Research and Development for Safety Improvement of Hydrogen Refueling Stations in Japan

September 11, 2017

The Association of Hydrogen Supply and Utilization Technology (HySUT)

Tetsufumi Ikeda   Tadashi Abe

te-ikeda@hysut.or.jp   ta-abe@hysut.or.jp
Contents

1. Introduction
2. Deployment of Commercial HRSs
3. Current Activities Overview
4. Safety and Reliability Technology for HRS
1. Introduction 1-1 About HySUT

HySUT
The Research Association of Hydrogen Supply/Utilization Technology

April 1st 2016

HySUT
The Association of Hydrogen Supply and Utilization Technology

1. Technology Development
✓ Fueling, Quality, Metering etc.
✓ Guidelines
✓ ISO/TC197

2. Safety and Reliability
✓ Future Technology
✓ Training and Education
✓ Database, Safety Control

3. Support Program
✓ HRS Operation

4. Others
✓ Public Awareness
✓ International Collaboration

42 Member Companies and Organizations

Oil  City gas / Industrial gas  Hydrogen station  Engineering / Machinery  Automotive
### 2. Deployment of Commercial HRSs(1)

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of HRSs</th>
<th>Number of FCVs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hokkaido</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>2. Tohoku</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>3. Kanto</td>
<td>39</td>
<td>685</td>
</tr>
<tr>
<td>4. Chubu</td>
<td>22</td>
<td>748</td>
</tr>
<tr>
<td>5. Kansai</td>
<td>12</td>
<td>177</td>
</tr>
<tr>
<td>6. Chugoku/Shikoku</td>
<td>6</td>
<td>68</td>
</tr>
<tr>
<td>7. Kyushu</td>
<td>12</td>
<td>105</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>92</strong></td>
<td><strong>1,799</strong></td>
</tr>
</tbody>
</table>
### 2. Deployment of Commercial HRSs(2)

<table>
<thead>
<tr>
<th>Company</th>
<th>Number of HRSs</th>
<th>Type</th>
<th>Number of HRSs</th>
</tr>
</thead>
<tbody>
<tr>
<td>JXTG Nippon Energy</td>
<td>40</td>
<td>On-site</td>
<td>15</td>
</tr>
<tr>
<td>Iwatani</td>
<td>16.5</td>
<td>Off-site</td>
<td>44</td>
</tr>
<tr>
<td>Air Liquide Japan</td>
<td>4</td>
<td>Mobile</td>
<td>33</td>
</tr>
<tr>
<td>Tokyo Gas</td>
<td>3</td>
<td>Total</td>
<td>92</td>
</tr>
<tr>
<td>Toho Gas</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osaka Gas</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nippon Mobile Hydrogen Station Services</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toyota Tsusho Air Liquide Hydrogen Energy</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idemitsu Kosan, Saibu Gas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chubu Gas, Seiryu Power Energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mie Hydrogen Station</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shikoku Taiyo Nippon Station</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oita EBL Hydrogen Station</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>1 to 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 2. Deployment of Commercial HRSs (3)

<table>
<thead>
<tr>
<th>Features</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Fuel (Integrated gas station)</td>
<td>✓ 18 HRSs by JXTG</td>
</tr>
<tr>
<td>Multi-Fuel (Hydrogen, Gasoline, CNG, LPG)</td>
<td>✓ Nissin HRS by Toho Gas</td>
</tr>
<tr>
<td>Multi-Fuel (Hydrogen, CNG)</td>
<td>✓ 2 HRSs by Tokyo Gas</td>
</tr>
<tr>
<td>Multi-Fuel (Hydrogen, LPG)</td>
<td>✓ Otsu HRS by Iwatani</td>
</tr>
<tr>
<td>Station with convenience store</td>
<td>✓ 2 HRSs by Iwatani</td>
</tr>
<tr>
<td>Near the highway</td>
<td>✓ 4 HRSs by JXTG</td>
</tr>
<tr>
<td></td>
<td>✓ 1 HRS by Toyota Tsusho</td>
</tr>
<tr>
<td>Airport</td>
<td>✓ Narita HRS by Idemitsu Kosan</td>
</tr>
<tr>
<td></td>
<td>✓ Kansai Airport HRS by Iwatani</td>
</tr>
</tbody>
</table>

Ebina-Chuo Station by JXTG (Multi-Fuel)

Narita Station by Idemitsu Kosan (Narita Airport)
3. Current Activities Overview

3-1 Support Programs for Commercialization

|--------|--------|--------|--------|--------|--------|--------|

- **NEDO/HySUT Technical and Social Demonstration Project (JHFC3)**
- **NEDO’s R&D project**
  Development of technologies for hydrogen production, delivery and storage systems
- **NEDO’s R&D project**
  Hydrogen Utilization Technology Development
- **Regulations Review**
- **Subsidies**
  - **HySUT (sponsored by automakers)**
    Support Program
    Aiming to stimulate demand for FCVs
  - **NeV (sponsored by METI)**
    Support Program
    for Installation of Commercial HRSs
- **Joint Announcement by 13 companies**
  ✓ Launch of FCVs in the market by 2015
  ✓ Construction of 100 HRSs by 2015
  ✓ Public-private collaboration

© 2017 The Association of Hydrogen Supply and Utilization Technology
### 3-2 Support Program for Commercial HRSs

<table>
<thead>
<tr>
<th>Program</th>
<th>Support</th>
<th></th>
<th>Construction</th>
</tr>
</thead>
</table>
| Installation of Commercial HRSs by NeV (Sponsored by METI) | ✓ Bus refueling  
  Support rate: 1/2  
  Max. amount: 3.9 million US$  
 ✓ Others  
  Support rate: 1/2 to 2/3  
  Max. amount: 1.8 to 2.9 million US$ | | |
| Aiming to stimulate demand for FCVs by NeV (Sponsored by METI) | Max. support amount per HRS: 0.22 million US$ | | Operation |
| Aiming to stimulate demand for FCVs by HySUT (Sponsored by automakers) | Max. support amount per HRS: 0.11 million US$ | | |

METI: Ministry of Economy, Trade and Industry  
NeV: Next Generation Vehicle Promotion Center
3-3 Number of FCVs and Refueling Data at Commercial HRSs

[Graph showing the number of FCVs and refueling amount over time from April 2015 to March 2017. The graph includes monthly data with blue bars representing the number of FCVs and a line graph representing the refueling amount (kg).]
3-4 Refueling Data at Commercial HRSs

Revision of exemplified standard for refueling

Number of HRSs (82MPa)
Number of HRSs (70MPa)
Av. Refueling Amount kg/charge
4. Safety and Reliability Technology for HRS

4-1. Basic concept for the infrastructure safety program

- Collection of Incident/trouble data and construction of a reliability database
- Preparation of a guidance document for Education and training for HRS operators
- Development of safety and reliability enhancing technology required in the future
- Further improvement of social acceptance

Construction of reliability database

Hydrogen Refueling Station

Education & training

Enhancement of social acceptance
4-2. HRS Reliability Database System

Contents

Commercial HRS

Event Data

Reliability Database

Analysis

International collaboration

Important Event Study

Output Feedback
HRS Reliability Database Analysis

Equipment Category of Events

FY 2015

- Dispenser: 24%
- Compressor: 27%
- Chiller: 16%
- Accessories: 12%
- Liquid Hydrogen: 1%
- Storage: 10%
- Hydrogen Production: 8%
- Others: 2%

FY 2016

- Dispenser: 26%
- Compressor: 29%
- Chiller: 15%
- Accessories: 9%
- Storage: 11%
- Liquid Hydrogen: 0%
- Hydrogen Production: 8%
- Others: 2%
4-3. Education & Training
Education & training for HRS operators

Directing vehicles
H₂ fueling
Inspection
Maintenance

Study of simulation training

Guidelines
Guidelines for HRS Education and Training Programs

Contents

1. Purpose and definitions
2. Physical properties and characteristics of hydrogen
3. Basic knowledge of high-pressure gas - Standards related to compressed $H_2$ stations
4. Hazard prevention - Explanation of hazard prevention requirements
5. Safety manuals - Equipment and task-oriented manuals
6. Fuel cell vehicles - What every $H_2$ station operator should know about FCVs
7. Simulation training for HRS - Hydrogen compression, pressure accumulation, guiding and fueling FCVs, routine inspections
8. Emergency training - What to do in combustion, fire fighting, or gas leaks
9. Case study of incidents - From hydrogen stations in and out of Japan

(Reliability database and others)
4-4 Social Acceptance Activity
HySUT Exhibition in FC EXPO 2017

28,000 Visitors

Ride & Drive
Survey data on FCV and Hydrogen Infrastructure

<table>
<thead>
<tr>
<th>Date</th>
<th>Survey respondents</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/27-28/2014</td>
<td>FC Expo visitors</td>
<td>208 (Male: 194 / Female: 14)</td>
</tr>
<tr>
<td>2/25-26/2015</td>
<td>FC Expo visitors</td>
<td>327 (Male: 246 / Female: 81)</td>
</tr>
<tr>
<td>3/3-4/2016</td>
<td>FC Expo visitors</td>
<td>329 (Male: 246 / Female: 83)</td>
</tr>
<tr>
<td>3/2-3/2017</td>
<td>FC Expo visitors</td>
<td>332 (Male: 289 / Female: 43)</td>
</tr>
</tbody>
</table>

Do you recognize that "FCV" is as safe as a gasoline-powered car?

Do you think “Hydrogen” is dangerous?

Do you think “HRS” is dangerous?
Example of activities for better social acceptance

One-stop portal site of “hydrogen energy”

http://hydrogen-navi.jp/
Summary

Support Program

Regulation Review

Technology Development

Cost Reduction

Reliability Improvement

Social Acceptance

Safety Activity

Education & Training

Dissemination
Thank you very much for your attention!

This program has been supported by New Energy and Industrial Technology Development Organization (NEDO).