Challenges and responses in refrigerant conversion

Tetsuji Okada
JRAIA
12. July. 2017
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1. Who is JRAIA?
2. Trend of legislation and Protocols
3. Market trend
4. Strategies to be taken as Japan
5. HFC step down
6. Refrigerant management in Japan
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1. Who is JRAIA?

- **Overview**

The Japan Refrigeration and Air conditioning Industry Association (JRAIA)

- Established in 1949.
- 168 member companies including the associate members. (as of 1st of June 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
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6. Refrigerant management in Japan
2. Trend of legislation and Protocols

1) Timeline in Japan

- Vienna Convention
- Montreal Protocol
- UNFCCC
- Kyoto Protocol (COP3)
- Paris Agreement (COP21)
- Dubai Pathway
- Kigali Amendment
- Ozone Layer Protection Law
- HCFC produce regulation starts
- HFC introduction
- Home Appliance Recycle Act
- Fluorocarbon Recovery & Destruction Act
- EoL Automotive Recycle Act
- Revised Fgas Act
- Revised “OLP” Law

Global

Japan

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2. Trend of legislation and Protocols

2) Regulation of refrigerant by "designated products" in Japan

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 air conditioning (Mini-Split)</td>
<td>750</td>
<td>2018</td>
</tr>
<tr>
<td>Commercial air conditioning (Split)</td>
<td>750</td>
<td>2020</td>
</tr>
<tr>
<td>Mobile air conditioning</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
2. Trend of legislation and Protocols

3) HFC phase down latest status in Japan

We can keep this line when the refrigerants in the designated products will be changed to new one.
## 2. Trend of legislation and Protocols

### 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><strong>Legislation/Act</strong></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>• <strong>High pressure gas safety act</strong></td>
</tr>
<tr>
<td><strong>National legislation</strong></td>
<td><strong>Building Code</strong> IMC, UMC, etc.</td>
<td><strong>Building Code</strong></td>
<td>• <strong>High pressure gas safety act</strong></td>
</tr>
<tr>
<td><strong>International standards</strong></td>
<td>ISO817 (refrigerant classification)</td>
<td></td>
<td>ISO5149 (safety)</td>
</tr>
<tr>
<td><strong>Standard / regulations (define ref types)</strong></td>
<td>ASHRAE34</td>
<td>Relevant standards based on ISO</td>
<td>• <strong>High pressure gas safety act</strong></td>
</tr>
<tr>
<td><strong>Standard / regulations (safety)</strong></td>
<td>ASHRAE15 UL60335-2-40 UL484, etc.</td>
<td>EN378 EN60335-2-40</td>
<td>• <strong>High pressure gas safety act</strong> JIS C9335-2-40 JRA standards, etc.</td>
</tr>
</tbody>
</table>
2. Trend of legislation and Protocols

4) Comparison of safety act

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.

<table>
<thead>
<tr>
<th>Standard / regulations (define ref types)</th>
<th>ASHRAE34</th>
<th>Relevant standards based on ISO</th>
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<td>Standard / regulations (safety)</td>
<td>ASHRAE15 UL60335-2-40 UL484, etc.</td>
<td>EN378 EN60335-2-40</td>
<td>• High pressure gas safety act • JIS C9335-2-40 • JRA standards, etc.</td>
</tr>
</tbody>
</table>
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## 3. Market trend

### 1) Refrigerant conversion status in each product sector

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Number of Units in 2016FY (in thousands)</th>
<th>Y/Y Ratio (%)</th>
<th>Refrigerant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential air conditioners</td>
<td>8,527.5</td>
<td>104.4</td>
<td>R410A &gt;&gt; R32 (almost 100%)</td>
</tr>
<tr>
<td>Commercial air conditioners</td>
<td>793.9</td>
<td>102.6</td>
<td>R410A &gt;&gt; R32 (only Small-size; 41%)</td>
</tr>
<tr>
<td>Residential heat pump water heaters</td>
<td>424.4</td>
<td>104.1</td>
<td>CO₂, (R32) (almost 100%)</td>
</tr>
<tr>
<td>Gas engine-driven air conditioners</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 refrigerated cabinets</td>
<td>312.4</td>
<td>101.4</td>
<td>R404 &gt;&gt; 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 &gt;&gt; NH₃, (+CO₂)</td>
</tr>
</tbody>
</table>
3. Market trend

2) World market trend of air conditioners

(2016; 102.31M-units)

xx% : A2L refrigerant ratio(unit)
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4. Strategies to be taken as Japan

1) JRAIA’s Vision and Activities on Environmental Conservation

EQUIPMENT

Energy Saving
Emission control on a CO₂ basis

Top Runner Program

REFRIGERANTS

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

Act on Rational Use & Proper Management of Fluorocarbons

Home Appliances Recycling Act

EoL Automotie Recycling Act

High Pressure Gas Safety Act

ALTERNATE REFRIERGANTS

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

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4. 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**

<table>
<thead>
<tr>
<th>Safety (precondition)</th>
<th>Low Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Risk of Flammability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environment Performance</th>
<th>Ozone Depletion Potential =0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Global Warming Potential(GWP)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy Efficiency</th>
<th>Superior for LCCP* value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Similar performance at high load cooling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Economic Feasibility</th>
<th>Reasonable Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acceptable level in Developing Countries</td>
</tr>
</tbody>
</table>

LCCP*: Life Cycle Climate Performance
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5. HFC step down

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

**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
5. HFC step down

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

- **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
5. HFC step down

3) Step toward revision of classification for A2L refrigerants (legislations to assure safety)
5. HFC step down

4) Main Point of the mitigation of High pressure gas safety Act

1. Revised classification A2L refrigerants. (R32, R1234yf, R1234zd)
2. Reference of JRA Standards and Guidelines.

<table>
<thead>
<tr>
<th>Refrigerants (former)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorocarbon (inert gas)</td>
<td>Notification or Approval for present refrigerant.</td>
</tr>
<tr>
<td>Fluorocarbon, NH3 (excluding inert gas)</td>
<td>Notification or Approval for A2L are needed same as other refrigerants.</td>
</tr>
<tr>
<td>Others (CO2, A3)</td>
<td></td>
</tr>
</tbody>
</table>
### 5. HFC step down

4) Main Point of the mitigation of High pressure gas safety Act

1. Revised classification A2L refrigerants. (R32, R1234yf, R1234zd)
2. Reference of JRA Standards and Guidelines.

#### Refrigerants (revised)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorocarbon</td>
<td>(inert gas, CO2,)</td>
</tr>
<tr>
<td>Fluorocarbon</td>
<td>(particular inert gas)</td>
</tr>
<tr>
<td></td>
<td>R32, R1234yf, R1234zd</td>
</tr>
<tr>
<td>Fluorocarbon, NH3</td>
<td>(excl. inert gas)</td>
</tr>
<tr>
<td>Others(A3)</td>
<td></td>
</tr>
</tbody>
</table>

A2L: Newly categorized

No need of Notification or Approval for A2L same as present refrigerants.
## 5. HFC step down

### 5) JRA Standards and Guidelines(1)

<table>
<thead>
<tr>
<th>products</th>
<th>No. of Std. or GL.</th>
<th>Title</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>refrigerant leak detector and alarm</td>
<td>JRA 4068</td>
<td>“Requirements of refrigerant leak detector and alarm for air conditioning and refrigeration equipment”</td>
<td>ISO 5149-1, -3:2014</td>
</tr>
<tr>
<td>refrigerant leakage from refrigerating and air conditioning equipment</td>
<td>JRA GL14</td>
<td>“Guideline for prevention of refrigerant leakage from refrigerating and air conditioning equipment and systems using fluolocarbon”</td>
<td>ISO 14903</td>
</tr>
<tr>
<td>chiller</td>
<td>JRA GL15</td>
<td>“Guideline of design construction for ensuring safety against refrigerant leakage from chiller using lower flammability(A2L) refrigerants”</td>
<td>ISO 5149-2, -3, -4 IEC 60335-2-40 IEC 60079-10-1</td>
</tr>
<tr>
<td>commercial air conditioners</td>
<td>JRA 4070</td>
<td>“Requirements for ensuring safety against refrigerant leakage from commercial air conditioners using lower flammability(A2L) refrigerants”</td>
<td>ISO 5149-1, -2, -3, -4 ISO 5149-1/Amd1</td>
</tr>
<tr>
<td></td>
<td>JRA GL16</td>
<td>“Guideline of design construction for ensuring safety against refrigerant leakage from commercial air conditioners using lower flammability(A2L) refrigerants”</td>
<td>ISO 5149-1, -2, -3, -4 ISO 5149-1/Amd1</td>
</tr>
</tbody>
</table>
## 5. HFC step down

### 6) JRA Standards and Guidelines(2)

<table>
<thead>
<tr>
<th>products</th>
<th>No. of Std. or GL.</th>
<th>Title</th>
<th>References</th>
</tr>
</thead>
</table>
| commercial refrigeration equipment       | JRA 4072           | “Requirements for ensuring safety against refrigerant leakage from commercial refrigeration equipment using lower flammability(A2L) refrigerants” | ISO 14903
                                           |                    |                                                                       | IEC 60079-10-1:2015                                                       |
|                                          |                    |                                                                       | IEC 60335-2-40:2013                                                       |
|                                          | JRA GL18           | “Guideline of design construction for ensuring safety against refrigerant leakage from commercial refrigeration equipment using lower flammability(A2L) refrigerants” | ISO 5149-1
                                           |                    |                                                                       | IEC 60079-10-1:2015                                                       |
|                                          |                    |                                                                       | IEC 60335-2-40:2013                                                       |
| commercial packaged air conditioner      | JRA 4073           | “Requirements for ensuring safety against refrigerant leakage from commercial packaged air conditioner for facilities using lower flammability(A2L) refrigerants” | IEC 60335-2-40 61D/338/INF:2016                                           |
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1) Market response (refrigerant management) < Based on the revised F-gas act >
   (Not limited to flammable refrigerants)

1. Inspection system (user) → legal regulation
   Require periodic inspection for equipment with a certain capacity or more

2. Improve the level of contractors → Operate with private qualification
   Lecture implementation, qualification acquisition

3. Qualifications of collection / destruction traders, certification
   → registration system for local governments

4. (Efforts as Industrial Association)
   Formulation of leakage prevention guidelines
Summary

1. Example of the measures for HFC step down in Japan is shown. (Effect of industry-academia-government collaboration)

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

3. It is needed to share the results of risk assessment in each region.

4. It is very important to assure safety and to mitigate the safety codes of each nation by using the results of risk assessment.
Thank you for your kind attention!!