Mid-term Outcome and Future Plan of Bio-ethanol Project in Korea

Presented by **Dr. CHOONG-SUB JUNG**

KiPEQ Korea Institute of Petroleum Quality

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Outline of Project

Investigation of Related Laws and Regulations

- **Petroleum Business Act** was enacted in 1970 and revised 18 times

- Petroleum Business Act was revised a full-scale revised to **Petroleum & Petroleum Alternative Fuels Business Act** in 2004

- It has possible to revitalize of supply **Petroleum & Alternative Fuels** in Korea

Investigation of Related Laws and Regulations

- **Petroleum & Petroleum Alternative Fuels Business Act** is defined as fuel which can alternate petroleum products without structure modification of combustion equipments (the exclusion of coal and natural gas)

- **Petroleum Alternative Fuels** include bio-diesel, bio-ethanol, coal liquefaction, natural bitumen and emulsification

Investigation of Related Laws and Regulations

The Standard of Automobile Gasoline in Petroleum & Petroleum Alternative Fuels Business Act

Items \ Classification	No. 1 (Regular)	No. 2 (Premium)
-	-	-
-	-	-
Benzene content (Vol. %)	Under 1.0	
Olefin content (Vol. %)	Under 18 (21)	
Oxygen content (weight %) *	Over 0.5 ~ under 2.3 (winter over 1.0 ~ under 2.3)	
Methanol content (weight %)	Under 1.0	

* Oxygen content is oxygen weight in MTBE, ETBE and bio-ethanol

Progressed Research

Feasibility Study for the Implementation of the imported bio-ethanol (KIER, 2005. 12)

- The need of actual assessment for production, transportation and use of bio-ethanol
- The expense of infrastructure construction make the determination of economic feasibility and the need of actual assessment before commercialization
- The Problems of corrosion and phase separation can be arise by the moisture in quality characteristics of bio-ethanol fuel

Outline of Project

Research of Actual Assessment for Introduction of Bio-ethanol Fuel

Period

- 2 Years : August 1, 2006 ~ July 31, 2008
  - 1st Year : August 1, 2006 ~ July 31, 2007
  - 2nd Year : August 1, 2007 ~ July 31, 2008

Management

- Korea Institute of Petroleum Quality (KiPEQ)

Participation Company

- 5 Oil refineries
  - SK Energy, GS Caltex, S-Oil, HD-Oil bank, SK-IC
- 1 alcohol company
  - Changhae ethanol

Outline of Project

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5 Oil refineries
(SK Energy, GS Caltex, S-Oil, HD Oil bank, SK-ICO)

- Supply of sub-octane gasoline
- Equipments construction and management for storage tanks and line blending of bio-ethanol, sub-octane

- Examination of foreign status
- Examination of domestic status
- Assessment of quality characteristics in Lab.
- Actual assessment in a gas stations

1 alcohol company
(Changhae ethanol)

- Supply of anhydrous bio-ethanol (over 99.5%)
- Construction of pilot and Production for anhydrous bio-ethanol

Results analysis of quality characteristics for bio-ethanol fuel and The establishment of plans for actual assessment

1st Year Results

1. Foreign and Domestics Status

1-1. Foreign status

- ○ Supply status of USA(E10, E85 etc)
- ○ Supply status of China(E10), India(E5)
- ○ Analysis of E3 actual assessment of Japan

1-2. Domestic status

- ○ Producer : Refinery → Oil reservoir (Tank truck, Oil pipeline)
- ○ Customer : Oil reservoir → Gas station (Tank truck)
- ○ Status of domestic gas station and distribution infrastructure

2. Lab Test (Quality characteristics of BE fuel)

2-1. Manufacture of bio-ethanol fuel

○ Bio-ethanol : Anhydrous bio-ethanol 99.5%

○ Manufacture of sub-octane gasoline :
Manufacture blending stocks (B/S) depending on refinery specifications such as vapor pressure and octane number etc

➡ Supply to sub-octane gasoline to satisfy the specification of 「The Act for Petroleum and Alternative Fuels」

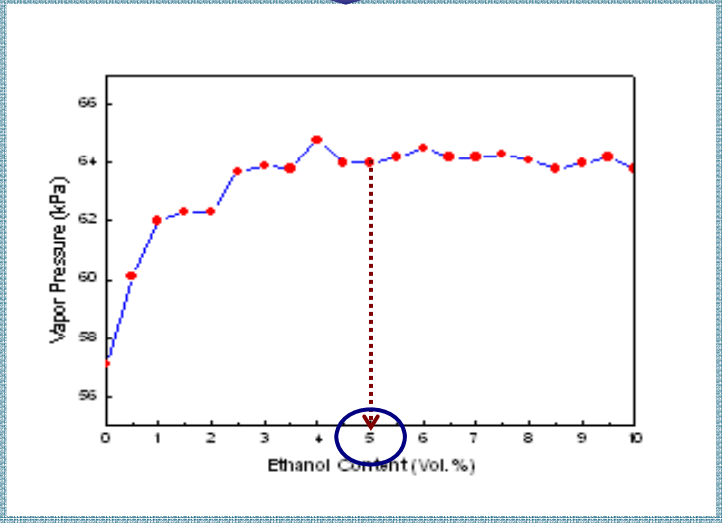
Octane number (RON)	Vapor pressure (37.8 ℃, kPa)		Aromatic (Vol.%)	Olefin (Vol.%)
	Summer	Winter		
91 ~ 92	<52	<70	>27	<18

2. Lab Test (Quality characteristics of BE fuel)

2-2. Major properties of bio-ethanol fuel

▷ Vapor pressure

○ ~ E5 : increase 7 ~ 8 kPa, E5 ~ E10 : stable, E10 ~ : decrease
(vapor pressure of bio-ethanol : ≈ 15 kPa)
→ increment of vapor pressure : bad influence to restart
☞ need to proper vapor pressure



▷ Distillation property

○ 50% distillation temperature was decreased to 10~20 ℃ due to the blending of bio-ethanol
→ bad influence to restart
☞ need to proper distillation property

▷ Octane number

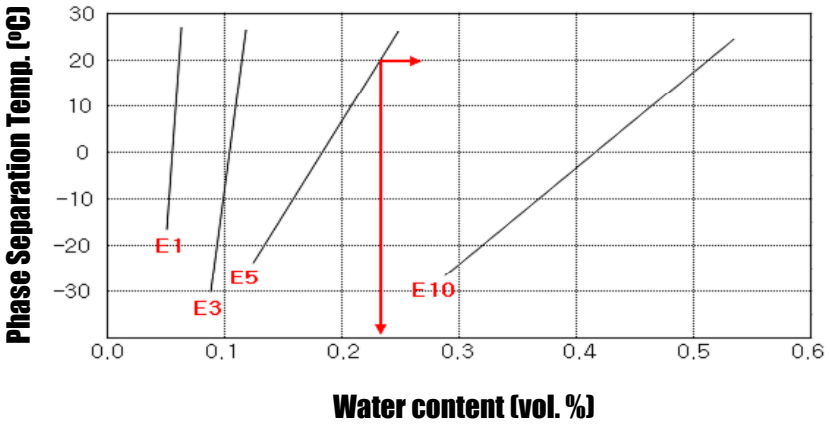
○ Increment of 2 ~ 2.5 when BE5 was blended
※ RON : 125~130, MTBE : RON,115~120

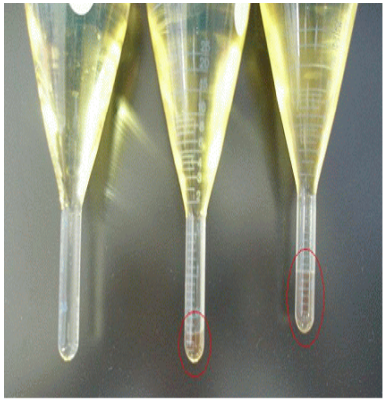
2. Lab Test (Simulation of phase separation due to water content)

2-3. Effect of water content on bio-ethanol ratio

○ **Simulation of phase separation on gasoline and ethanol due to water content**

→ **Decrement of octane number, bad influence upon fuel feeding system**





※ Phase separation take place when water content is over 0.2% at E5

○ Phase separation (at 20 ℃)
- E3 : water content ≈ 0.14 Vol.%
- E5 : water content ≈ 0.19 Vol.%
- E10 : water content ≈ 0.54 Vol.%

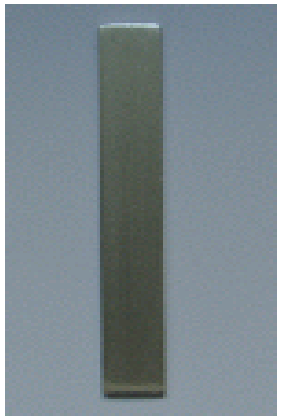
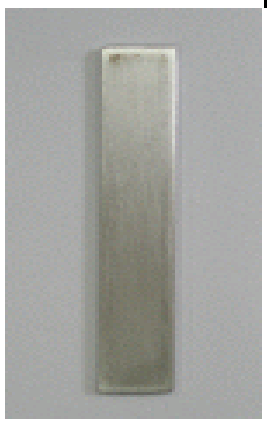
2. Lab Test (Corrosion test)

2-4. Corrosion test for aluminum plate (100 ℃, 120 hr)

○ White particle was formed on aluminum plate due to strong corrosion, and weight was decreased.

※100 ℃ × 720 h = almost 15 yr (according to Japan Automobile Research and Institute)

∴ 100 ℃, 120 h → 2.5 yr

	Sample	Initial state	Sub Octane Gasoline	E5	E10
Al	Variation of appearance				
	Weight variation	-	0.0002	0.0002	-0.0190

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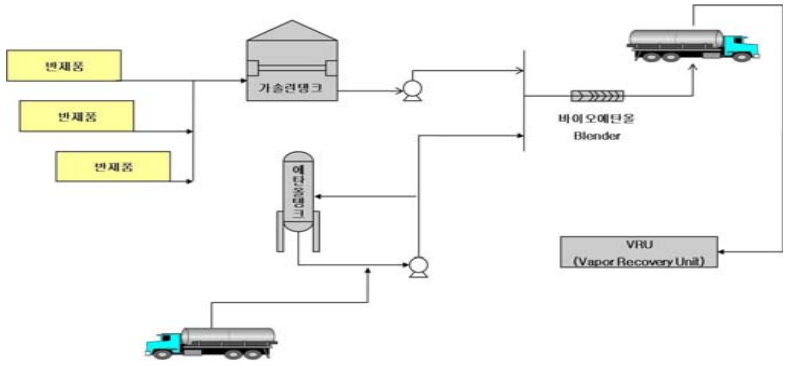
2. Construction Status of Storage Tanks and Line Blending

Construction status (SK Incheon Oil)

○ **Scheme of storage tanks and line blending**
- bio-ethanol tanks (Stainless steel, protection of water mixing (Installation Silica Dessicator))
- sub-octane gasoline tanks (Carbon Steel)
- Installation of control system for line blending
  ☞ ethanol mixing ratio : 1~10 Vol.% blending




Ethanol tank


Gasoline tank


Pump


Shipment place

○ Demonstration (2007. 7. 27)
– production capacity : 20,000 L
(E5 : ethanol content 5.2 Vol.%)

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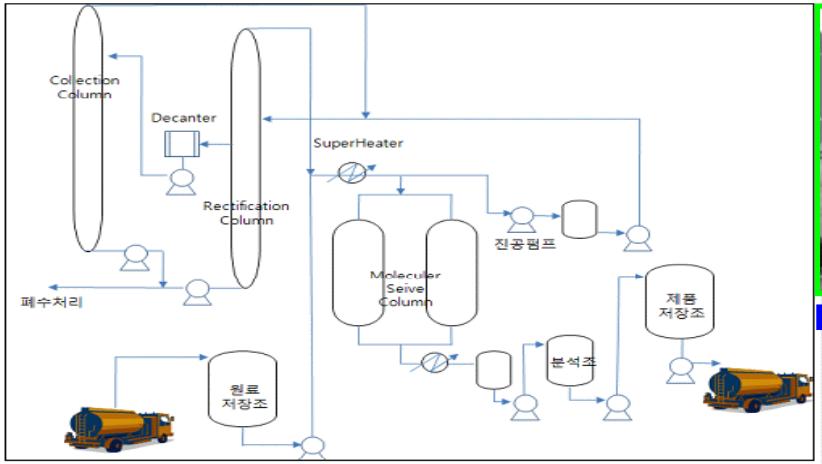
3. Construction of Pilot Plant for Water Free Bio-ethanol

Construction place (Changhae Ethanol)

◯ **Pilot Plant for bio-ethanol**

- production capacity : 1 kL/day, bio-ethanol purity : > 99.5 Vol.%
- building : 4th floor (30 m), PLC control system



Protection system of water

Molecular Sieve

Packing materials

◯ **Production (2007. 7)**

- production capacity : 6,000 L (purity >99.9 Vol.%)

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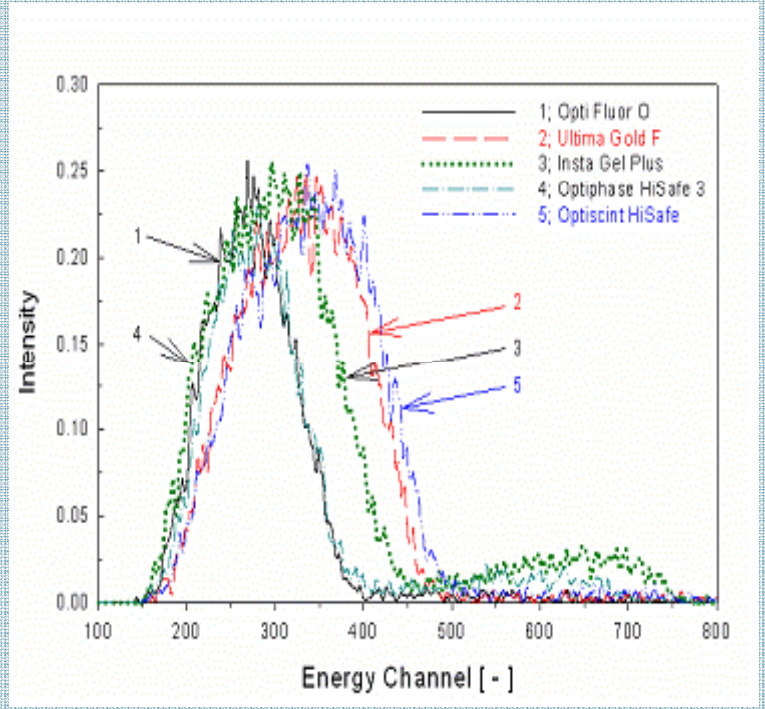
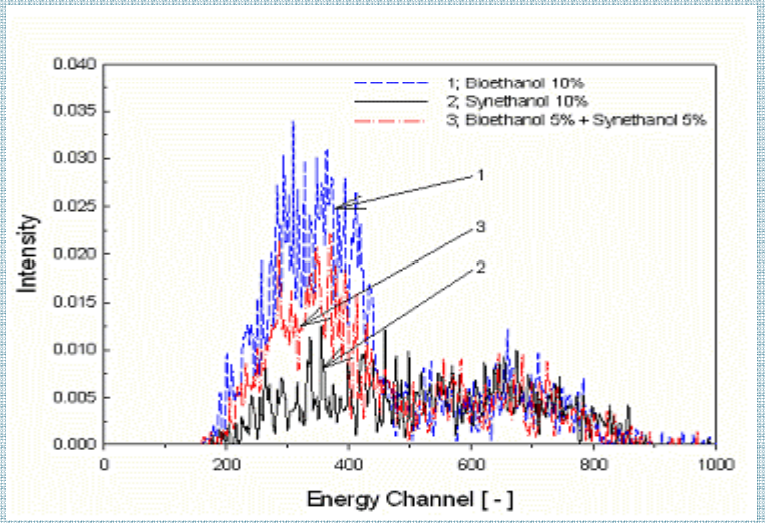
4. Bio-ethanol Analysis of the Mixture of Gasoline and Ethanol

Results

Selection of optimum scintillation agent



Analysis of bio-ethanol



Mixing ratio [Vol.%]	CPM
Sub-octane gasoline : Bioethanol = 90 : 10	5.04
Sub-octane gasoline : Synethanol = 90 : 10	1.51
Sub-octane gasoline : Bioethanol : Synethanol = 90 : 5 : 5	3.21

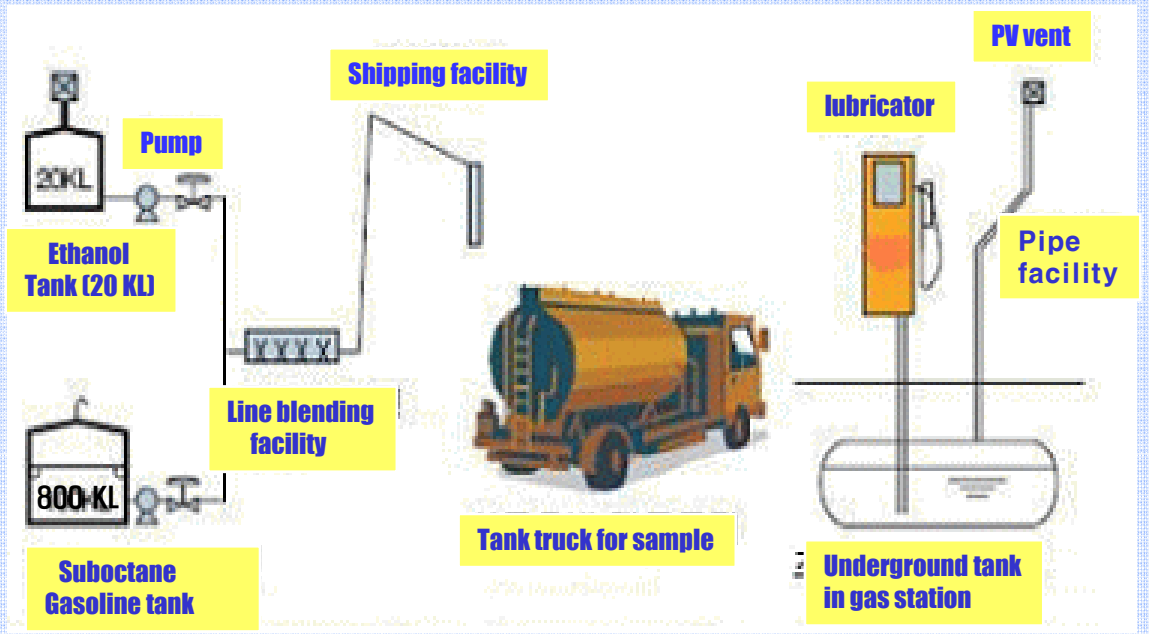
Progressing Status of 2nd Year

Progressing Status of 2nd year

Scheme of production, transportation, storage and supply in bio-ethanol fuel blending

Production of anhydrous bio-ethanol in changhae ethanol

Production of sub-octane gasoline In 5 oil refineries



E1 ~ E10 manufacture equipments (Sk Incheon)

Transportation equipments

Storage/supply equipment 4 model gas station (Gyeongki, Chungcheong, Honam, Youngnam)

Progressing status of 2nd year

1-1. Scheme for management of demonstration gas station

SK 인천정유 — **Blending of bio-ethanol fuel**

CHANGHAE ETHANOL — **Production of anhydrous ethanol**

GS 칼텍스 — **Honam (E3)**

Actual consumer

SK energy — **Gyeonggi (E5)**

Hyundai Oilbank — **Chungcheong (E5)**

S-OIL 에쓰-오일 — **Yeongnam (E3)**

Consumption of a gas station 7,000L/month

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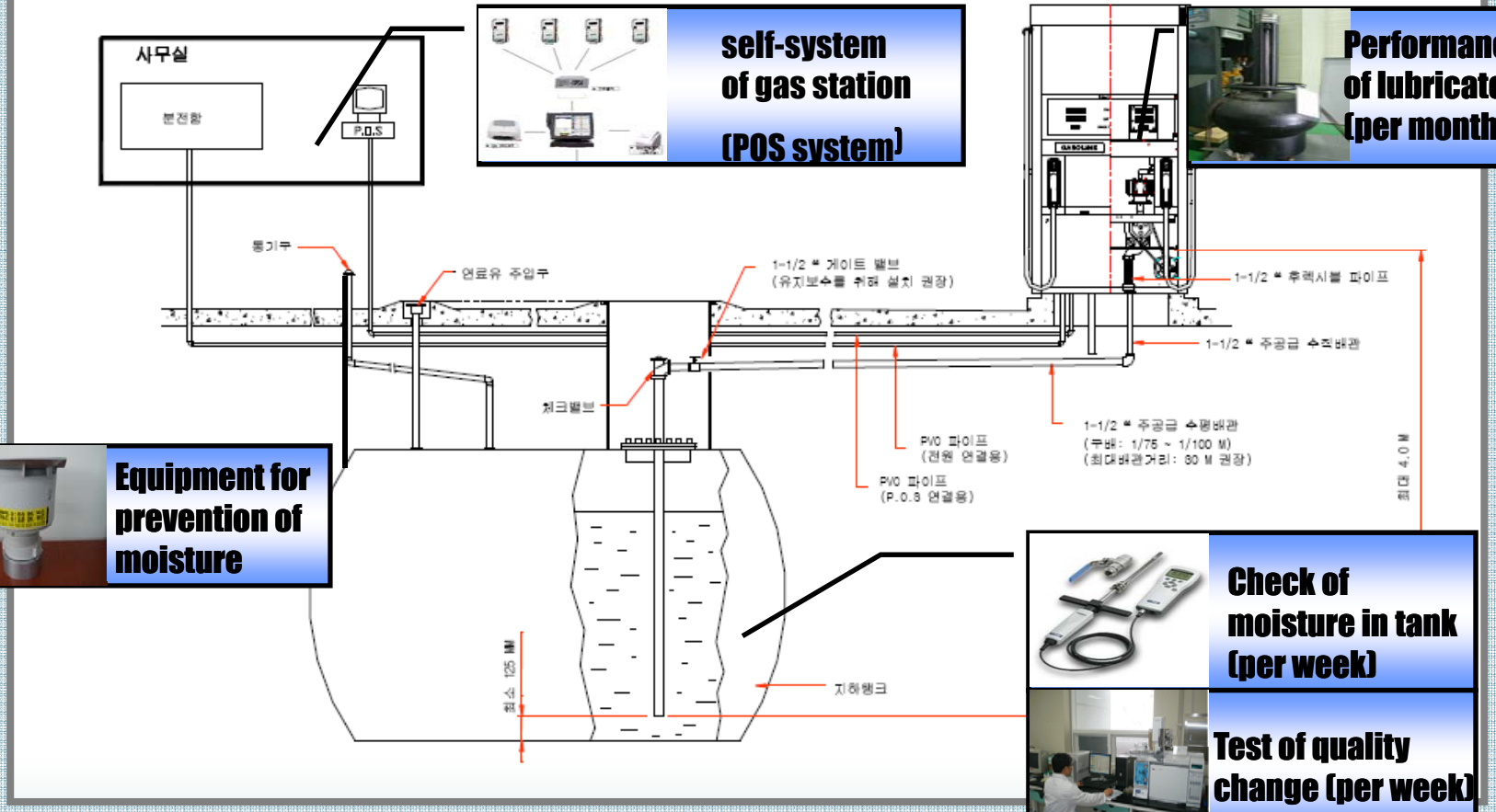
Proceeding status of 2nd year

1-2. Management system of demonstration gas station



self-system of gas station (POS system)

Performance test of lubricator (per month)

Equipment for prevention of moisture

Check of moisture in tank (per week)

Test of quality change (per week)

Future Plans

Future Plans

Study of actual assessment for Oil reservoir

Management of blending facilities of sub-octane gasoline and bio-ethanol for actual assessment

- Blending control system and line mixer of reservoir tank
- Check the performance of facility like volume control system
- Analysis of quality for a final product, sub-octane gasoline, and bio-ethanol

Study of the actual assessment of gas station

Actual assessment of demonstration gas station

- Check the moisture amount in storage tank when sampling
- Analysis of quality change (per week)
- Performance test of lubricator (per month)

Future Plans

- **Determination of optimized distribution infrastructure and bio-ethanol ratio**

- Find the reason for phase separation by moisture and corrosion problem of metal, rubber
- Regular quality test of the demonstration gas station and establish the effective protect method due to moisture
- Indicate the optimized distribution infrastructure for Korea environment

Future Plans

Application of government policy for introduction of bio-ethanol

- Presentation of quality standard for bio-ethanol (BE100)
- Application of government policy and establishment of distribution infrastructure for introduction of bio-ethanol

※ The first consideration of government policy

- The stable supply of raw materials
- Economic feasibility for the correspondence of the existing fuel

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Thanks for your attention!