Fuel Quality Monitoring (FQM) in EU, US and Japan

Japan Automobile Research Research Institute
Keiko Hirota
Sustainable Automobile Society in Asia

Fuel Quality Requirement

Emission Regulation

Vehicle Technology

Air Quality Improvement
CO2 Reduction
Import deregulation made stricter control necessary

• **Before 1996:**
  – Only several companies could supply fuels
    • Refining capability was a requisite to import petroleum products
  – The several companies were controlling supply chains

• **Since 1996:**
  – Regulations were relaxed: Any company can import
  – Fuels from various sources came into market
  – Stricter control of fuel quality became necessary
Law and standard in Japan

- Law
  - METI
    - Agent of Energy Resource Distribution division
  - Law of FQM

- Standard
  - Mandatory standard by Law of FQM
  - Japanese Industrial Standard mark (JIS)
  - Standard Quality Mark (SQ)

Provider
- Prohibition of off spec fuel

Car safety

Environmental protection

Consumer protection
Law

Quality control
1977 Regulation on inflammable oil sales
JIS standard

Inflammable oil
Kerosene mixture <4%
Quality analysis
Mandatory for provider

Inflammable
Kerosene mixture <4%
No detection of methyl alcohol
Gum <5mg/100ml

Inflammable oil
No lead detected
Sulfur <0.01%
MTBE <7% Benzene <5%
Orange coloring (differentiate from kerosene)

Diesel
Sulfur <0.2%
Cetane index >45
90% distillation temperature <360°C

Fuel quality analysis
Management by production, importer
Fuel Quality Certificate
Inflammable oil, diesel, kerosene

Low sulfur diesel for emission standard target for a long term
1996 Law of FQM

Emission enforcement of toxic substance
2000 Law of FQM

Engine performance and fuel quality
1986 Regulation on inflammable oil sales amendment

Trade liberalization and fuel quality
Mandatory for env’tl, safety, health impact
Prevention of mixture
1996 Law of FQM

Sulfur contents <0.05%
Benzene <1%
### Quality standards items for gasoline and diesel oil

#### Gasoline

<table>
<thead>
<tr>
<th>Item</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>No detection</td>
</tr>
<tr>
<td>Sulphur content</td>
<td>0.001%(10ppm)</td>
</tr>
<tr>
<td>MTBE</td>
<td>&lt; 7%</td>
</tr>
<tr>
<td>Oxygen content</td>
<td>&lt; 1.3%</td>
</tr>
<tr>
<td>Benzene content</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Kerosene</td>
<td>&lt; 4%</td>
</tr>
<tr>
<td>Methanol</td>
<td>No detection</td>
</tr>
<tr>
<td>Ethanol</td>
<td>&lt; 3%</td>
</tr>
<tr>
<td>Washed gums</td>
<td>&lt; 5mg/100ml</td>
</tr>
<tr>
<td>Color</td>
<td>Orange</td>
</tr>
<tr>
<td>Octane</td>
<td>Regular &gt; 89</td>
</tr>
<tr>
<td></td>
<td>Premium &gt; 96</td>
</tr>
<tr>
<td>Density</td>
<td>&lt; 0.783g/cm³</td>
</tr>
<tr>
<td>Distill</td>
<td>T10/T50/T90</td>
</tr>
<tr>
<td>Copper corrosion</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>RVP</td>
<td>44–78 kPa (kgf/cm²)</td>
</tr>
<tr>
<td>Oxidation stability</td>
<td>&gt; 240min</td>
</tr>
</tbody>
</table>

#### Diesel

<table>
<thead>
<tr>
<th>Item</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur content</td>
<td>0.001%(10ppm)</td>
</tr>
<tr>
<td>Cetane index</td>
<td>&gt; 45</td>
</tr>
<tr>
<td>Distillation T90</td>
<td>&lt; 360 °C</td>
</tr>
<tr>
<td>Flash point</td>
<td>&gt; 45°C</td>
</tr>
<tr>
<td>Cloud point (CP)</td>
<td>Depends on regions and month</td>
</tr>
<tr>
<td>Cold Filter Plugging Point (CFPP)</td>
<td>Depends on regions and month</td>
</tr>
<tr>
<td>Carbon residue of 10% bottom</td>
<td>&lt; 0.1%</td>
</tr>
<tr>
<td>Kinematic viscosity (30°C)</td>
<td>&gt; 1.7mm²/S</td>
</tr>
</tbody>
</table>


- Oxygen contents: 1.3wt% (Max.)
  - To meet Japanese emission regulation
  - Equivalent to 7% MTBE
- Ethanol content: 3vol% (Max.)
  - Car safety
  - Aluminum corrosion and rubber expansion

Source: METI
FQM in Japan

- Visit without notice, Punishment
- Report duty
- Quality verify
- Oil company (refinery, import)
  - Distributor
  - Depot
  - Petro station 47584 (2005)
- Investigation of cause
- Incompliance
- FQM plan, Report duty
- Government
- Sampling at Petro station by appointed institute
- Analysis fee USD 82-182/sampling
- Analysis fee: 3000 USD Min./year
- Mandatory check duty
  - By company
  - (Each 10 days)
- Punishment risk
- Mandatory check by appointed institute
  - (Once a year)

Report duty

Hearing, Visit without notice, Punishment etc

Mandatory check duty

Analysis fee USD 82-182/sampling
## FQM regulation and compensation in Japan

<table>
<thead>
<tr>
<th>Negative impacts of FQM regulation</th>
<th>Compensate measure of negative impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory check by company</td>
<td>FQM plan certification system</td>
</tr>
<tr>
<td>Each 10 days</td>
<td></td>
</tr>
<tr>
<td>Mandatory check by appointed</td>
<td>The cost of mandatory check is subsidized.</td>
</tr>
<tr>
<td>Institute for all petro stations</td>
<td></td>
</tr>
<tr>
<td>Fine &lt; \1,000,000 or Imprisonment</td>
<td>SQ mark</td>
</tr>
<tr>
<td>&lt; 1 year</td>
<td>at Petro station</td>
</tr>
<tr>
<td>Public announcement</td>
<td></td>
</tr>
<tr>
<td>Shut down business for 6 month</td>
<td></td>
</tr>
</tbody>
</table>
Consumer Protection: Quality Certificate by Government in Japan

SQ (Standard Quality) Mark Guarantees Fuel Quality at Petro Station. The SQ Mark Provide the Fuel Quality Information for Consumer.
1977 Clean Air Act Amendment
1970s Regulations on vehicle + fuel quality

1980 Standard + market intervention

1982 Air pollution problem

1990 Severe pollution from vehicle, Clean Air Act Amendment due to loose standard

1970s Regulation on vehicle
1975 Regulation on fuel market

Oxygen content up to 2wt%

Permissible limit on lead in gasoline

1. Diesel oil (cetane <40, lead content >0.05wt%) was not allowed.
   Permissible limit on aromatics

2. Quality standard for vapor pressure, distillation, sulfur, aromatic content, olefin, metal content and detergent.
   Prohibition of leaded gasoline.

3. Mandatory on RFG in the area where ozone concentration is beyond standard

4. Mandatory on oxygen content more than 2%.
Law and standard in the US

EPA

Air pollution + health effect prevention
  • Conventional gasoline, RFG
  • Diesel

Law

ASTM

Voluntary standard: safety + engine performance

Gasoline standard (D4814)
Diesel standard (D975)

Local government standardization by local government law

Supplier Waiver
Fuel quality monitoring system in United States

- **Federal gov. (EPA)**
  - Submission of sampling results
  - Investigation to upstream
  - Incompliance
  - Report

- **Analysis institute**
  - Voluntary check by company
    - 10-20%
    - Keep PTD for 3 years
  - Setting “tolerance” (permissible sampling result)

- **Refinery, importer**
  - Product analysis duty
  - Agreement of fuel specification
  - Heavy punishment
  - Verify sold product quality

- **Distributor**
  - Voluntary check before distribution
  - Sampling 20,000 stations

- **Retailer**
  - Sampling by EPA
    - 2,000 stations

- **States gov.**
## FQMS measures in US

<table>
<thead>
<tr>
<th></th>
<th>Government</th>
<th>Private sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various distribution system</td>
<td>Quality check at retail level</td>
<td>Voluntary check before from distribution to retail</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sampling check by non-profit organization</td>
</tr>
<tr>
<td>High penalty cost</td>
<td>Organize sampling method seminar by EPA Setting tolerance</td>
<td>Participate sampling method seminar Product Transfer Document (PTD)</td>
</tr>
<tr>
<td>Strict penalty</td>
<td>Fine max $27,500/day Imprisonment Shut down business etc.</td>
<td>Submission of sampling result (PTD) or other source of sampling results. Periodical report to EPA</td>
</tr>
</tbody>
</table>
EU FQ Regulation

Air pollution + health effect prevention
- 1976 Permissible limit of sulfur on diesel.
- 1981 Permissible limit of lead and benzene in gasoline
- 1994 Reduction of permissible limit on sulfur in diesel.

75/16/EEC
78/611/EEC
93/12/EEC

Reduction of oil dependence
- 1988 Permissible level on oxygen in gasoline

85/536/EEC
CEN standardization
EN228:1987 for gasoline
EN 590:1987 for diesel

Air pollution control + protection from deterioration of engine performance
- 1988 Permissible limit on oxygen benzene in gasoline
- Octane index minimum level for leaded gasoline.

85/210/EEC
CEN standardization
unleaded gasoline (EN228:1993)
diesel (EN590:1993).
EU members follow CEN standard

Harmonization; + future common target
- Fuel standard of gasoline and diesel after 2000
- Fuel standard of gasoline and diesel after 2005

98/70/EC
2003/17/EC (Amendment by CEN)
unleaded gasoline (EN228:2004)
diesel (EN590:2004).
Law and standard in EU

- **EU committee**
  - EU Directive (98/70/EC)
  - (2003/17/EC)

- **CEN (Institute of EU standard)**
  - Gasoline (EN228)
  - Diesel (EN590)
  - FQM standard
    - EN14274 FQM
    - EN14275 Sampling

- **Law**

- **EU member country adapt the EU directive domestically (98/70/EC)**

- **Supplier**
FQM in EU

EU committee

Ratification, report
Proposal of environmental friendly standards

EU member country

Heavy punishment
Verification quality
Trace to upstream
Incompliance

Refinery

Voluntary check before distribution

Agreement of quality in distribution process

Distributor

Analysis institute

The result of 95% confidential level is permissible

Sampling check
Max: Belgium 1527samples/1million KL
Min: France 5 samples/1 million KL (Gasoline)
2 samples /1million KL (Diesel)

Ex) Belgium
Payment of sampling cost

Penalty:
## FQMS measures in EU

<table>
<thead>
<tr>
<th></th>
<th>Government</th>
<th>Private sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various distribution system</td>
<td>Quality check at retail level</td>
<td>Voluntary check before distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sampling check by NGO</td>
</tr>
<tr>
<td>High sampling test</td>
<td>The government charge sampling cost if petro station fail the results (Belgium) 95% of confidential level is permissible.</td>
<td>Voluntary standard at retail level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No mixture during distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Certificate of distribution process</td>
</tr>
<tr>
<td>Penalty</td>
<td>Public announcement</td>
<td>Public announcement by NGO</td>
</tr>
<tr>
<td></td>
<td>Shut-down</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fine and vigilance (Germany)</td>
<td></td>
</tr>
</tbody>
</table>
Fuel Quality Control

How we can complete the FQ regulation and standard?

- Obligation of control/ management by law
- Check and improve by monitoring
- Severe penalty by government
- Information transparency

US・EU

Responsibility for penalty
US: Sharing from upstream to downstream
EU: Ownership

Voluntary monitoring at upstream
The monitoring cost covered by Company

Japan

Responsibility for penalty
Sharing from upstream to downstream

Mandatory sample check at downstream
The monitoring cost covered by government
Expected Effects of Fuel Quality Improvement

– Guarantee of Standards for EURO2/EURO4 Compliant Fuels
– Appropriate Fuel Quality for Vehicle Technology
– Reduction of Air Pollution
– Prevention of Health Effects
– Promotion of Automobile Industry
Blue Sky for all of us
Thank you for your attention!

khirota@jari.or.jp
Toward Harmonization of Fuel Quality and Vehicle Technology

- Availability of Emission Control technology
- Ready for Low Emission Vehicles
- Necessity of a Consistent Schedule in order to Achieve Better Air Quality.

Need an Incentive for Fuel Improvement.
Sampling and Analysis to Asian countries

Potential problems on

- Adulterations
- Penalty
- Number of sampling
- Human resource + analysis facilities

Possibility on

- National standard.
- AAF recommendation.

- Obligation of control/management by law
- Check and improve by FQ monitoring
- Severe penalty by government
- Information transparency
Off spec fuel quality problems in Asia

- Limited Number of Samples
- Insufficient Analysis Facilities
- Lack of Skilled Human Resources

- The FQM exists, but system operation is not enough.

(FQM : Fuel Quality Monitoring)

Increase Government Initiative for Fuel Quality Improvement
Conclusion: Needs for the Government Initiative for Better Fuel Quality toward EURO2/EURO4

- Needs for the Increase Number of Mandatory Sampling
- Needs in Analytical Capacity Improvement
- Needs in Human Resources Development

Let’s improve fuel quality together.
We can make better environment!
Current FQM in Asia
(FQM : Fuel Quality Monitoring)

Japanese Case:
Mandatory Check Duty by Company (Each 10 days)
Mandatory Check by Appointed Institute
(Once a year at all Petro Station) The number of petro station (2005) : 47584

Source: JARI survey result 2004
Results of Fuel Monitoring and Lead Phase Out Policy

After 2000, lead phase out policy was introduced by region.

According to MOE/KPBB, 12 out of 31 samples were over the Indonesian standard level.

According to JARI-JAMA-JETRO project, 17 out of 90 samples were over the Indonesian standard level.

It is urgent matter to guarantee appropriate fuel quality.
Fuel Quality and Safety Gas Station Campaign in Thailand

1002 petro station participated out of 18902 petro station (5.3%). (2008)

370 out of 1002 gas stations (40%) were certificated.

http://www.doeb.go.th/bfbs/index.html
History of Emission control in Japan
(Gasoline Passenger car)

- **CO**
  - 1965: 50%
  - 1970: 60%
  - 1975: 50%
  - 1980: 45%
  - 1985: 5%
  - 1990: 1.6% (0.8%)
  - 2000: 2.6% (1.3%)
  - Mode change (10→10-15)

- **HC**
  - 1965: 59%
  - 1970: 75%
  - 1975: 59%
  - 1980: 48%
  - 1985: 8%
  - 1990: 2.6% (1.3%)
  - Mode change (10→10-15)

- **NOx**
  - 1965: 70%
  - 1970: 39%
  - 1975: 70%
  - 1980: 39%
  - 1985: 27%
  - 1990: 20%
  - 1995: 8%
  - 2000: 2.6% (1.3%)
  - Mode change (10→10-15)

- * IW ≤ 1,000kg
- IW > 1,000kg

**Lead phase out**
- Regular gasoline: 1975
- Premium: 1986

**Benzene contents**
- 1996: 5%
- 2000: 1%

Data source (Emission) Mr. Morimitu JARI China RT, (Lead contents) PAJ, PEC
Emission Control Level and counter-measures on Gasoline Passenger Cars

Source: Mr. Morimitsu, JAMA FQM seminar 2005
Efforts from oil industry and government budget

Total investment from oil industry

1970

Desulfurization of heavy oil
7.2 Billion USD

1980

Lead phase out
2.7 Billion USD

1990

Low sulfur in diesel
2.7 Billion USD

Low benzene
1.2 Billion USD

2000

2003

Converted as 1 USD = 109.65 yen