Risk of Flammability

**Environment performance**
- Ozone Depletion Potential = 0
- Low Global Warming Potential (GWP)

**Energy efficiency**
- Superior for LCCP* value
- Similar performance at high load cooling

**Economic feasibility**
- Reasonable Cost
- Acceptable level in Developing Countries

* LCCP: Life Cycle Climate Performance
### 3. Trend of legislation and Protocols

#### 1) Overview of Legislation in Japan

<table>
<thead>
<tr>
<th>Legislation on refrigerants</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“Ozone Layer Protection Act” (1988)</strong></td>
<td></td>
</tr>
<tr>
<td>- Regulation on production and consumption of CFC and HCFC (abbr. OLP Act)</td>
<td></td>
</tr>
<tr>
<td>- Maximum allowance of refrigerant consumption similar to Kigali agreement</td>
<td></td>
</tr>
<tr>
<td><strong>“Act on Rational Use and Proper Management of Fluorocarbons” (revised in 2015)</strong></td>
<td></td>
</tr>
<tr>
<td>- Regulation on emission of HFC/HCFC/CFC refrigerants (abbr. Fgas Act)</td>
<td></td>
</tr>
<tr>
<td>- Target GWP and year for each product group</td>
<td></td>
</tr>
<tr>
<td><strong>“High Pressure Gas Safety Act” (revised in 2016)</strong></td>
<td></td>
</tr>
<tr>
<td>- Regulation on safety of flammable (toxic) gas</td>
<td></td>
</tr>
<tr>
<td>- Method of safe use of products and refrigerants</td>
<td></td>
</tr>
<tr>
<td>- A2L refrigerants are included as “particular inert gas”</td>
<td></td>
</tr>
<tr>
<td><strong>“Global Warming Countermeasure Plan” (Cabinet Decision in 2016)</strong></td>
<td></td>
</tr>
<tr>
<td>- Regulation on emission of energy origin CO₂</td>
<td></td>
</tr>
</tbody>
</table>
4. HFC step down
1) Steps to execute HFC reduction plan: challenges and response (1/2)

Step 1
Selection of candidate refrigerant
- Basic physical properties (energy efficiency), compatibility with lubricating oil, etc.
- Efficiency evaluation, confirmation of reliability etc.
- Low GWP refrigerant has flammability.

Step 2
Confirmation of equipment safety
- Risk assessment by product (Life cycle perspective, region by region)
- Development of new standards and guidelines by risk assessment
- Association for Evaluation of A2L Refrigerant by Industry-Government-Academia Collaboration

Step 3
Confirmation of safety standards
- Design complying with IEC, ISO and national standards
- Amendment of standard itself
- Especially concerning the mildly flammability, it is a new concept
4. HFC step down

1) Steps to execute HFC reduction plan: challenges and response (2/2)

**Step 4**

**Confirmation of safety regulations**
- Partial relaxation of Building Codes, High Pressure Gas Safety Act (in Japan)
- Security guarantee based on the above new standards and guidelines
- Addition of new category from the viewpoint of flammability

**Step 5**

**Market acceptability**
- Overcoming the additional issues related to the rising product price by installation of risks and installation work, understanding of the market is indispensable
- Example of risk countermeasure: installation of ventilator, gas sensor, installation of shutoff valve etc.
- briefing sessions for the market, measures to promote penetration

**Step 6**

**Expanding penetration into the market**
- Overcoming economic issues (cost increase etc.)
- Level of capital investment due to alternative refrigerant
4. HFC step down

2) Step toward revision of classification for A2L refrigerants

(legislations to assure safety)

Step toward revision

2011

Step 1: Evaluation of Performance (Efficiency)

Step 2: Risk Assessment

JRA standards & guidelines

Step 3: IEC, ISO revised

Step 4: High Pressure Gas Safety Act

Step 5, 6: Market launch
Including product and installation, etc.

Legal action

Building Act
Fire Service Act

Activities of the committee for the risk assessment of mildly flammable refrigerants

Japan

Global
5. Legislation and Protocols in Japan

1) Timeline

- **Global**
  - Vienna Convention
  - Montreal Protocol
  - UNFCCC
  - Kyoto Protocol (COP3)
  - Paris Agreement (COP21)

- **Japan**
  - Ozone Layer Protection Act
  - HCFC produce regulation starts
  - HFC introduction
  - EoL Automotive Recycle Act
  - Revised “OLP” Act (2018)
  - Home Appliance Recycle Act
  - Fluorocarbon Recovery & Destruction Act
  - Revised Fgas Act (2015)

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5. Legislation and Protocols in Japan

2) Overview of revised Fgas Act

“Act on Rational Use and Proper Management of Fluorocarbons”

1) Phase-down HFCs

- Users of products
  - Low GWP HFCs
  - Natural Refrigerant
  - HFCs
  - Refrigerator
  - Air conditioner
  - Insulators
  - Dust blowers
- Manufacturers of HFCs
- Manufacturers of products containing HFCs

2) Promote low GWP products

- Users of products
- Supermarkets
- Approved destructors
- Approved recyclers
- Registered re-fillers/recovery operators

3) Prevent leakage from commercial equipment

- Reports of leakage
- Periodical check
- Maintenance
- Promotion of recycling

4) Promote proper collection, destruction and recycling

The Act has been implemented to cover entire life cycle since April 2015, requests all stakeholders to make efforts to reduce emissions of HFCs.

5. Legislation and Protocols in Japan

“Act on Rational Use and Proper Management of Fluorocarbons”

Target

- 43.4 mil-tCO₂ (2020)
- 36.5 mil-tCO₂ (2025)

Scope of previous Act
### 5. Legislation and Protocols in Japan

3) Regulation of refrigerant by "designated products"

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

<table>
<thead>
<tr>
<th>Designated Products</th>
<th>Target GWP (Weighted Average GWP)</th>
<th>Target year</th>
</tr>
</thead>
<tbody>
<tr>
<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>
<td>2023</td>
</tr>
<tr>
<td>Condensing unit and refrigerating unit</td>
<td>1500</td>
<td>2025</td>
</tr>
<tr>
<td>Cold storage warehouses</td>
<td>100</td>
<td>2019</td>
</tr>
<tr>
<td>Urethane foam</td>
<td>100</td>
<td>2020</td>
</tr>
<tr>
<td>Dust blowers</td>
<td>10</td>
<td>2019</td>
</tr>
</tbody>
</table>

RACHP sectors
### 5. Legislation and Protocols in Japan

#### 4) Comparison of safety act

<table>
<thead>
<tr>
<th></th>
<th>U.S.</th>
<th>Europe</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legislation/Act</td>
<td>Clean Air Act SNAP</td>
<td>F–Gas Regulation, Act</td>
<td>• Act on Rational Use and Proper Management of Fluorocarbons</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• High pressure gas safety act</td>
</tr>
<tr>
<td>International</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>regulations</td>
<td>ASHRAE34</td>
<td>Relevant standards based on ISO</td>
<td></td>
</tr>
<tr>
<td>(define ref types)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard /</td>
<td>ASHRAE15</td>
<td>EN378</td>
<td>• High pressure gas safety act</td>
</tr>
<tr>
<td>regulations</td>
<td>UL60335-2-40, UL484, etc.</td>
<td>EN60335-2-40</td>
<td>• JIS C9335-2-40</td>
</tr>
<tr>
<td>(safety)</td>
<td></td>
<td></td>
<td>• JRA standards, etc.</td>
</tr>
</tbody>
</table>

**What is “High Pressure Gas Safety Act”?**

This act is the regulation for high pressure gas, but covers toxicity and flammability of the refrigerants, and applies to HVAC equipment of the size above certain refrigerant volume.
6. High Pressure Gas Safety Act

1) Main Point of the mitigation of High pressure gas safety Act (1/2)

1. Revised classification A2L refrigerants. (R32, R1234yf, R1234ze)
2. Reference of JRA Standards and Guidelines.

<table>
<thead>
<tr>
<th>Refrigerants(former)</th>
<th>Notification or Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorocarbon (inert gas)</td>
<td><strong>No need of Notification or Approval for present refrigerant.</strong></td>
</tr>
<tr>
<td>Fluorocarbon, NH$_3$ (excl. inert gas)</td>
<td><strong>Notification or Approval for A2L are needed same as other refrigerants.</strong></td>
</tr>
<tr>
<td>Others (CO$_2$, A3)</td>
<td></td>
</tr>
</tbody>
</table>
1. Revised classification A2L refrigerants. (R32, R1234yf, R1234ze)
2. Reference of JRA Standards and Guidelines.

<table>
<thead>
<tr>
<th>Refrigerants (revised)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorocarbon (inert gas, CO₂)</td>
</tr>
<tr>
<td>Fluorocarbon (particular inert gas) R32, R1234yf, R1234ze</td>
</tr>
<tr>
<td>Fluorocarbon, NH₃ (excl. inert gas)</td>
</tr>
<tr>
<td>Others (A3)</td>
</tr>
</tbody>
</table>

A2L: Newly categorized

No need of Notification or Approval for A2L same as present refrigerants.
7. Energy Efficiency Improvement

1) Top Runner Program and Results

**Overview of Top Runner Program**

- **TRP Standard Value**
  - More than 50%
  - Less than 50%
  - Weight average (EE) should be more than standard value.

- **Product A+**
- **Product B+**
- **Product C+**
- **Product D+**

**Reference Year**

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

- **31 items: 2016**
  - Home appliances, Cars, Office appliances etc.

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

- **Reduction**: 30.7%

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

2) High Ambient T3 climate calculation

**Frequency of temperature**

- ISO T1: Load 0 at 20°C, Load 100 at 35°C(T1) / 46°C(T3)
- ISO T3

**Full, half and actual EER/EER46**

- Full T3
- Half T3: 1.905
- Actual T3: 1.617
- Half T1: 1.347
- Actual T1: 1.2
- Full: 1.111

**Example:** Inverter R=1.2

**CSPF/EER46**

- T1 calculation
- T3 calculation

- T3 climate calculation

- ISO T3 climate hours

- tj: Outdoor temperature (°C)
  - EER46 means full EER at 46°C.
  - EER35 means full EER at 35°C.

\[
R = \frac{\text{Half EER/Full EER}}{\text{at 35°C}}
\]

\[
C = \frac{\text{Half capacity/Full capacity}}{\text{at 35}} = 0.5
\]
### 8. Market trend

1) Refrigerant conversion status in each product sector

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Number of Units in 2016FY (x 1,000)</th>
<th>Y/Y Ratio (%)</th>
<th>Refrigerant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential A/Cs</td>
<td>8,527.5</td>
<td>104.4</td>
<td>R410A ⇒ R32 (almost 100%)</td>
</tr>
<tr>
<td>Commercial A/Cs</td>
<td>793.9</td>
<td>102.6</td>
<td>R410A ⇒ R32 (only Small-size; 41%)</td>
</tr>
<tr>
<td>Residential H/P water heaters</td>
<td>424.4</td>
<td>104.1</td>
<td>CO₂, (R32) (almost 100%)</td>
</tr>
<tr>
<td>Gas engine-driven A/Cs</td>
<td>30.5</td>
<td>98.1</td>
<td>R410A</td>
</tr>
<tr>
<td>Water chilling units</td>
<td>12.9</td>
<td>98.8</td>
<td>R410A, R134A</td>
</tr>
<tr>
<td>Air to air heat exchangers</td>
<td>109.2</td>
<td>93.2</td>
<td>NA</td>
</tr>
<tr>
<td>Commercial ref. cabinets</td>
<td>312.4</td>
<td>101.4</td>
<td>R404 ⇒ R410A, CO₂</td>
</tr>
<tr>
<td>Condensing units</td>
<td>91.3</td>
<td>98.3</td>
<td>R410A</td>
</tr>
<tr>
<td>Refrigeration units</td>
<td>29.7</td>
<td>102.2</td>
<td>R22 ⇒ NH₃, (+CO₂)</td>
</tr>
</tbody>
</table>
Summary

1. Successful example of measures for HFC step down in Japan. (efforts by industry-academia-government collaboration)

2. Risk assessment is key issue for each product sector and each country. (especially refrigerant life cycle and regionality)

3. Results of risk assessment in each region need to be shared.

4. Ensuring safety and relaxation of national safety codes based on risk assessment results are very important.

5. Energy Efficiency also very important, and the seasonal efficiency is one of the effective measures.
Thank you for your kind attention!!