Benchmarking of Biodiesel Fuel Standardization in East Asia

Abstract

A common agreement on biodiesel fuel standards for East Asia countries was discussed. The concepts to develop the agreement were (1) Based on the European fatty acid methyl ester (FAME) standard (EN14214), (2) Consideration of various oils such as coconut (which has a lower viscosity and flashpoint) and soybean (which has a lower iodine number) and (3) For oxidation stability consideration of metal fuel tanks which are popular in the East Asia Region. Basically all members agreed the EAS-ERIA Biodiesel Fuel Benchmark Standards.

1. INTRODUCTION

1.1. Policy Relevance

The importance of biofuels has been recognized in the Cebu Declaration on East Asian Energy Security on 15 January 2007, in which the standardization was encouraged for practical use. In order to contribute to the promotion of biofuels in East Asian countries, Japan announced “Fueling Asia-Cooperation: Initiative for Clean Energy and Sustainable Growth”, which included the promotion of biomass energy. It was welcomed by all participating countries.

Then, Energy Cooperation Task Force (ECTF) proposed launching a study on biodiesel fuel standard to discuss the concrete measures. The 1st EAS Energy Ministers’ meeting (EMM1) was held in Singapore on 23 August 2007. The importance of biodiesel fuel standard was mentioned in the joint statement.

1.2. Background

The Kyoto Protocol emphasized the concept of “carbon neutral” Biofuels can have climate change benefits as they are produced from renewable sources.

Asian countries are actively promoting the introduction of biofuels due to soaring oil prices and increased energy consumption. The utilization of biofuels is also important from the viewpoint of energy security and diversification of transport fuels.

However, the low-quality biodiesel fuel raises serious concerns regarding the effect on engine performance caused by fuel impurities and the oxidation. Therefore, biodiesel fuel standards have been established in many countries. Harmonization of standards within the East Asia region will facilitate the use and trading of good quality biodiesel.

2. OUTLINE OF ERIA ENERGY PROJECT

2.1. Objective

The objective of this project is to make a benchmark standard of biodiesel fuel in East-Asia. If it is possible, the distribution of good-quality biodiesel fuel and stabilize the economic infrastructure can be achieved.

Table 2.1.1 Introduction of biodiesel fuel

Country	Mixing ratio	Main Feedstocks	Strategy / Goal
Malaysia	2-5%	Palm	National Biofuel Policy, 2006 /B5
Indonesia	up to 10%	Palm	National Energy Program / Biodiesel fuel usage 47 million kL in 2025
Thailand	B2 (2008) B5 (2011) B10 (2012)	Palm	Biodiesel Development and Promotion Strategy / Enforce nationwide B2 in April, 2008, B5 in 2011, B10 in 2012
Philippines	B1 (2007) B2 (2009)	Coconut	Biofuel Law 2006 On going research Jatropha
India	5%	Jatropha	Jatropha biodiesel fuel demonstration 2005-2007 Jatropha biodiesel fuel introduction 2011-2012
China	5% 20%	Used food oil Jatropha	Now under consideration in biodiesel fuel standardization


Palm


Rapeseed


Soybean


Coconut


Jatropha


Waste cooking oil

Fig.2.1.1 Main Biodiesel Materials in each country

2.2. Procedure

To make a benchmark standard of biodiesel fuel in East-Asia, Working Group (WG) for discussions is established. The points of discussion are follows.

- Share the same recognition concerning the importance of ensuring biodiesel fuel quality and the basic measurements for biodiesel fuel standardization.
- Study the characteristics of biodiesel fuel and current situation in each country, and gather the necessary information in order to formulate biodiesel fuel standards.
- Focus on Japanese standards (biodiesel fuel 5%) as a typical example.
- Japan Automobile Manufacturers Association and Petroleum Association of Japan agree to cooperate on this activity.

2.3. Schedule

Figure 2.3.1 shows a schedule of the WGs with EAS (East Asia Summit)-related meetings. Four times of WGs were held.

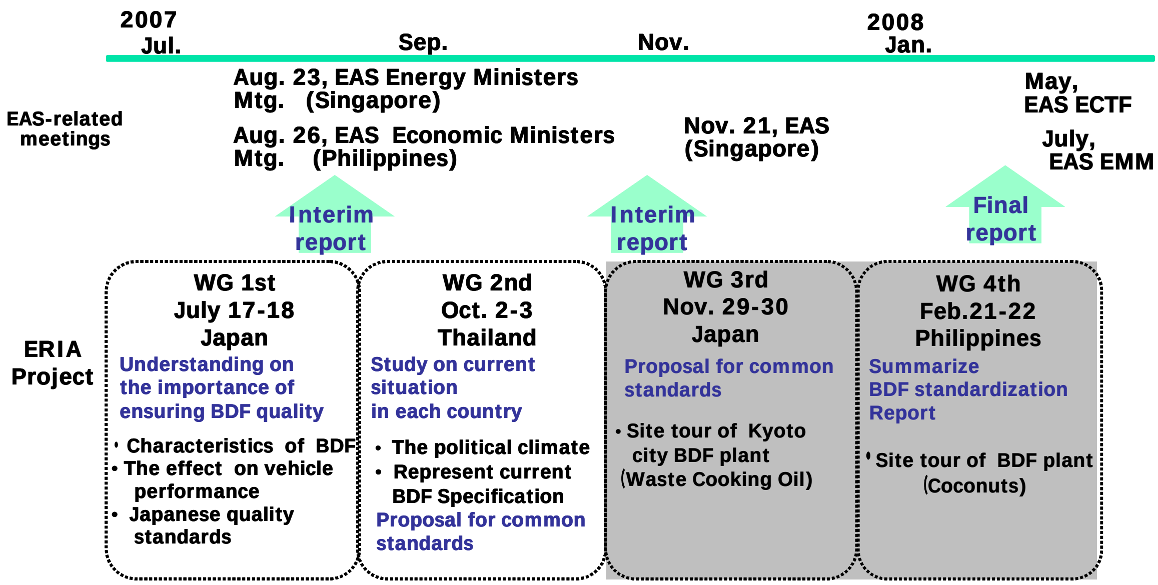

Fig. 2.3.1 Final schedule of the WGs

3. TREND OF BIODIESEL FUEL IN JAPAN

3.1. The governmental target for introducing biodiesel fuel in Japan and its actual situation

Biofuels (Organic compounds derived from plants and other biomass except for derivatives of crude oil, petroleum gas, natural gas and coal) like bio ethanol and FAME (Fatty Acid Methyl Ester; a product derived via chemical treatment from fatty oils like plant oils) play an important role as a measure to mitigate global warming, because the biofuels can be treated as carbon neutral materials according to the Kyoto protocol. The logic is that the amount of carbon dioxide generated from the combustion of biofuels is canceled out the amount of carbon dioxide absorbed during the growth of plants and other biomass.

The Japanese government has committed to the Kyoto protocol, meaning that the amount of green house gas emissions shall be reduced by six percent in 2010 from the 1990 emission level. To comply with its own plan to meet the Kyoto protocol, it has a target to introduce a 500,000 kl-crude oil equivalent of biofuels (including bio ethanol) by 2010.

The introduction of 500,000 kl-crude oil equivalent of biofuels is crucial to meet the commitment, as this measure alone could contribute to one percent reduction in greenhouse gases, out of a total target of six percent.

In a New National Energy Strategy issued by the Ministry of Economy, Trade and Industry in May 2006, the Ministry raised the target for the reduction of crude oil dependence in the country's transportation sector to ca. 80% in 2030, compared to 100% at present, with the aim to reduce in carbon dioxide emissions and its huge dependence on fossil fuels.

Electric vehicles and hydrogen-fuel cell vehicles and intelligent transportation system could be promising mid- and long-term measures to reduce carbon dioxide emissions and the dependence on oil.

Those next generation vehicles are, however, still in their research and development stage. On the other hand, bio fuels are liquid, can be used in existing vehicles and have an immediate effect on carbon dioxide emission reduction and oil dependence. Hence biofuels are useful.

Ethanol, ETBE (Ethyl Tertiary Butyl Ether) and FAME are under consideration as biofuels. The PAJ (Petroleum Association of Japan, a Japanese oil industry body) have committed themselves to introduce 210,000 kl-crude oil equivalent of ETBE into gasoline. Regarding the remaining 290,000 kl-crude oil equivalent, discussions are still ongoing

3.2. Situation and Future for Biodiesel fuel Penetration in Japan

To promote biomass energy and material, “Biomass Nippon Comprehensive Strategy” was established in 2002 by the Cabinet which was jointed by some Ministries; the Ministry of the Environment, the Ministry of Economy, Trade and Industry(METI), the Ministry of Agriculture, Fishery and Forest(MAFF) etc.

The MAFF promotes the “Biomass Town Concept” with cities, towns and villages playing a central role, an overall plan for using regional biomass as shown in Fig.3.2.1. As of March 31, 2007, 90 cities, town and villages have announced this concept. In these biomass towns, resources from cattle excrement or food waste, etc. are converted into energy at biomass conversion facilities such as power generation facilities or composting facilities to ensure that biomass is effectively used inside and outside of the regions.

The METI was established the “Law on the Quality Control of Gasoline and Other Fuels” (“Quality Assurance Law”). The Quality Assurance Law has been amended to allow up to 5% Fatty Acid Methyl Esters (FAME) by mass (in the USA and Europe, blending is by volume) and to prevent the use of unprocessed vegetable oils. The requirements take effect in March 2007. The diesel fuel properties specified in this law are sulfur, cetane index, T90 distillation temperature and upper limits on FAME and triglicerides. For biodiesel fuel, additional requirements include limits for methanol, total acid number (TAN), low molecular weight acids and oxidation stability as acid value growth. Both diesel fuel and biodiesel fuel/diesel blends have limits on FAME and triglycerides to clearly distinguish between the two and to prevent the use of unprocessed triglycerides.

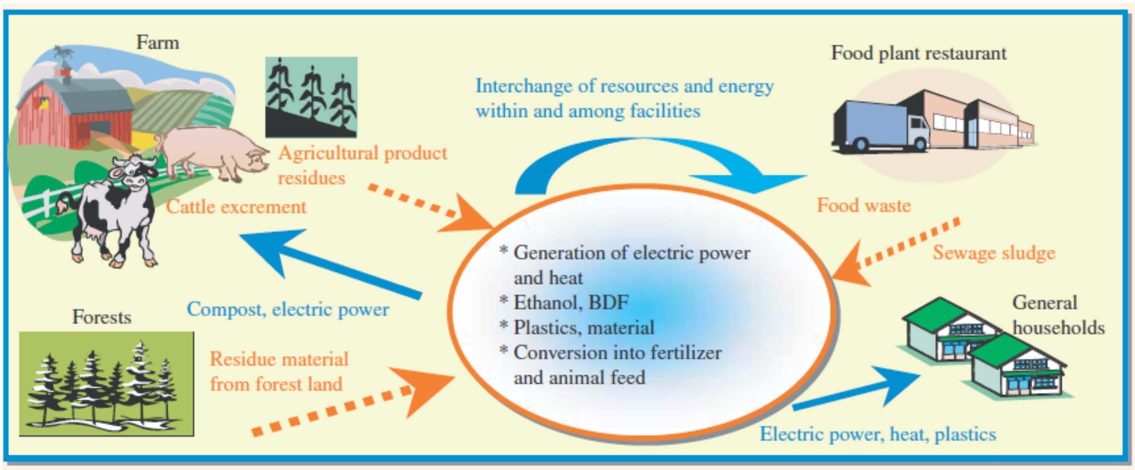

Fig.3.2.1 Biomass Town Concept in Japan

In this concept, Biodiesel fuel (BDF) is used in public automobile, such as garbage truck and city bus as the fuel of "production and consumption at regional area".

Biodiesel fuel (BDF) can be substituted for light oil and used in automobile diesel engines. It is made from biomass materials such as waste food oil. BDF has low sulfur content, so the exhaust contains low concentrations of sulfur oxides. Since it is an oxygen-containing fuel it promotes engine combustion, making it a clean fuel characterized by low carbon monoxide and dark smoke emissions. The process of producing biodiesel fuel involves first causing fats (triglycerides) in waste food oil to react with methanol (transesterification) to produce fatty acid methyl esters. Glycerin and other byproducts produced at the same time are separated out from the obtained reaction oil. The remaining oil is then refined into biodiesel fuel.

Kyoto City collects about 125 kiloliters of waste food oil annually at about 1,000 collection sites in the city in cooperation with members of unit communities. The collected oil is made into biodiesel fuel at a dedicated plant with a capacity of 5,000 liters per day. The fuel is used in garbage trucks (equivalent to 210 trucks) and city buses.

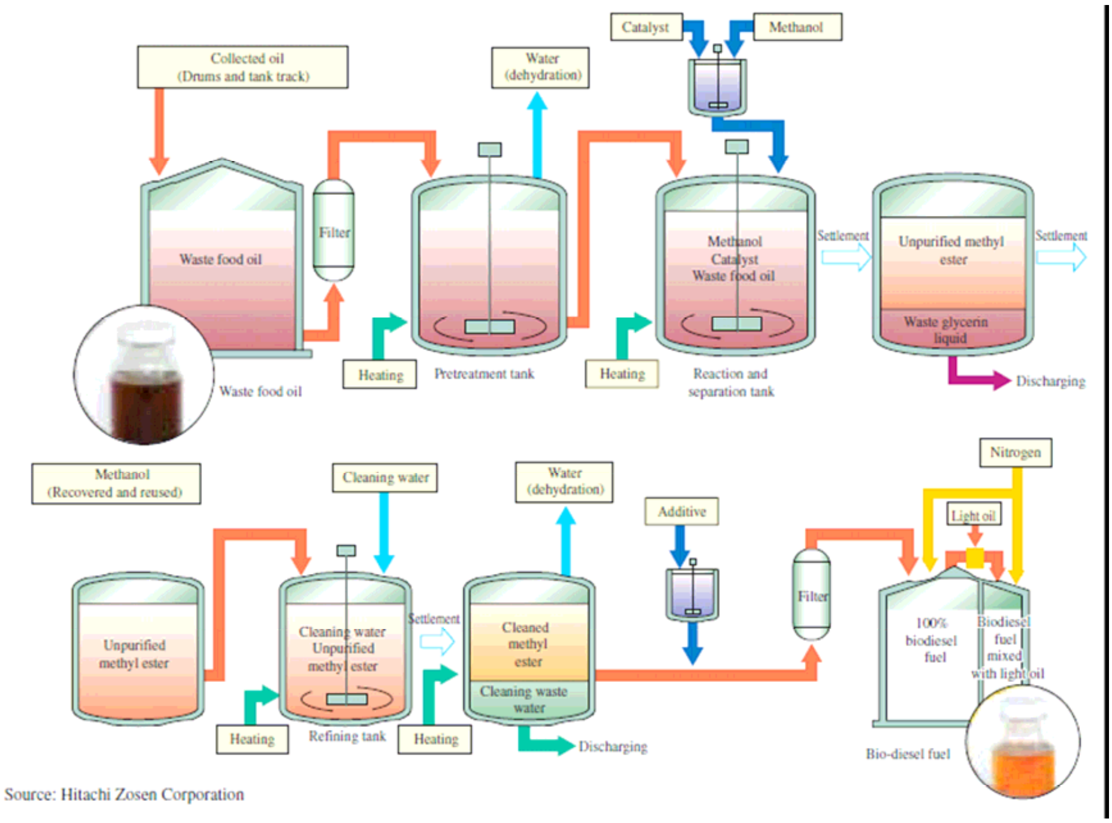

Fig.3.2.2 Biodiesel fuel production process in Kyoto City Plant

3.3. Regulation in Japan

3.3.1. Outline of Fuel Regulation in Japan

Fuel quality has a significant impact on vehicle performances. So it is very important to control the quality of fuels at the pump from the viewpoint of safety, Environment and customer protection. If inadequate fuels are distributed and fueled in vehicles, serious trouble may happens. Fig.3.3.1 shows an example of actual market trouble cased by in adequate fuel. High content alcohol fuel corrodes metals in fuel line parts. As a result, fuel leakage happened.

Fig.3.3.1 Example of Market Trouble Caused by fuel

In Japan, Ministry of Economy Trade and Industry (METI) is responsible for fuel quality in the market. By The Fuel Raw in Japan, METI is obligated to do next four items;.

- ✓ Registration of gas stations
  Gas stations are required to register to METI
- ✓ Developing fuel quality standard (mandatory and voluntary)
- ✓ Requiring gas stations to report quality check of gasoline once in:
  10 days, or a year if supply chain is approved by METI
- ✓ Fuel quality monitoring at pump
  Check work can be outsourced to the four registered testing organization

Table 3.3.1 Quality standard items for gasoline and diesel fuel

Items	Level	
Lead	No detection	*
Sulfur	< 10 ppm	*
MTBE	< 7 vol%	*
Oxygen Content	< 1.3 wt%	*
Benzene	< 1 vol%	*
Kerosene	< 4 vol%	*
Methanol	No detection	*
Ethanol	< 3 vol%	*
Existent Gum	< 5 mg/100mL	*
Color	Orange	*
Octane	Regular > 89	
	Premium > 96	
Density	< 0.786 g/cm3	
Distillation Temp.	(specified)	
Copper Corrosion	< 1 max	
RVP	44 - 65 kPa (Summer)	
Oxidation Stability	> 240 min	

Items	Level	
Sulfur	< 10 ppm	*
Cetane Index	> 45	*
90% distillation temp.	< 360 deg.C	*
Flash Point	> 45 deg.C	
Pour Point	Depend on region and month	
CFPP		
10% Carbon Residue	< 0.1%	
Kinematic Viscosity	> 1.7 mm2/s	

Note: * = mandatory

Table 3.3.1 shows a current fuel quality standard in Japan. Asterisk (*) in the table is mandatory items because these properties directly relates to issues of safety and environmental. There are about 50,000 filling stations in Japan. METI gathers about 200,000 fuel samples/year and investigates the quality. If METI finds any off-spec fuels, METI instruct fuel suppliers to follow fuel regulations. If they do not follow, METI order to suspend business up to 6 months and in some case, fuel distributors will be given criminal penalty.

If FAME bended diesel fuel is commercialized in Japan, The Fuel Raw has to be modified that it can be included FAME components.

3.3.2. Developing Biodiesel fuel Standard in Japan

Currently biodiesel fuel has not been introduced commercially. However bio fuels like bio ethanol and biodiesel fuel has been discussed for reducing CO_2 from the transportation section. In order to use bio fuels for automobile, developing adequate specification is essential. METI organized Fuel Policy Sub-committee which is a kind of advisory committee of METI, to discuss biodiesel fuel specification.

There are many kinds of biodiesel fuel like crude vegetable oil, refined vegetable oil, FAME (Fatty Acid Methyl Ester), hydrogenated vegetable oil and BTL (bio mass to liquid). First, it was agreed to select FAME as biodiesel fuel we should develop standard because FAME was used as fuel for fleet use in some area governments and was expected to be used in Japan.

FAME has quite different character from fossil derived diesel fuels. As shown in Fig.3.3.2, the character of FAME is different by raw materials. For example, SME (Soya Methyl Ester) has a tendency to be easy oxidized. FAME from fish oils produces sludge easily. PME (Palm Methyl Ester) and TME (Tallow Methyl Ester) are easy to form wax. Refining process also influences to quality of FAME. If washing process is not enough, some impurities like methanol, glycerin and so on remain in FAME.

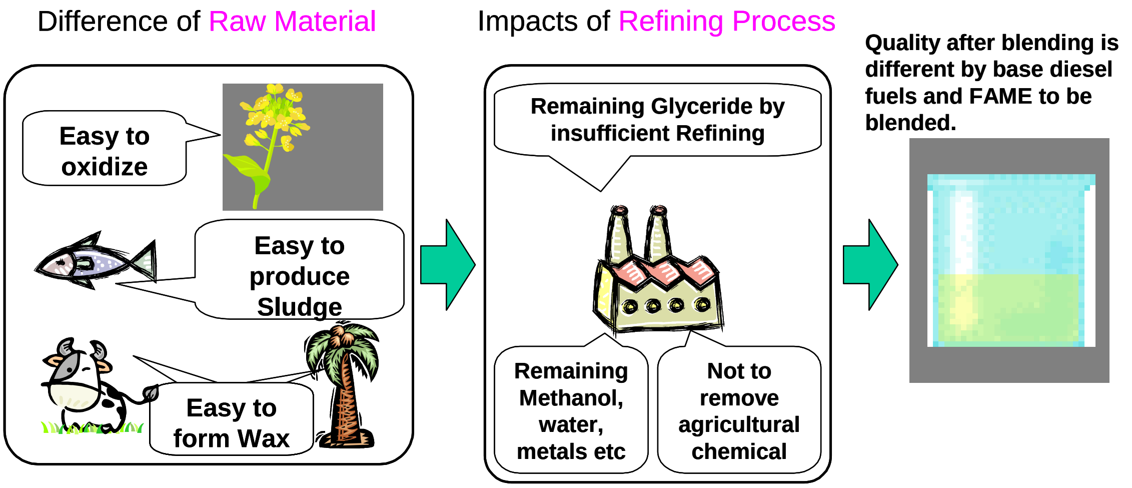

Fig.3.3.2 Characteristics of FAME ; Effects of Raw Materials and Refining Process

These characteristics relates to vehicle performance closely as shown in Fig.3.3.3. If quality of FAME is not controlled properly, serious trouble and/or fatal damage in vehicles may be expected.

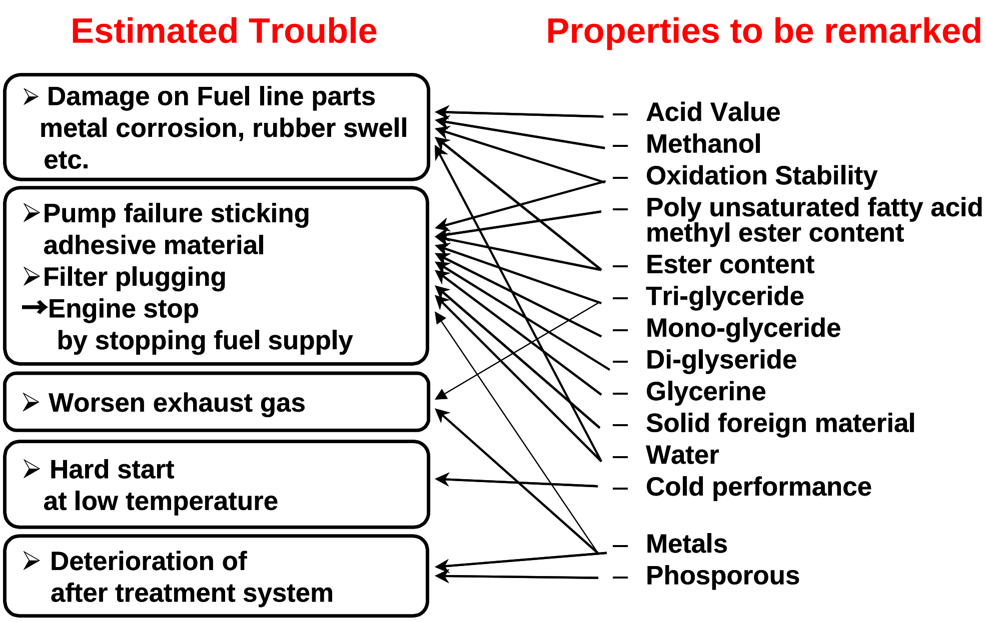

Fig.3.3.3 FAME Properties to be Remarked and Estimated Impacts

For developing biodiesel fuel specification, METI has conducted the FAME conformity tests to gather technical knowledge about FAME. In order to shorten the period for developing the specification, European FAME specification, EN14214 was selected as a base specification. Even though starting from EN14214, more than two years and about four hundred million JPY were spent.

Table 3.3.2 is a summary result of the conformity tests. In the conformity tests, the testing FAME which completely meets EN14214 was prepared and was blended into Japanese JIS No.2 diesel fuel by 5vol%, and then was used in each test. Corrosion was observed in the fuel tank tests and metal dipping tests as the problem related to FAME properties even though the testing FAME used in the conformity tests met European requirements.

Table 3.3.2 Summary of METI Conformity Test Results

Test Items	Results	Summary
Material Compatibility		
Metals	**Fail**	**Corrosion in Tern Sheet**
Rubber & Plastics	Pass	No effects of Ester as far as less than 5v%
Cold Performance	–	Poor Startability
Long Storage Test	Pass	Slight Degradation
Fuel Line Parts Test		
Fuel Filter Test	Pass	Same as diesel fuel with B5
Fuel Tank Test	**Fail**	**Corrosion and melting plating in lead-tin alloy coated and electrolytic zinc-coated steel sheets**
Fuel Pipe Test	Pass	Same as diesel fuel with B5
Fuel Hose Test	Pass	Same as diesel fuel with B5
FIE Durability Test	Fail	Wear in Injectors with B5
Engine Durability Test		
LD, ID&DI	Pass	Observation of no trouble with B5
HD, DI	Fail	Flow loss and Wear in Injectors with B5
Vehicle Durability Test (LDV, IDI)	Pass	Observation of no trouble with B5
Emission Test	Pass	Little Impact with up to 10v%

Note) Test FAME consists of PME:RME:SME=60:38:2 and is blended in commercial diesel fuel by 5%. Test FAME completely met EN14214.

Figure 3.3.4 is an example of corrosion observed in the fuel tank test. The cause of corrosion was lack of oxidation stability. FAME blended diesel fuel was oxidized during tests and produced corrosive acids. No other problems related to FAME were observed. These results suggested that only oxidation stability requirement in EN14214 is not enough for ensuring the performance of vehicles. As the next step, the effect of improving oxidation stability was investigated. Oxidation stability is easily improved with anti-oxidant agents as shown in Fig.3.3.5. The oxidation stability of the testing FAME was improved to 10 Hrs with Rancimat method using additive technology and then blended into JIS No2 diesel fuel by 5vol %. Fig.3.3.6 shows the photograph of the fuel tank inside after finishing the test. No corrosion was observed and the effectiveness of improving oxidation stability was confirmed. Based on the conformity tests, Japanese biodiesel fuel specification was developed.

Lower Side of tank   Upper Side of tank

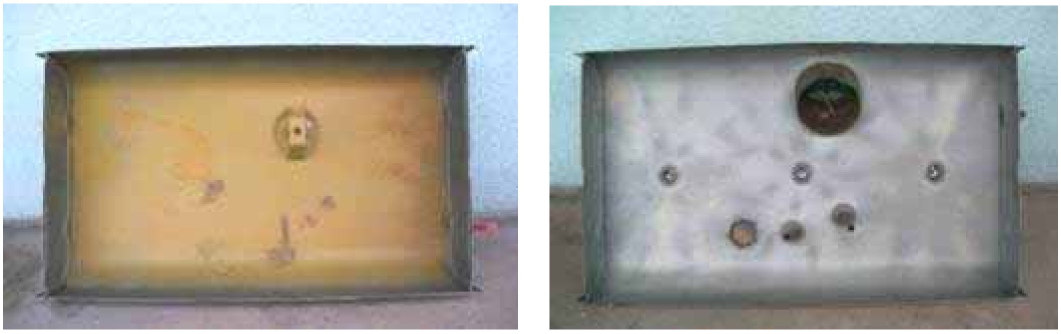

Fig.3.3.4 Results of Fuel Tank Test

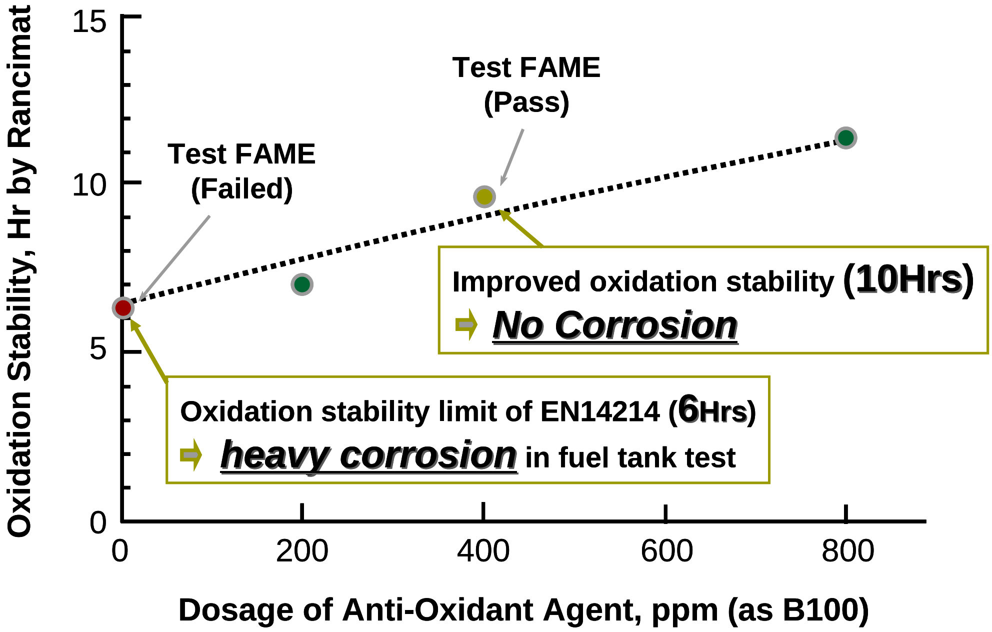

Fig.3.3.5 Effect of Anti-Oxidant Agent on Oxidation Stability

Lower Side of tank Upper Side of tank

Fig.3.3.6 Results of Fuel Tank Test : Effects of Improving Oxidation Stability

3.3.3. Japanese B5 diesel fuel specification

In Japan, the quality of FAME blended diesel fuel is regulated by The Fuel Raw as a compulsory standard as a compulsory standard. The standard of neat FAME (B100) for blending stock is not included the compulsory standard but it's as a voluntary specification.

Figure 3.3.7 shows the difference of fuel regulation in Europe and Japan. In Europe, there are two specifications for specifying the quality of FAME blended diesel fuels. That is, one is diesel fuel specification, EN590. The other is FAME (B100) specification, EN14214. EN590 refers to only ester contents as the properties related to FAME.

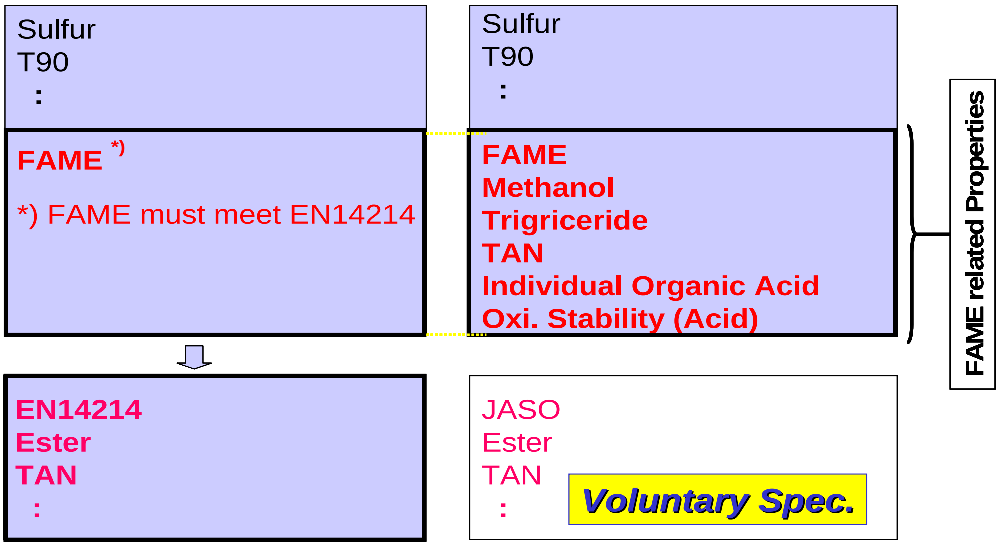

Fig.3.3.7 Difference of Fuel Regulation in Europe and Japan

It means that both EN590 and EN14214 are necessary to specify the quality of FAME blended diesel fuel, European governments regulated both specifications and monitor the quality of both diesel fuel and FAME before blending. There is no way to check the quality of FAME after blending, because no specifications related to FAME except for ester content in EN590.

In case of Japan, fuel quality is controlled at fuel pump. This principle is also applied to FAME blended diesel fuel. Then, the quality of FAME blended diesel fuel is regulated by The Fuel Raw as a compulsory standard as a compulsory standard which dose not include specification of neat FAME (B100) for blending stock. The specification of B100 for blending stock was developed as a "guideline for FAME producers", named JASO M360. In this paragraph, these two standardizations will be explained in details as follows.

(1) Compulsory Diesel Fuel Standard (Specification of The Fuel Raw)

METI developed the specification of FAME blended diesel fuel based on the conformity test results as shown in Table 3.3.3.

Existing items in the present diesel fuel standard are following 3 items.

- Sulfur Content should be 0.005 mass% or less.
- Cetane index should be 45 or more.
- 90% distillation point should be 360 deg.C or less.

New additional items are classified into two groups. Either of the following (i) or (ii) should be satisfied.

⇒Standard to be satisfied by Diesel Fuel in which FAME is not contained.

(i) FAME content is 0.1 mass% or less.

Triglyceride content is 0.01 mass% or less.

⇒ Standard to be satisfied by Diesel Fuel in which FAME is contained.

(ii) FAME content is 5.0 mass% or less.

Triglyceride content is 0.01 mass% or less.

Methanol content should be 0.01 mass% or less.

Acid value should be 0.13 mgKOH/g or less.

Total of formic acid, acetic acid and propionic acid should be 0.003 mass% or less.

Oxidative stability should be 0.12 mgKOH/g or less for acid value growth.

Table 3.3.3. Compulsory Diesel Fuel Standard

Regulatory Item		FAME Blended Diesel Fuel	Diesel Fuel
Existing Items	Sulfur	0.001mass% max	
	Cetane Index	45 min	
	T90	360 deg.C max	
Additional Items	FAME Content	5.0 mass% max	0.1 mass% max
	Triglyceride Content	0.01 mass% max	0.01 mass% max
	Methanol Content	0.01 mass% max	-
	TAN	0.13 mgKOH/g max	-
	Individual Organic Acid*)	0.003 mass% max	-
	Oxidation Stability (Acid Value Growth)	0.12 mgKOH/g max	-

*) Total Formic, Acetic and Propionic acids

Regulatory items should be added to the diesel oil standard in order to specify the upper limit of the FAME content in diesel fuel (up to 5% is allowed) and the properties of the fuel satisfying the aspect of 1, 2 and 3 based on the use of FAME satisfying the neat standard.

1. FAME sufficiently refined (purity is high) should be blended. (Triglyceride, Methanol)
2. FAME in fresh condition (not degraded with time) should be blended. (Acid value, Specific Acids)
3. Properties should be such that generation of acid and sludge from the heat and oxidative degradation is controlled (oxidative stability is established)

Differences from the regulated value of EN Standard are follows.

Content of the specific organic acid

Oxidative stability (acid value growth)

Items to study based on the regulated value of EN Standard are follows.

FAME blending ratio to diesel fuel

Acid Value

Methanol

Triglyceride

FAME Content

When the FAME blending ratio in diesel fuel (ester content) is increased, blotting of fuel from the fuel hose will take place. In the EN Standard (EN590), the blending ratio in diesel fuel is limited to 5 % or less.

As for the FAME blending ratio in diesel fuel, it can be used as the upper limit for the effect on safety and also in identifying diesel fuel containing FAME or not containing FAME.

When the compulsory standard for diesel fuel is simply increased, items investigated regarding fuel quality by producers and distributors will also increase whether or not FAME is contained n the diesel fuel In order to avoid increasing the burden unnecessarily when diesel fuel not containing FAME is handled, the FAME blending ratio should be used as criteria.

Conformity study was based on the fact that the FAME blending ratio is limited to 5% in Europe. A variety of test was conducted within the range where the FAME blending ratio was 5% or less. No phenomenon connected to problems and considered possible due to ester was confirmed. As to the soak test for plastics and rubber in which a significant effect was anticipated, no significant effect was observed for the FAME blending.

In the fuel filter durability test using the conventional test method, pressure tightness decreased after the durability test for the plastic filter case. It was considered an effect of FAME on rubber (NBR) and plastics (nylon 6). Effect from acid in addition to ester was also considered.

In the fuel filter test under the revised test conditions adjusted for actual in-use conditions, it was confirmed that no problems existed.

Triglyceride Content

Triglycerides are purely vegetable oil and animal fat. When blended with diesel fuel even in a concentration with impurities, it easily forms sludge from oxidative degradation and causes clogging of the fuel filter or improper sliding of parts. As to the measuring method of Neat FAME before blending with diesel fuel, 0.2 mass% or less is specified by the EN Standard (EN14214).

Provisions are necessary because triglycerides (the very fat) will blended with diesel fuel without forming methyl ether.

Triglyceride content is used as an index to measure the refinement level of FAME before blending with diesel fuel similar to methanol.

5% equivalent by EN Standard should be used as the standard value.

Conformity test result shows that combustion residuals are easily formed from triglyceride (increase of carbon residue). No problems caused by triglycerides occurred in the conformity test including the durability test using the triglyceride content equivalent to the EN Standard.

Methanol Content

Methanol aggressively corrodes metal.

The present quality law specifies that ‘no methanol shall be detected’ in the compulsory standard item for gasoline.

Currently, blending methanol in diesel fuel is not considered, but in the case of the FAME blended diesel fuel, methanol is used in the production of FAME, and methanol may be contained in the fuel.

It is appropriate that the standard value should be ‘not detected,’ the same as gasoline.

The level presently prescribed for ‘not detected’ for gasoline is 0.5 mass% or less.

In the case of FAME, methanol is not added intentionally but will be included as an impurity accompanying the synthesis process.

In this compulsory standard, only the critical items to be prescribed for FAME should be applied after it is blended with diesel fuel, and it is necessary to decide whether the quality of the FAME before blending was appropriate.

Among the items proposed as a compulsory standard, residual methanol and triglyceride (both are row materials for synthesis) should be a measure of the refinement level of FAME before blending.

Accordingly, it is considered appropriate to use the 5% equivalent to the European Standard.

Acid Value and Content of Specific Acid

When the acid value or the content of specific acid is increased, the metal of motor vehicle fuel system corrodes. By EN Standard (EN 14214), required acid value of 100% FAME is 0.5 mgKOH/g or less.

The cause of corrosion is the acid originated form FAME, and it is necessary to specify the combination with the acid value of FAME blended diesel fuel and concentration of specific acid.

When the acid value specified by EN 14214 (0.50 mgKOH/g) is applied to the 5%

FAME blended diesel fuel, the acid value should be 0.03 mgKOH/g.

There have been cases where fatty acid was added in diesel fuel to improve lubrication, it was confirmed that this additive would not cause corrosion with the present dosage, and the maximum available acid value in the existing diesel fuel is 0.10 mgKOH/g. Accordingly, 0.13mgKOH/g is caused as the upper limit for the standard.

Specifying the acid value only is not sufficient for corrosion, and it is necessary to specify the short chain fatty acid, which demonstrates strong corrosiveness. From the study of acids generated from FAME and from the results of corrosion tests for each acid, the specifications for formic acid, acetic acid and propionic acid should be provided.

Formic acid, acetic acid and propionic acid are important according to the results of the study of corrosive acids generated by FAME when showing oxidative degradation.

The evaluation results of corrosiveness from these acids confirmed that no corrosion would occur when formic acid, acetic acid and propionic acid is 0.003 mass% or less, and when caproic acid is 0.01 mass% or less in a system without moisture (tens of parts per million level).

A study of the method of analysis indicated that formic acid, acetic acid and propionic acid can be analyzed by a relatively easy method, but caproic acid cannot be analyzed with same test method.

Because it is known that caproic acid is generated by oxidative degradation of methyl linolenate and acetic acid is also generated, it is possible to restrict the caproic acid content to a certain level or less by restricting the acetic acid content.

It was confirmed that no problem such as a decrease in durability would occur in fuel filter durability test using FAME blended diesel fuel with acetic acid 0.003 mass% or less and acid value of 0.13 mgKOH/g.

Oxidative Stability

Organic acid, fatty acid and moisture are generated and during the process FAME undergoes oxidation degradation, and these corrode metals. Furthermore, when oxidative stability is decreased, polymer (sludge) is generated to cause failure in sliding of the fuel pump and injector.

As to measuring method of the neat FAME before blending with diesel fuel oxidative stability of 6 hours or more of the organic acid is required by EN Standard (EN14214).

No measuring method and standard value for neat FAME are provided with respect to sludge; however, in the European Diesel Fuel Standard (EN590), 25 g/m3 is specified in accordance with ISO 12205 (ASTM D2274). This will remain the same when it is amended in 2004 to allow 5% FAME blending.

A study on oxidation stability was conducted based on the concept that it is necessary to specify both acid value (yield of organic acid) and yield of sludge as FAME blended diesel fuel.

Because it is considered appropriate to evaluate the oxidative stability after thermal oxidation degradation progress to some extent, a study was conducted on the method by which the yield of sludge and acid value can be measured at the same time by reviewing test conditions and referencing the existing oxidation test method, for example oxidation stability test for gasoline, lubricant and so on.

Although corrosion occurred in the fuel tank circulation test conducted with the fuel used for the fuel system rig durability test, corrosion did not occur with fuel in which oxidative stability was established (fuel with antioxidant added) in the fuel tank circulation test conducted with the test method partially reviewed.

While the difference in the results is significant, according to the testing laboratory, in both yield of sludge and acid value growth, even if the same sample was used, the difference remarkably reduced for fuel for which the oxidative stability was established (with antioxidant added).

There was some correlation between the yield of sludge and acid value growth as a whole, and it was decided that the restriction of yield of sludge can be controlled by specifying the standard value on acid value growth.

Because the average acid value growth for fuel assumed to be border in the fuel tank circulation test was 0.06 mgKOH/g, the standard value was determined as 0.12 mgKOH/g considering the 95% confidence level.

As a result of the fuel simulation test, in a high temperature and common pressure rail system, it was confirmed that the degradation of the fuel accelerated and problems like corrosion and deposit build-up also occurred.

Build-up of deposits was observed in the suction control valve (a valve to regulate supply and pressure of fuel) of the supply pump (a pump to boost fuel pressure and to supply fuel to injection nozzles) in fuel system rig durability test and in the fuel system pipe in vehicle endurance test. While it may not be a problem in practical use, it was considered necessary to maintain the level of fuel used for the durability test this time as the minimum.

Although corrosion occurred in the fuel tank circulation test using the conventional test method, it was confirmed that no problem existed by conducting the fuel thank durability test again using the fuel in which oxidative stability was reviewed (fuel with antioxidant added).

<u>Polyunsaturated Fatty Acid Methyl Ester Content</u>

Because polyunsaturated acid methyl ester, such as methyl linolenate, has many unsaturated bonds in the same molecules, a large amount of sludge is easily generated from oxidative degradation, and blocking of the fuel system is likely for occur, even if the content is small.

As to the content of methyl ester with unsaturated bonds, some are provided with the metrology and the standard value for neat FAME according to the EN Standard (EN14214). Specifically, the metrology and the standard value exist for the content of methyl linolenate with three unsaturated bonds. As for polyunsaturated fatty acid methyl ester with four or more unsaturated bonds, the standard value exists while the metrology did not exist. In the EN Standard (EN14214), the content of methyl linolenate should be 12 mass% or less, and the content of polyunsaturated fatty acid methyl ester with four or more unsaturated bonds should be 1 mass% or less.

While it was confirmed that the yield of the sludge increase when the content of methyl linolenate was substantial, it was determined that yield of sludge can be controlled by the standard value of oxidation stability (acid value growth).

As polyunsaturated fatty acid methyl ester with four or more unsaturated bonds, analysis was extremely difficult after blending with diesel fuel, and it was considered appropriate to specify it according to the Neat FAME Standard.

Yield of sludge in the simulation test increased when the content of methyl linolenate in FAME blended diesel fuel increased.

It was found that the methyl linolenate significantly decreased oxidative stability. It was considered necessary to maintain the level of the durability test fuel as the minimum.

Build-up of deposits was observed in the suction control valve (a valve to regulate supply and pressure of fuel) of the supply pump (a pump to boost fuel pressure and to supply fuel to injection nozzles) in fuel system rig durability test and in the fuel system pipe in vehicle endurance test. While it may not be a problem in practical use, it was considered necessary to maintain the level of fuel used for the durability test as the minimum.

As to polyunsaturated fatty acid methyl ester with four or more unsaturated bonds, no confirmation was made through a simulation test or with a durability test, and no results sufficient to examine the presence of contents and the problem were obtained. However, the oxidative stability might decrease significantly to the same level oxidative stability as the FAME blended diesel fuel with which the problem is caused, even with a small quantity.

Cetane Index

Cetane number and the cetane index are indicators that show the ignitability of diesel fuel, and the engine cannot be operated unless they are above the appropriate value.

In compulsory standard cetane index 45 or more is required.

The cetane index is an indicator estimating the cetane value from the density and distillation characteristics. It is not always applicable when a substance with different composition is mixed, because it is based on mineral oil refined from crude oil.

While the variation is large to some extent when compared with conventional diesel fuel, the cetane index can be applied when the blending ratio is within 5%.

When FAME is blended, the cetane index tends to be large compared with the cetane value. This tendency is more significant with the increase in the blending ratio of FAME.

Variation in correlation between cetane value and cetane index is significant compared with diesel fuel without blending of FAME.

Within the range of the FAME blending ratio 5%, the cetane index is higher than cetane value by 1.3 on average.

Test Method

FAME content and triglyceride content in diesel fuel are determined by using high performance liquid chromatography.

Methanol content in FAME blended diesel fuel are determined by using gas chromatography with oxygen detector (GC-AED), with head space, or with water extraction. Because the study was made to add the methyl linolenate as a standard item initially, the study on GC-AED method was examined as a test method to analyze methanol and methyl linolenate simultaneously. However, a more general test method can be considered to analyze methanol only. Water extraction – gas chromatography and head space – gas chromatography were studied and established the method.

Acid value are determined by potentiometric titration.

Formic acid, acetic acid and propionic acid in FAME blended diesel fuel are determined by using water extraction ion chromatography.

Oxidation stability of FAME blended diesel fuel is estimated by TAN growth after heat degradation. Increase of TAN after 16 hour heating to 115 deg.C while bubbling oxygen at 3.0 L/h through the sample is measured. The test apparatus used in this method is defined in ISO-12205-1995 'Petroleum Products – Determination of the Oxidation Stability of Middle – Distillate Fuels'.

The other information

The test method and the limit of the oxidation stability were newly developed by METI because current oxidation stability test method and the limit were not suitable for applying FAME blended diesel fuel. This diesel fuel regulation was come into effect from March 2006. For reducing the work of fuel distributors who will not blend FAME, two properties, ester content and triglyceride content are measured at first. If both were not detected, distributors do not need to measure other four properties.

(2) Neat FAME (B100) for blending stock (Specification of JASO 360)

Basically standard items and values were according to the FAME standard in Europe with EN 14214 as the starting point. The items especially focused are the following.

Oxidative stability

Acid value and content of specific acids

Cold temperature properties

Oxidation Stability

Standard value is not established but quality requirement is 'In accordance with the mutual agreement between parties concerned'.

While a new evaluation method was established as the standard for the FAME blended diesel fuel, it was found that the oxidative stability was different for the same FAME depending on the diesel fuel based on the series of studies.

However, the properties of the diesel fuel that affect the oxidation stability after it is blended with FAME were not identified.

If the standard of the oxidative stability of FAME that is applicable for the mixture with any kind of diesel fuel is established, it will be an excessively strict standard.

Accordingly, the subject item was defined as 'Based on mutual agreement between the manufacturer and the user'.

(However, "10 hours min." of oxidation stability is needed to meet the Japanese Compulsory Diesel Fuel Standard (Specification of The Fuel Raw).)

Acid Value and Content of Specific Acid

Standard value is 0.5 mgKOH/g or less. This value is equal to the European Standard.

As to the acid value after blended with diesel fuel, a value in which 5% based on the

European Standard is added as contribution of the FAME origin acid to the acid value of the conventional diesel fuel was used.

When it is assumed that formic acid, acetic acid and propionic acid, which are specific acids, are contained FAME in the quantity equaling 0.5mgKOH/g, the concentration becomes 20 ppm, 27 ppm and 33 ppm, respectively. Because the total is 30ppm or less and the acid value of the FAME 0.5 mgKOH/g is almost equivalent, the standard for the content of a specific acid is not added to the neat standard.

Table 3.3.4 Japanese FAME Specification (JASO M360)

JASO M360 -Automotive fuel – FAME as blend stock

Item	Unit	Specification	
		Limit	Test Method
Ester content	mass %	96.5 min	EN 14103
Density (@15 deg.C)	g/cm^3	0.860-0.900	JIS K 2249
Kinematic viscosity (@40 deg.C)	mm^2/s	3.50-5.00	JIS K 2283
Flash point	deg.C	120 min	JIS K 2265
Sulfur content	mg/kg	10 max	JIS K 2541-1, -2, -6 or -7
10% carbon residue	mass %	0.3 max	JIS K 2270
Cetane number		51.0 min	JIS K 2280
Sulfated ash content	mass %	0.02 max	JIS K 2272
Water content	mg/kg	500 max	JIS K 2275
Total contamination	mg/kg	24 max	EN 12662
Copper corrosion	rating	1 max	JIS K 2513
Oxidation stability	hours	Agreement between producer and distributor	
Acid value	mgKOH/g	0.50 max	JIS K 2501or JIS K 0070
Iodine value	gl/100g	120 max	JIS K 0070
Methyl linolenate	mass %	12.0 max	EN 14103
Methanol content	mass %	0.20 max	EN14110
Monoglyceride content	mass %	0.80 max	EN 14105
Diglyceride content	mass %	0.20 max	EN 14105
Triglyderide content	mass %	0.20 max	EN 14105
Free glycerol content	mass %	0.02 max	EN 14105 or EN 14106
Total glycerol content	mass %	0.25 max	EN 14105
Metals (Na+K)	mg/kg	5.0 max	EN 14108 and EN 14109
Metals (Ca+Mg)	mg/kg	5.0 max	EN 14538
Phosporous	mg/kg	10.0 max	EN 14107
Pour point	deg.C	Agreement between producer and distributor	
CFPP	deg.C		

<u>Cold Temperature Properties</u>

Standard value is not established but quality requirement is 'Based on the mutual agreement between parties concerned'.

Because the low temperature performance of the FAME blended diesel fuel significantly depends on the property of both FAME and diesel fuel to be blendes, it is difficult to specify the low-temperature performance of FAME.

Although specifications of the low-temperature performance (grading) are provided in European Standard similarly to the diesel fuel standard, this is intended for use with neat FAME, and it is difficult for use as the indicator when it is blended with diesel fuel.

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4. CURRENT STATUS OF BIODIESEL FUEL IN EAST-ASIAN COUNTRIES

4.1. Australia

4.1.1. Policy and measure of BDF

i) Target and strategy from energy and environment point of view

ii) Concrete target and strategy for BDF

In 2001 the previous Government announced a biofuels production target (ethanol and biodiesel) of 350ML by 2010. This target remains in place however the new Government is considering its position on strategy and targets for biofuels.

In 2004 the Biofuels Capital Grants Programme provided grants for new or expanded biofuel production. This program provided industry with $37.6m (AUD) and approximately 158ML of production capacity for biodiesel was supported under this grants program. The Biofuels Capital Grants Program is still in place.

Biodiesel is currently effectively excise free – excise is payable and an offset is available via a cleaner fuel grant.

There is no regulation requiring the mandatory use of biodiesel and/or diesel/biodiesel blends.

iii) Main crops for BDF and its production planning

Tallow and used cooking oil are currently the main feedstock used to produce biodiesel in Australia. Canola oil, from domestically grown canola crops, has been used in the past as feedstock. A small amount of Palm oil (imported from Malaysia) has also been used recently to produce biodiesel in Australia.

Australia has a biodiesel production capacity of 568ML. The amount produced domestically for 2006-2007 was 76.3ML.

Recent feedstock price increases has lead to scaling down of production and the closure of some biodiesel plants in Australia.

iv) Regulations and incentives to promote BDF utilization

See detail above about biofuels target, capital grants program and taxation.

4.1.2. Standardization of BDF

i) Concept of BDF standards and regulations

The quality of fuel in Australia is regulated by the *Fuel Quality Standards Act 2000* (the Act) that places an obligation on the fuel industry, including fuel suppliers, to supply fuels that meet strict environmental requirements. The requirements are in place to reduce the adverse effects of motor vehicle emissions on air quality and human health, and to enable Australia to effectively adopt new vehicle engine and emission control technologies. The Department of the Environment, Water, Heritage and the Arts is responsible for developing and enforcing of fuel quality standards and information standards (labelling) made under the Act.

It is an offence under the Act to supply fuel that is subject to a standard that does not comply with the standard. The Act sets our responsibilities for fuel suppliers whether they are refineries, importers, distributors or service/filling stations. The regulations set out documentation, record keeping, fuel sampling procedures and enforcement details.

ii) Standards of BDF

The quality of biodiesel fuel is regulated under the Act. The Fuel Standard (Biodiesel) Determination 2001 (the biodiesel standard) was introduced in 2003. It is the legal instrument that sets the fuel quality standard for biodiesel (B100) in Australian law. The intent of the biodiesel standard is that it applies to both neat (100%) biodiesel (B100) and biodiesel used for blending.

The Australian Government is currently developing a proposed position on the management of diesel/biodiesel blends.

(1) Current status of BDF standardization

The Australian biodiesel standard is closely aligned with EN14214 and ASTM D6751. See Table 4.1.1.

(2) Reference standards

The Australian biodiesel standard refers to EN and ASTM test methods. See Table 4.1.1.

(3) Remarkable items

Distillation – T90 360°C (max)

Water and sediment - 0.050 % vol (max)

Acid value - 0.80 mg KOH/g (max)

The following parameters are not specified:

Iodine number
Methly linoleate
Polyunsaturated FAME
Monoglyceride
Diglyceride
Triglyceride
Cloud point
Cold Filter plugging point

iii) Specification values

See Table 4.1.1

Table 4.1.1 Biodiesel specification and test methods

Parameter	Standard	Test Method	Date of effect
Sulfur	50 mg/kg (max) 10 mg/kg (max)	ASTM D5453	18 Sep 2003 1 Feb 2006
Density	860 to 890 kg/m 3	ASTM D1298 or EN ISO 3675	18 Sep 2003
Distillation T90	360 deg.C (max)	ASTM D1160	18 Sep 2003
Sulfated ash	0.020% mass (max)	ASTM D874	18 Sep 2003
Viscosity	3.5 to 5.0 mm 2 /s @ 40 deg.C	ASTM D445	18 Sep 2003
Flashpoint	120.0°C (min)	ASTM D93	18 Sep 2003
Carbon residue (10% distillation residue) (100% distillation sample)	0.30 % mass (max) OR 0.050 % mass (max)	EN ISO 10370 ASTM D4530	18 Sep 2003
Water and sediment	0.050 % vol (max)	ASTM D2709	18 Sep 2003
Ester content	96.5 % (m/m) (min)	EN 14103	18 Sep 2003
Phosphorus	10 mg/kg (max)	ASTM D4951	18 Sep 2003
Acid value	0.80 mg KOH/g (max)	ASTM D664	18 Sep 2003
Total contamination	24 mg/kg (max)	EN 12662 ASTM D5452	18 Sep 2004
Free glycerol	0.020 % mass (max)	ASTM D6584	18 Sep 2004
Total glycerol	0.250 % mass (max)	ASTM D6584	18 Sep 2004
Oxidation stability	6 hours @ 110 deg.C (min)	EN 14112 or ASTM D2274 (as relevant for biodiesel)	18 Sep 2004
Metals	≤ 5mg/kg Group I (Na, K) ≤ 5mg/kg Group II (Ca, Mg)	EN 14108, EN 14109 (Group I) EN 14538 (Group II)	18 Sep 2004
Methanol Content	≤ 0.20%(m/m)	EN 14110	18 Dec 2004
Copper strip corrosion (3 hrs @50°C)	if the biodiesel contains no more than 10 mg/kg of sulfur – Class 1 (max) if the biodiesel contains more than 10 mg/kg of sulfur - No. 3 (max)	EN ISO 2160 ASTM D130 ASTM D130	18 Dec 2004
Cetane number	51.0 (min)	EN ISO 5165 ASTM D613 ASTM D6890 IP 498/03	18 Sep 2005

4.2. China

4.2.1. Policy and measure of BDF

i) Target and strategy from energy and environment point of view

Till 2007, the population of vehicle in China is about 43 million, and the private vehicle is about 28 million, commercial vehicle is about 10 million. In the recent years, the vehicle increase in China is more than 15%, it is forecast that this trend will last at least till 2010.

As a result, the vehicle fuel is becoming more and more relying on abroad market, although more than 94% of the Chinese energy consumption is from domestic. In 2006, the petroleum import in China is 145 million ton and this data may be 160 million ton in 2007, which is nearly 50% of the petroleum consumption in China. This status gives both the Chinese economic and energy safety a huge challenge.

On the other hand, the air environment in the middle and large cities is facing more and more heavy burden, especially the emission given by vehicle. Although the vehicle emission standards are becoming more and more strict, majority of the air pollutions in big city, such as CO, HC, NOx, are still from vehicle emission.

Above that, the green house gas emission is being paid more and more attention by both government and folk in China recently. It is statistic that the total GHG emission from China ranks number 2 all over the world, although it is much low level from the eye of population average. Even the clean produce and energy consumption is becoming the index of evaluating the achievements of the local officer's career by the central government.

ii) Concrete target and strategy for BDF

According to "Mid/long-term Development Strategy of Renewable Energy ", at the year of 2020, the concrete strategy for renewable energy in China is: (1) the electric power generation takes over about 30% of the total power; (2) the biogas is about 24 billion m^3; (3) the bio-fuel production is 10 million ton. The evaluated total investigation is about 1500 billion RMB.

But the target of BDF is keeping adjust. The target of 10 million ton BDF at 2020 is really a great challenge and it is really hard to come into reality.

iii) Main crops for BDF and its production planning

In China, many crops are trying to cultivate from now on.

(1) Jatropha

Jatropha is the most important oil-bearing crop in China. It has been mass planted in

Sichuan, Hainan, Guizhou and Yunnan province, Thousands hectares of Jatropha has been planted there during the past few years, and millions hectares area are planned to planted within the next decade years.

The most important domestic company involved in Jatropha include CNPC, PetroChina, CNOOC and COFCO, which are all the biggest companies in China., the foreign companies include Suntech Group of British and BECOO Company of USA and other companies.

Panzhihua city, Sichuan province is the biggest plant base of Jatropha in China. It is reported that more than 5 million Mu (1Chinese Mu equals 0.0667 hectare) of Jatropha will be planted by CNOOC in Sichuan province. Till now, more than 220 thousand Mus has been planned there. The factory of first stage, with manufacture ability 60 thousand ton, has been set up. By plan, before 2010, the Jatropha area will be 500 thousand Mu and the BDF yield will be 100 thousand tons then by CNOOC.

It is reported that PetroChina planned to plant Jatropha with area of 1.8 million Mu in Sichuan province, and 400 thousand Mu of Jatropha in Yunan province.

Also in Panzhihua， another bio fuel plant base will be built by BECOO Company, the area will be 1 million Mu and the produced BDF will be 400 thousand tons.

In Zhenfeng contry, Guizhou province, about 20 thousand Mu Jatropha has been planted, the planned area about 500 thousand Mu there. The lowest price of the Jatropha seed was given and the related financial subsidy for plant was also given.

In Yunnan province, total about 18 million Mu land is suitable for oil crop plant. The Suntech Group has signed a long term memorandum, in which 1 million Mu area will be used for bio diesel plant. It is planned that a 150 million Mu oil herb base will be set up before 2020, and more than 2 million tons Jatropha seed will be produced.

2）Chinese pistache

Chinese pistache is another main woody oil plant in China besides Jatropha, which is mostly planted in Central and North China, such as in Hebei province, Henan province, Shanxi province and Shannxi province.

In Handan city Hebei province, the resource of Chinese pistache ranked No.1 in China. There is about 200 thousand Mu wild Chinese pistache and 100 thousand Mu artificial Chinese pistache, some BDF factories have been set up.

In Hebei province, about 110 thousand Mu Chinese pistache has been planted by Hainan Zhenghe Company in order to obtain BDF stock..

The largest area distribution of wild Chinese pistache is in Shannxi province, which is statistic to be more than 4 million Mu.

Anhui province has declared that Chinese pistache will be the main BDF oil plant there.

In Mianci coutry Henan province, several thousand hectares of Chinese pistache will be planted within several years.

Till now, more 10 million Mu energy forest for Chinese pistache has been planned to plant.

(3) Oil herb

The ordinary oil herb includes rapeseed, soybean, peanut, cotton seed , fiberflax and others.

For it is shortage of edible oil in China, no such oil herb is permitted to produce BDF.

It is reported that even on the precondition of not vying for land with food and oil, there are still about 267 million hectares forest land suitable for energy oil herb theoretically in China. It has the potential of 170 million tons of BDF yearly. The land needs to be development with great effort.

(4) Oil algal and fiber bio resource

Oil algal and fiber bio are the largest potential resource for BDF. They have the advantage of not vying land with humans and beasts, and the quantity is really huge. But till now, the technology of the aspect is still need to break through.

(5) Opportunity and challenge

The Main crops for BDF in China are nearly clear now, and its production plan is magnificent. But we are still far from mass usage of BDF in China. The biggest barriers are the price is still shortage of competition with fossil fuel and we still do not know much about the results of mass production of woody oil forest.

BDF in China has the following opportunities:

- Vehicle energy shortage
- National policy supporting from long-term development.
- Large uncultivated mountain and beach.
- Global warming is now becoming elementary knowledge to both government and the public.
- Large mount of investigation has entered this field.

But BDF is facing the following challenges:

- Bio-diesel Performance. Such as Oxidation Stability, Low temperature flow ability and etc are still needed to improve, and we are shortage of less running experience in the field of vehicle.
- Bio-diesel price. Raw material rises in price if mass production, and energy obtain by LCA is still needed to make clear.

- Unlike other countries rich in fertile land, we are shortage of land for food and oil to support the largest population in China.

As a result, the central government has drawn the so called “Four Not” policy that is: Not vying for land with farmer; Not vying for food with human; Not vying for feed with animals and not deteriorating environment. This policy almost bans the BDF from oil herb such as rapeseed, soybean, peanut, cotton seed, fiberflax etc., which relates the most mature produce technology and ripe vehicle experiment in the world. The status results in that we have lots of work to do in the field of both stock cultivation and vehicle usage.

iv) Regulations and incentives to promote BDF utilization

Sep 4th 2007, State Council of China issued “Mid/long-term Development Strategy of Renewable Energy ”. The strategy decided to develop the renewable energy including Bio-diesel.

The Renewable Energy Act promoted by Central government is issued on January 1st 2006, which provided the detailed executive methods.

(1) Controlling the total quantity.

According the strategy, the total quantity of renewable energy will be 15% of the total energy consumption. BDF yield will be 10 million ton before 2020.

(2) The power is mandatory sold to electrified wire netting company.

As well as bio-electric is concerned, the power generated is mandatory sold to electrified wire netting company, although the price is higher than coal power and hydropower.

(3) The concessional electric price.

January 2006, the State Council signed the related law named *Implementation Management Methods of Price and Cost Apportionment of Renewable Energy Power.* It specified that the bio electric power will be given financial allowance of 0.25RMB per kWh by the government, and the allowance should last 15 years.

(4) Apportion the higher cost by the whole society.

The higher cost will be apportioned by the whole related society. The calculated methods and formula is also designed in the *Methods.*

(5) Dedicated funding.

The renewable energy produce and the related profession will be supported by dedicated funding.

The consumption tax will be avoided or reduced after the Fuel Tax policy issued.

In the field of vehicle fuel, dedicated regulations and incentives are still not published, for the total quantity of biodiesel in the market is still very small.

In China, we are needed urgently the policy support in the field of BDF. Neither FAME for blend stock nor FAME blended diesel oil is supported by definite policy in China till now.

Both the bio-fuel producer and oil distributor are still needed standard specification.

4.2.2. Standardization of BDF

i) Concept of BDF standards and regulations

In China, Biodiesel is designed to be a kind of diesel alternative fuel made from vegetable oils and animal fats by conversion of the triglyceride fats to esters via transesterification.

The stock could be both vegetable oil and animal fats. It was thought unnecessary to retrofit any parts in diesel engine when biodiesel fuel is used.

ii) Standards of BDF

(1) Current status of BDF standardization

The un-compulsory standard for FAME blended diesel fuel, GB/T20828-2007, was issued in May 2007.This standard is for the quality control of Diesel fuel BD-100.

We have still only one standard on biodiesel in China. The following standards are being researched and will be issued in the near future.

- National Specifications for B5 and B10
- Measurement for Free glycerol and Total glycerol in Bio diesel
- Measurement for Oxidation stability of Biodiesel
- Other related measuring methods for components in biodiesel

(2) Reference standards

The Chinese biodiesel standard is based on ASTM D6751-03a “Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels”

(3) Remarkable items

Now, the remarkable items in China include:

- Oxidation Stability
- Low temperature flow ability
- Total acid number

iii) Specification values

GB/T20828-2007 has specified 17 items on biodiesel fuel (B100) blend stock for distillate fuels, it is shown in the following table.

Biodiesel	China	EU	U.S.
	GB/T 20828-2007	EN 14214:2003(1)	ASTM D 6751-06b(1)
Cetane Number, min	49	51	47
Ester content, wt%, min	-	96.5(2)	-
Sulfur, ppm, max	50	10	15/500 (2)
Density at 15deg.C., kg/m^3, min-max	820-900(1)	860-900	-
Viscosity at 40deg.C., cSt, min-max	1.9-6.0	3.5-5.0	1.9-6.0
Flash point, deg.C., min	130	120	130
10%, wt%, max	0.3	0.3	-
Water and sediment, vol%, max	None	-	0.05
Water, ppm, max	500	500	-
Ash, wt%, max	0.02(2)	0.02	0.02(3)
Total contamination, ppm	-	24	-
Copper corrosion (3hr at 50deg.C.), max	1	Class1	No.3
Acid value, mg KOH/g, max	0.8	0.5	0.5
Methanol, wt%, max	-	0.2	-
Monoglycerides, wt%, max	-	0.8	-
Diglycerides, wt%, max	-	0.2	-
Triglycerides, wt%, max	-	0.2	-
Free glycerides, wt%, max	0.02	0.02	0.02
Total glycerin, wt%, max	0.24	0.25	0.24
Linoleic acid methyl ester, wt%, max	-	12	-
Polyunsaturated methyl ester, wt%, max	-	1	-
Iodine number, max	-	120	-
Phoshorus, ppm, max	-	10	10
Alkali, (Na+K), ppm, max	-	5	-
Metals, (Ca+Mg), ppm, max	-	5	5
Distillation T90, deg.C., max	360	-	360
CFPP, deg.C., max	Report	+5 to -44 (3)	-
Oxidation stability at 110deg.C., hr, min	6	6	3
Sodium & potassium, ppm, max	-	-	5
Cloud Point deg.C.	-	-	Report(4)

4.3. Indonesia

4.3.1. Policy and measure of BDF

The enormous increase of crude oil price in mid-2005 had forced the Indonesian government to reform country's energy-mix scenario and develop biofuel. Thus, early in 2006 the government issued Presidential Regulation no. 5/2006 on National Energy Policy, which among others state that the utilization of biofuel, which is practically none at that time, has to be developed such that it will contribute at least 5 % to the national energy mix by the year 2025. This regulation was then followed by Presidential Instruction No. 1/2006 that ministers and provincial governors must support and promote the establishment of domestic biofuel industry.

As the first implementable follow-up to these Presidential Regulation and Instruction, the Director General of Oil and Gas (as the Fuel Authority) through Decree no. 3675 of March 17th 2006 issued new fuel specifications that, among others, permit diesel fuel to contain up to 10 %-vol. fatty acids methyl ester (FAME, i.e. biodiesel) provided the FAME quality meet Indonesian Biodiesel Standard. This decree has allowed Pertamina (the state-owned oil and gas company of Indonesia) to start selling B5 (5 %-vol biodiesel, 95 %-vol petroleum diesel) at 5 fuel-dispensing stations in Jakarta on May 20th 2006. Biosolar is Pertamina's trademark for this product. P.T. Eterindo Wahanatama is the supplier of the biodiesel used for preparing the fuel blend. By the end of 2006, the number of Pertamina's fuel-dispensing stations selling biosolar has grown to 197 in Jakarta and 12 in Surabaya.

In August 2006, through Presidential Decree no. 10/2006, the president also established a National Team for Biofuel Development to accelerate the reduction of poverty and unemployment, whose primary task is to prepare Blue Print and Roadmap of Biofuel Development. (Note that a shift in policy seems to have occurred : Presidential Regulation no. 5/2006 stressed biofuel development for national energy security, whereas Presidential Decree no. 10/2006 stressed biofuel development for reduction of poverty and unemployment).

In December 2006, the National Team for Biofuel Development published the document "Blue Print of Biofuel Development for Accelerating the Reduction of Poverty and Unemployment" (in Indonesian). According to this blue print, the targets of biodiesel production are :

- 2.41 million m^3 (10 % of domestic diesel fuel consumption) by 2010,
- 4.52 million m^3 (15 % of domestic diesel fuel consumption) by 2015, and
- 10.22 million m^3 (20 % of domestic diesel fuel consumption) by 2025.

The main crops utilized for biodiesel production are oilpalm (*Elaeis guineensis*) and physic nut (*Jatropha curcas*). However, every local/provincial government is allowed to also develop local-specific resources such as coconut (*Cocos nucifera*). Indonesia currently (data for 2006) produced 15.8 million ton of crude palm oil or CPO (from 6.1 million hectares plantation area), mainly for edible uses, and practically no jatropha oil (cultivation/plantation is just starting). According to the blue print, the development of plantation area dedicated for biodiesel production is planned as follows :

- 1.5 million ha for oilpalm and 1.5 million ha for jatropha by 2010
- 4 million ha for oilpalm and 3.0 million ha for jatropha from 2015 to 2025 (with increased productivity per ha).

The blue print also planned mandatory utilization of B5 in the transportation sector starting in 2008 and B10 starting in 2009.

However, the realization of the above plans of the National Team for Biofuel Development is currently very questionable due to the following reasons :

- the target of developed plantation area by 2010 is considered too high;
- jatropha plantation is just starting and thus can only be expected to produced significant amount of oil from 2011, the main raw material is currently palm oil;
- the crude palm oil (CPO) price has recently increased enormously, from US$350/ton in mid-2006 to around US$700/ton in the beginning of 2007 and reached US$990/ton by the end of 2007; and
- the government as yet has not set/decided any further implementable policy.

Due to the high price of biodiesel, which in turn caused by the enormous increase of CPO price, in April 2007 Pertamina reduced the content of biodiesel in biosolar down to 2.5 %-vol and stated that if the government do not set a real incentive policy, Pertamina's biodiesel program will be discontinued (at that time, Pertamina already has 201 fuel-dispensing stations in Jakarta and 15 in Surabaya that sell B5).

In January 2007, many biofuels producers united/allied in the Indonesian Biofuel Producers Association (APROBI ≡ Asosiasi Produsen Biofuel Indonesia) to better negotiate their own interests and strive for sustainable biofuel business in Indonesia. APROBI insists/urges the government of Indonesia to :

- establish clear incentive policies (tax reductions, mandatory use of biofuels, etc);
- secure the feedstock supply through percentage allocation of CPO (*crude palm oil*) for biodiesel;
- accelerate the availability of diversified feedstocks (jatropha, coconut etc.).

With appropriate support from the government, APROBI is optimistic that the production of biodiesel in Indonesia, which was 170,000 ton in 2006, would grow to 645,000 ton in 2007, 1,995,000 ton in 2008, and 3,593,000 ton in 2009 (note that this

2009 figure is already much higher than the government/blue print target for 2010). The list of biodiesel producers in Indonesia and their respective production capacity is provided in Table 4.3.1.

Table 4.3.1. Biodiesel producers in Indonesia and their respective production capacity.

APROBI Members :		Capacity, ton/yr	Non-members of APROBI :		Capacity, ton/yr
1.	Eterindo Wahanatama	**120,000**	15.	Asian Agro	150,000
		120,000	16.	Mopoli	150,000
2.	Platinum Resins Indonesia	**50,000**	17.	Sampurna/PTPN XI	160,000
3.	Indo Biofuels Energy	**20,000**	18.	Musimas	100,000
		120,000	19.	Sari Dumai Sejati	100,000
4.	Energi Alternatif Indonesia	**300**	20.	Indobiofuel	200,000
5.	Ganesha Energy	**5,000**	21.	Energi Indo Pratama	100,000
6.	Wilmar Bioenergi	**350,000**	22.	Karya Prajona NLY	100,000
		700,000	23.	Anugrah Inti Gema Nusa	50,000
7.	Sumi Asih Group	**100,000**	24.	Wahana Abadi Tirta	30,000
		200,000	25.	Rejeki Anugrah P.	1,650
8.	Sinar Mas Group	100,000	26.	Artha Trans Jaya	1,200
9.	Darmex Oil	200,000	**Bold font** : already producing Normal font : planned Source : APROBI		
10.	El Nusa IndoBio Energy	200,000			
11.	Bakrie Sumatera Plantation	100,000			
12.	Rekayasa Industri/Pertamina	5,000			
13.	AGB Energy	-			
14.	Rajawali Nusantara Indonesia	-			

4.3.2. Standardization of BDF

The biodiesel quality standard is needed to :

☑ ensure the quality of produced and traded biodiesels in order to build-up and preserve consumers trust on the product, and

☑ guide and accelerate the domestic R & D activities on biodiesel production and utilization toward the establishment of a healthy and strong domestic biodiesel industry.

The initial draft of Indonesian Biodiesel Standard was prepared in 2003 – 2004 by the Indonesian Biodiesel Forum (FBI, Forum Biodiesel Indonesia), an independent multi-stakehoders organization formed in February 2002 to promote production, trading and utilization of biodiesel in Indonesia. The draft (or tentative standard) was formulated on the basis of ASTM D6751-02 and EN 14214-02 as reference standards and the following 2 important issues/considerations :

1. Indonesia has a (much) larger biodiversity (and thus stock of potential raw materials) than many developed countries (e.g. EU, USA, Australia, and Japan). Thus, while fatty oils in temperate regions mainly comprise C_{16} – C_{18} fatty acids, in Indonesia are also found fatty oils mainly composed of C_8 – C_{14} fatty acids or containing large amount of C_{20} – C_{24} fatty acids. Furthermore, some reactive unsaturated C_{16} – C_{18} fatty acids other than linoleic and linolenic acids are found in several potential fatty raw materials.
2. To facilitate provincial developments in the entire country, it is essential that small and medium enterprises could participate in biodiesel production and business. Therefore, the quality standard should be simple (do not include too many parameters) but effective. Also, without jeopardizing/sacrificing the quality and accuracy of the results, the equipment and methods of tests should be within reach to small and medium enterprises (large producers could, of course, choose the sophisticated and expensive alternatives such as those adopted by ASTM D6751 and EN 14214).

The tentative standard was proposed to the government in 2004 and then taken up for further considerations and improvements in the year 2005 by a technical committee facilitated/supported by Directorate of New and Renewable Energy and Energy Conservation, Ministry of Energy and Mineral Resources. After a final scrutiny by all stakeholders at national level in December 2005, the tentative national standard was finally (February 22th 2006) approved by the National Standardization Institute as SNI-04-7182-2006. The biodiesel quality requirements according to this standard are shown in Table 4.3.2.

Table 4.3.2. SNI-04-7182-2006 : Biodiesel Quality Requirements in Indonesia

Quality parameter and unit	**Limit**	**Test Method**	**Alternative method**
Density at 40 ^oC, kg/m^3	850 – 890	ASTM D 1298	ISO 3675
Kinematic viscosity at 40 ^oC, mm^2/s (cSt)	2.3 – 6.0	ASTM D 445	ISO 3104
Cetane number	Min. 51	ASTM D 613	ISO 5165
Flash point (closed cup), ^oC	Min. 100	ASTM D 93	ISO 2710
Cloud point, ^oC	Max. 18	ASTM D 2500	-
Cu strip corrosion (3 hrs, 50 ^oC)	Max. no. 3	ASTM D 130	ISO 2160
Carbon residue (%-wt) : - in original sample - in 10 % distillation residue	Max. 0.05 (Max. 0,3)	ASTM D 4530	ISO 10370
Water and sediment, %-volume	Max. 0.05	ASTM D 2709	-
90 % distillation temperature, ^oC	Max. 360	ASTM D 1160	-
Sulfated ash, %-wt	Max. 0.02	ASTM D 874	ISO 3987
Sulfur, ppm-wt (mg/kg)	Max. 100	ASTM D 5453	ISO 20884
Phosphorous, ppm-wt (mg/kg)	Max. 10	AOCS Ca 12-55	FBI-A05-03
Acid value, mg-KOH/g	Max. 0.8	AOCS Cd 3-63	FBI-A01-03
Free glycerol, %-wt	Max. 0.02	AOCS Ca 14-56	FBI-A02-03
Total glycerol, %-wt	Max. 0.24	AOCS Ca 14-56	FBI-A02-03
Alkyl ester content, %-wt	Min. 96.5	Calculated	FBI-A03-03
Iodine value, %-wt (g-I_2/100 g)	Max. 115	AOCS Cd 1-25	FBI-A04-03
Halphen test	negative	AOCS Cb 1-25	FBI-A06-03

The standard resembles the US (ASTM D6751-02), rather than the more complicated EU standar (EN 14214), with the following exceptions/differences :

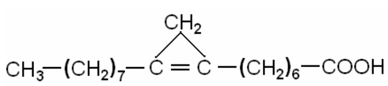
- Density, alkyl ester content, and iodine value are adopted as additional quality parameters.
- The measurement of density is to be carried out at 40 ^oC (not at 15 ^oC as specified in EN 14214) because the maximum allowable cloud point temperature is 18 ^oC (i.e. higher than 15 ^oC). The temperature of 40 ^oC is chosen as the measurement

temperature because kinematic viscosity is also to be determined at that temperature.

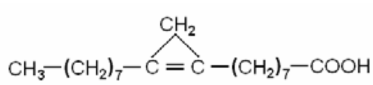
- To allow small and medium industries participate in biodiesel production, wet analytical methods (based on American Oil Chemists Society [AOCS] standard methods) have been chosen for the quality parameters that are specific for biodiesel (as compared to petroleum diesel). These are methods for determination of phosphorous, acid value, free and total glycerols, alkyl ester content, iodine value, and Halphen test. The FBI (Forum Biodiesel Indonesia) methods are Indonesian translation (+ adaptation for biodiesel) of the AOCS methods; an example of the adaptation for biodiesel is the smaller amounts of reagent used in the total glycerol determination, because the total glycerol content of biodiesel is much lower than that of fatty oil. The AOCS procedures for measuring iodine value and acid value are actually similar to the corresponding EN methods
- The alkyl ester content is calculated from the acid value, total and free glycerols, and saponification value (AOCS Cd 3-25) by assuming that all the bound glycerol (i.e. total glycerol – free glycerol) is present as triglyceride. The method is based on the fact that according to mol balance :

  Mol alkyl ester = mol total acids – mol free acids – 3 x (mol glycerol)

  The detail of the calculation formula, including the Indonesian translation of AOCS Cd 3-25, is described in FBI-A03-03. This method of determining alkyl ester content is thus very conservative but obviating the need of determining the contents of mono-, di- and triglycerides (which require relatively capital intensive chromatographic apparatus).
- The upper limit of 115 is chosen for iodine value (as compared to 120 in EN 14214) because fatty oils with relatively substantial content of linoleic acid (and/or its isomers such as eleostearic acid) and/or higher polyunsaturated fatty acids usually have iodine value exceeding 115.
- The requirement of negative response to Halphen test is an additional quality parameter of SNI-04-7182-2006. This test is meant to ensure the absence alkyl ester of cyclopropenoid fatty acids, i.e. malvalic and sterculic acids, in biodiesel.



Malvalic acid



Sterculic acid

Cyclopropenoid fatty acids are usually contained in fatty oil from plants that belong to the *Malvaceae* family (kapok, cotton, sterculia, etc). As examples, kapok seed oil, which is a potential non edible fatty oil in Indonesia, contains 8 – 20 % and sterculia oil (the oil from which sterculic acid got its name) contains around 70 % of these acids. Cyclopropenoid fatty acid groups easily polymerize at high temperatures, thus presumed will cause engine trouble due to polymer or gum formation. Fatty acid alkyl esters containing relatively high level of cyclopropenoid fatty acids are therefore considered not suitable to be used as biodiesel. The cyclopropenoid ring uniquely give positive response to Halphen test (appearance of red coloration in a hot mixture of the tested oil/biodiesel with a solution of 1 % sulfur in carbon disulphide, and butyl/amyl alcohol solvent).

Although very effective, Halphen test is actually too strict, because the use of cottonseed FAME in the USA apparently present no engine problem (cottonseed oil, which also give positive response to Halphen test, contains only ≈ 0.5 % cyclopropenoid). The method is adopted because of the absence of a simple but more accurate procedure.

- Note also that the required limit for flash point is minimum 100 ^{o}C, which is lower than minimum 130 ^{o}C specified in ASTM D6751-02, to allow lauric oil (coconut, palm kernel, etc, which primarily composed of C_8 – C_{12} fatty acids) to be utilized as raw materials. A flash point of not less than 100 ^{o}C is also considered sufficient to insure the absence of residual alcohol (methanol).

Future improvements to SNI-04-7182-2006 would quite probably consist of :

1. An oxidation stability test which comprehensively measure the oxidative degradation tendency of biodiesel in terms of formation of sludge and volatile as well as non volatile acids. This test will then replace the iodine value measurement.
2. A direct thermal stability test to replace the Halphen test.

However, satisfactory procedures to carry out this test is not yet available (in the literature) and thus still have to be developed.

4.4. Malaysia

4.4.1. Policy and measure of BDF

i) Target and strategy from energy and environment point of view

Under the National Energy Policy, three principal energy objectives are instrumental in guiding the future energy sector development; the supply, utilization and environmental. They are (a)The Supply Objective: To ensure the provision of adequate, secure, and cost-effective energy supplies through developing indigenous energy resources both non-renewable and renewable energy resources using the least cost options and diversification of supply sources both from within and outside the country; (b) The Utilization Objective: To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption; and (c) The Environmental Objective: To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

In the Eighth Malaysian Plan, Renewable Energy was announced as the fifth fuel in the new Five Fuel Strategy in the energy supply mix. It is targeted that RE will contribute 5% of the country's total electricity demand by the year 2005, that is by the end of the Eighth Malaysia Plan period. With this objective in mind, greater effort is being undertaken to encourage the utilization of renewable resources, such as biomass, biogas, solar and mini-hydro, for energy generation.

A programme aimed at increasing public awareness of the positive attributes of RE and energy efficiency (EE) measures is being carried out by the Centre for Education and Training in Renewable Energy and Energy Efficiency (CETREE), University Science Malaysia, Penang. The government is currently working on 'hands-on' applications of RE with a number of on-going projects.

Ministry of Energy, Water and Communications has identified palm oil wastes as the biggest resource that can be easily developed. Solar is another important option, particularly for rural electrification and water heating.

A recent renewable study identified the renewable energy resource potential in the country, in ringgit value, as follows:

Renewable Energy Resources	Energy Value in RM million (Annual)
Forest residue	11,984
Palm oil biomass	6,379
Solar thermal	3,023
Mill residues	836
Hydro	506
Solar PV	378
Municipal waste	190
Rice husk	77
Landfill gas	4

To achieve the national objectives, the Government is pursuing the following strategies: -

- **Secure supply**
  Diversification of fuel type and sources, technology, maximize use of indigenous energy resources, adequate reserve capacity to cater for contingencies, adequate reserve margin for generation, upgrading transmission and distribution networks and distributed generation (islanding);
- **Sufficient supply**
  Forecast demand, right energy pricing and formulate plans to meet demand.
- **Efficient supply**
  Promote competition in the electricity supply industry.
- **Cost-effective supply**
  Promote competition and provide indicative supply plan to meet demand based on least cost approach using power computer software such as WASP;
- **Sustainable supply**
  Promote the development of renewable and co-generation as much as possible.
- **Quality supply (low harmonics, no surges and spikes, minimal variation in voltage)**
  Match quality with customer demand with variable tariffs;
- **Efficient utilization of energy**
  Bench marking, auditing, financial and fiscal incentives, technology development, promotion of ESCOs, Labeling, Ratings, correct pricing, energy managers; and
- **Minimizing Negative Environmental Impacts**
  Monitor the impacts, improve efficiency of utilization and conversion and promote renewable.

ii) Concrete target and strategy for Biofuel

The National Biofuel Policy was announced by the Honorable Prime Minister of Malaysia in March 2006. In May 2006, the Biofuel Bill 2006 has passed the Parliament of Malaysia. The National Biofuel Policy encourages the use of biofuels in line with the nation's Five-Fuel Diversification Policy. It spells out a comprehensive framework with concrete initiatives in line with the objectives of the United Nations Framework Convention on Climate Change (UNFCC) to which Malaysia is a party. The National Biofuel Policy was formulated after extensive consultation with all the stakeholders and as a result of research findings by PORIM/MPOB since 1982. The policy focuses on blending processed palm oil with petroleum diesel and also converting palm oil into biodiesel (methyl ester), mainly for export. The implementation of the National Biofuel Policy is spearheaded by the Ministry of Plantation Industries and Commodities.

The National Biofuel Policy envisions (a) the use of environmentally friendly, sustainable and viable sources of energy to reduce the dependency on depleting fossil fuels and (b) the enhancement of prosperity and well-being of all stakeholders in the agriculture and commodity based industries through stable and remunerative prices. The policy is underpinned by five strategic thrusts:

Thrust 1: Biofuel for transportation
Thrust 2: Biofuel for Industry
Thrust 3: Biofuel technologies
Thrust 4: Biofuel for export
Thrust 5: Biofuel for cleaner environment

On the implementation, the government has committed 130 Government vehicles which include heavy and light duty to use blended biofuel that consists of 5% processed palm oil with 95% petroleum diesel on trial basis. Some private transport companies have segregated a total of 101 public passenger buses and two deep sea fishing boats to trial on this blended biofuel. On the other hand, the mandatory use of palm oil based methyl esters for domestic purposes is still pending for Government decision.

iii) Main crops for BDF and its production planning

At present, the major crop for BDF production in the country is palm oil. Malaysian and Indonesian Governments pact agrees to use 40% (~6 million tonnes) of current palm oil production (15 million tonnes) for the production of biodiesel. This 6 million tonnes of palm oil is a moral pledge between the two Governments and no legal implications on either countries should biodiesel usage fall below or shoot above this level. Currently Malaysia Government has approved 91 biodiesel manufacturing licenses with total annual capacity of 10.5 million tonnes. Current production capacity (as of October 2007) exists in Malaysia is about 800,000 million tonnes per annum. Jatropha curcas is another crop of interest of the Malaysian Government. The government has planned on a demonstration project on cultivation of Jatropha curcas to establish the economic feasibility study of the crop for biodiesel production.

iv) Regulations and incentives to promote BDF utilization

Under the Promotion of Investment Act 1986, numerous incentives have been given to promote the private sector involvement to capitalize on this new development. These incentives are provided for producers and generally available for all the manufacturing industries including biodiesel industry.

The major tax incentive is Pioneer Status. A company granted Pioneer Status enjoys a 5-year partial exemption from paying income tax. It pays tax on 30% of its statutory income. To encourage investment in the states of Sabah and Sarawak and the designated Eastern Corridor of Peninsular Malaysia, companies located in these areas will enjoy a 100% tax exemption on their statutory income during their 5-year exemption period.

The incentives for strategic and high technology projects, and commercialization of R&D findings of the public sector in resource based industries also have been given to the relevant companies. A company which invests in its subsidiary company engaged in the commercialization of R&D findings will be given tax exemption equivalent to the amount of investment made in the subsidiary company. At the same time, the subsidiary company that undertakes the commercialization of R&D findings will be given pioneer status with 100% tax exemption on statutory income for 10 years.

4.4.2. Standardization of BDF

i) Concept of BDF standards and regulations

The Malaysian specification/standard of palm biodiesel was formulated based on European biodiesel specifications, EN 14214 as a basis. The test methods are based on ASTM, ISO, EN and Malaysian test methods which are identical to ASTM or ISO methods. The standard drafting for biodiesel was undertaken by the Technical Committee (TC) on Petroleum Fuels which it membership includes oils and gas companies (e.g. Shell, Petronas, Caltex, Exon Mobile etc.), government agencies (e.g. MPOB, Department of Environment, Department of Transportation, etc.) and representatives from Malaysian Automotive Association (MAA). The Malaysian standard on palm biodiesel is expected to be published by early 2008. The provisional voluntary Malaysian standard on B5 palm olein biofuel blend (MS 2007:2007) was published in March 2007.

ii) Standards of BDF

(1) Current status of BDF standardization

Currently, the Malaysian standard on palm methyl ester is released for public comments.

(2) Reference standards

Reference standards for Malaysian biodiesel standard is ASTM D6751 and EN 14214.

(3) Remarkable items

The parameter on CFPP for Malaysian biodiesel is +15°C. We acknowledged the important of polyunsaturated methyl esters in biodiesel and maintained it as 1 %wt. maximum. The iodine value was 110°C as certain oil palm species is highly unsaturated.

iii) Specification values

The specification of palm methyl ester is as follows (next page):

Property	Unit	Limits		Test methods
		Minimum	Maximum	
Ester content	% (m/m)	96.5	-	EN 14103
Density at 15 °C[c]	kg/m^3	860	900	ISO 3675 ISO 12185 ASTM D 4052
Viscosity at 40 °C	mm^2/s	3.50	5.00	ISO 3104 MS 1831
Flash point	°C	120	-	ISO 3679[e] MS 686
Sulfur content	mg/kg	-	10.0	ISO 20846 ISO 20884 ASTM D 5453
Carbon residue (on 10% distillation residue – ISO 10370)[f] (on 100% distillation sample – ASTM D 4530)	% (m/m)	-	 0.30 0.05	 ISO 10370 ASTM D 4530
Cetane number		51.0	-	ISO 5165 MS 1895
Sulfated ash content	% (m/m)	-	0.02	ISO 3987 ASTM D 874
Water content	mg/kg	-	500	ISO 12937 ASTM E 203 ASTM D 1160
Total contamination	mg/kg	-	24	EN 12662 ASTM D 5452
Copper strip corrosion (3 h at 50 °C)	rating	Class 1		ISO 2160 MS 787
Oxidation stability, 110 °C	hours	6.0	-	EN 14112
Acid value	mg KOH/g	-	0.50	EN 14104 MS 2011
Iodine value	g iodine/ 100 g	-	110	EN 14111
Linolenic acid methyl ester	% (m/m)	-	12.0	EN 14103
Polyunsaturated (>=4 double bonds) methyl esters	% (m/m)	-	1	-
Methanol content	% (m/m)	-	0.20	EN 14110
Monoglyceride content	% (m/m)	-	0.80	EN 14105 ASTM D 6584
Diglyceride content	% (m/m)	-	0.20	EN 14105 ASTM D 6584
Triglyceride contenth	% (m/m)	-	0.20	EN 14105 ASTM D 6584
Free glycerolh	% (m/m)	-	0.02	EN 14105 EN 14106 ASTM D 6584
Total glycerol	% (m/m)	-	0.25	EN 14105 ASTM D 6584
Group I metal (Na+K) Group II metals (Ca+Mg)	mg/kg mg/kg	-	5.0 5.0	EN 14108 EN 14109 EN 14538
Phosphorus content	mg/kg	-	10.0	EN 14107 ASTM D 4951
CFPP	°C	-	15	EN 116

4.5. New Zealand

4.5.1. Policy and measure of BDF

i) Target and strategy from energy and environment point of view

The New Zealand Government released the final New Zealand Energy Strategy (NZES) in October 2007. This sets out the Government's vision and action plan for a reliable and resilient system delivering sustainable, low emissions energy services. It includes an emphasis on reducing transport emissions and reducing our dependence on imported oil, which will require a combination of energy sources for vehicles, including biofuels and electricity. The NZES also notes an in-principle goal to halve domestic transport emissions per capita by 2040 relative to 2007 emissions.

The New Zealand Government also announced in October 2007 the in-principle decision to introduce an Emissions Trading Scheme (ETS). This will operate alongside the other policies and measures included in the NZES to reduce domestic emissions and achieve New Zealand's broader sustainability objectives. It is intended that there is a staged entry of sectors into the ETS.

ii) Targets/strategies/regulations/incentives for BDF

A key action in the NZES is the implementation of a biofuels sales obligation, which will require all suppliers of petrol and diesel to also supply biofuels (bioethanol or biodiesel). The obligation will start at a low percentage in 2008, and progressively increase in the years following to 2012. To implement the obligation, the Biofuel Bill was introduced in October 2007 and is expected to be in force from 1 July 2008. The government plans to review the biofuels sales obligation in 2010 to consider obligation levels after 2012.

iii) Main crops for BDF and its production planning

There is currently only around 15 million litres of biodiesel production capacity in New Zealand, and the biodiesel being produced is all being sold via the contractual market, rather than being incorporated in the retail fuel mix. For the most part, the feedstocks being utilised are tallow and waste-cooking oil, approximately 11 million litres and 3 million litres respectively. New Zealand's biggest source of biodiesel is tallow. The known New Zealand tallow production for use as biodiesel feedstock is close to 150 million litres, representing approximately 5 PJ, or 2.25% of New Zealand's petrol and diesel use. The quantity of waste-cooking oil estimated to be available for biodiesel production in New Zealand is 5 million litres.

The planned biodiesel production capacity is around 150 million litres by 2012.

While the majority of the planned production is based on tallow, one company intends to upscale to a 70 million litre plant using a combination of waste-cooking oil and rapeseed oil. Algae is being investigated as a feedstock for second generation biofuels.

4.5.2. Standardization of BDF

The quality of petrol and diesel in New Zealand is regulated by the Petroleum Products Specifications Regulations 2002. The Government has recently agreed to biodiesel and ethanol specifications for incorporation in these regulations, which will be renamed appropriately. The new regulations are expected to be in force by the middle of 2008. A voluntary biodiesel standard – *Automotive Biodiesel: Specification for manufacture and blending* (NZS 7500) was published in 2005 and will remain in place until the regulations are in force.

The agreed B100 specifications for blending with diesel for retail sale are as follows:

Property	**Unit**	**Minimum**	**Maximum**	**Test Method**
Ester content	% mass	96.5	-	EN 14103
Density at 15ºC	kg/m³	860	900	ASTM D1298
Viscosity at 40ºC	mm²/s	**2.0**	**6.0**	ASTM D445
Flash point	ºC	100	-	ASTM D93
Sulphur	mg/kg	-	10	IP 497 or ASTM D5453
Carbon residue (on 100% distillation residue) or Carbon residue (on 10% distillation residue)	% mass % mass	- -	0.05 0.30	ASTM D4530 ISO 10370
Cetane number		47	-	ASTM D613 or ASTM D6890
Sulphated ash	% mass	-	0.020	ASTM D874
Water	mg/kg	-	500	IP 438
Total contamination	mg/kg	-	24	IP 440
Copper strip corrosion (3 h at 50ºC)	rating	class 1		ASTM D130
Oxidation stability, 110ºC	hours	10.0[1]	-	EN 14112
Acid value	mg KOH/g	-	0.50	ASTM D664
Iodine Value	g iodine/100 g	-	140	EN 14111
Linolenic acid methyl ester	% mass	-	12.0	EN 14103
Polyunsaturated (>=4 double bonds) methyl esters	% mass	-	1	
Methanol	% mass	-	0.20	EN 14110
Monoglycerides	% mass	-	0.80	ASTM D6584
Diglycerides	% mass	-	0.20	ASTM D6584
Triglycerides	% mass	-	0.20	ASTM D6584
Free glycerol	% mass	-	0.020	ASTM D6584
Total glycerol	% mass	-	0.25	ASTM D6584
Group l metals (Na+K)	mg/kg	-	5.0	EN 14108 and EN 14109
Group ll metals (Ca+Mg)	mg/kg	-	5.0	EN 14538
Phosphorus	mg/kg	-	10.0	ASTM D4951

[1] Note that where there is a written supply agreement or contract between the supplier and the end user (i.e. non-retail sale), the minimum oxidation stability required is 6.0 hours.

4.6. Philippines

4.6.1. Introduction

It has been recognized that fossil fuels are major pollution sources. Oil dominates the energy sources in the Philippines, constituting 36% of the energy mix. However, with the thrust towards diversification and development of indigenous and renewable energy sources, oil demand in the power sector has significantly been reduced, now to only 11%. The remaining high demand for oil therefore now rests with the transport sector.

The Philippines is practically importing all of its oil requirements, both as crude oil and as finished products. The very high and increasing oil prices provide incentives for indigenous energy sources. With the Philippines having vast agricultural and underutilized lands, biofuels are very attractive.

4.6.2. Biodiesel Policy

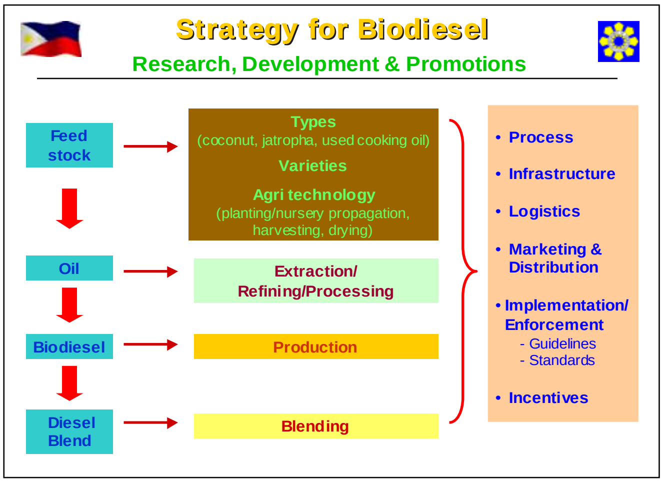
During the early 1980's, the Philippine National Oil Company and the Ministry of Energy embarked on a Cocodiesel Program using coconut oil as a diesel blend. However, technical problems (e.g. filter clogging), the improvement of vegetable oil prices in the world market, and the relatively lower prices of diesel caused the program to be discontinued. Nonetheless, researches continued. The same is also true for ethanol in gasoline.

Meanwhile, pursuant to the government's thrusts to reduce dependence on oil, increase self-sufficiency, improve air quality, as well as improve the economic condition in the countryside and promote rural development, i.e., encourage "balik probinsiya" and decongest the urban centers, a landmark legislation was passed. The Biofuels Act of 2006 (Republic Act No. 9367) declared as a policy "to achieve energy independence and fuel diversification while meeting environmental challenges through the utilization of agricultural-based feedstocks". This law, mandating the use of biofuels, was signed on January 12, 2007 and became effective on February 6, 2007 after its publication in 2 newspapers of general circulation.

Specifically for biodiesel, Section 5.3 of the law provides that: "Within three (3) months from the effectivity of this Act, a minimum of one percent (1%) biodiesel by volume shall be blended into all diesel engine fuels sold in the country: *Provided*, that biodiesel blend conforms to PNS for biodiesel." The law further states that "Within two (2) years from the effectivity of this Act, the National Biofuels Board (NBB) created under this Act is empowered to determine the feasibility and thereafter recommend to DOE to mandate a minimum of two percent (2%) blend of biodiesel by volume which may be increased taking into account considerations including but not limited to domestic supply and availability of locally-sourced biodiesel component."

4.6.3. Strategy for Biodiesel

Pursuant to the law, the concerned agencies are pursuing the following strategy.



A. Research and Development / Promotions. There are on-going research and development studies for each level in the supply chain, i.e., from the agri-based feedstocks to the extracted oil, biodiesel and the blended petroleum fuel. In all of these levels, considerations are made on the (1) process/infrastructure/logistics for land use, viable basestocks, agro-industrial development, quality products, etc.; (2) marketing and distribution to ensure supply security – availability and accessibility, supply competition, export market,…; (3) implementation / enforcement of regulations/guidelines, standards, as well as monitoring compliance; and (4) incentives to encourage investments and sustainability of the program. With very low blend of 1%, and the requirement of the law for monitoring at the gasoline station pump, blending must be homogeneous. This poses a big challenge to the oil companies who are liable to the motorist, and the government, in terms of huge penalties for non-compliance.

Promotions are underway at the various levels.

B. Supply Management. Learning from experiences of other countries that have embarked on a program on biofuels, the law made sure that all levels in the supply chain have a lead agency to take care of. A National Biofuels Board (Board) was created, composed of Heads of concerned Departments and Authorities, and chaired by the Secretary of the Department of Energy (DOE), namely: the Department of Trade and Industry (DTI); Department of Science and Technology (DOST); Department of Agriculture (DA), Department of Finance (DOF); Department of Labor and Employment (DOLE); Philippine Coconut Authority (PCA); and the Sugar Regulatory Administration (SRA). The Board also agreed to include as non-voting members the heads of the Department of Agrarian Reform (DAR) and the Department of Environment and Natural Resources (DENR).

The Board has to ensure adequate and continuous agricultural supply for the fuel program, without sacrificing food and other traditional uses of the feedstocks. Thus, one of the key functions of the Board is to recommend to the DOE the level of the mandatory blend of biodiesel to petroleum diesel considering availability of biodiesel from local supply.

The DA is in-charge for the biodiesel feedstocks, and assisted by the PCA, with coconut as the feedstock of accredited biodiesel producers. To handle jatropha, which has a potential feedstock, the Philippine Forest Corporation is actively involved in the plantation/propagation. The Alternative Fuels Corporation, a subsidiary of the Philippine National Oil Company, was recently created to cover R&D and investment promotions for jatropha and other alternative fuels. Of course, the DOE is lead for the products – biodiesel and the diesel fuel blends.

C. Feedstocks. There are many possible feedstocks for biodiesel. At the moment, the following are the present and high potential feedstocks.

Coconut. Coconut, known in the Philippines as the tree of life, is at present the only feedstock that can meet the Philippine National Standard for biodiesel and the diesel blend B1(Diesel with 1% biodiesel), having consistently passed all the necessary tests.

Coconut and its products are major exports of the Philippines. Coconut methyl ester (CME) started as a by-product of oleo-chemical plants. Researches led to its "refinement", making it suitable for use as a blending component of diesel. Over time, it was established that CME not only substitutes part of our diesel requirements, as a blend, but also enhances its quality, in terms of detergency and solvency, thus contributing to cleaner air.

With surplus coconut for its traditional uses in the food and oleo-chemicals sector, CME as fuel was encouraged. As of July 2007, there are 5 commercial plants and one (1) LGU-based plant that have been accredited by the DOE for biodiesel production, with a total annual capacity of 250 million liters. Local requirement (potential diesel displacement) is 60M liters at 1% blend.

Jatropha. Jatropha, known locally as *tuba-tuba* or *tubang bakod* , has been identified as a potential feedstock for biodiesel, being a non-food crop, and supposed to grow well in non-agricultural lands. Speciation studies are on-going, to determine appropriate varieties/species for commercialization, considering climate, rainfall, soil, geography, etc. While jatropha does not compete with food, it must not also be allowed to compete with land use.

Others. The DOE is also in receipt of proposals for registration and accreditation of biodiesel from used cooking oil. Consistency of the biodiesel product quality is seriously being looked into.

D. Incentives. The Biofuels Law provides incentives for biofuels.

Specific Tax. Biofuels are zero (0) rated, regardless of source – local or imported.

Value Added Tax (VAT). The sale of raw materials used in the production of biofuels are exempted from the 12% VAT.

Philippine Clean Water Act Fees and Charges. Water effluents from biofuels production used as liquid fertilizer and other agricultural purposes which are considered “reuse” are exempted under by RA 9275.

Government Financial Institutions Loans. High priority will be accorded to Filipino entities that shall engage in production, storage, handling and transport of biofuels and biofuel feedstocks, including the blending with petroleum, as certified by the DOE.

The above incentives are on top of those applicable under the Omnibus Investments Code of 1987 for projects falling under the Investment Priority Projects (IPP) which is updated annually. Production facilities, vehicles, etc. for the program have been part of the IPP.

E. Regulations / Prohibited Acts. To ensure consumer safety and welfare, three (3) units in the DOE are involved with biofuels.

When used as fuel (blended into diesel), the product falls under the jurisdiction of the Oil Industry Management Bureau. The blended fuel is subject to such laws as the “Oil Deregulation Law”, “Clean Air Act” and the “Biofuels Law”, among others. The OIMB oversees the downstream oil industry sector and monitors quality, quantity, price, supply and demand, and production and marketing processes of fuels, as well as developments in the sector.

As a biofuel, the blending component of the petroleum product, its accreditation and monitoring is handled by the Energy Utilization Management Bureau.

The Energy Research and Testing Laboratory Service, meanwhile, conducts tests on samples obtained in the course of monitoring and inspection of the pure biodiesel and the blended fuels. The ERTLS is also undertaking correlation between laboratories and equipment among the government, industry players and third party testing facilities to minimize, if not totally avoid inconsistent and contestable test results.

4.6.4. Standardization

A. **Mandate.** Petroleum products sold in the country have to conform to the Philippine National Standards (PNS). Thus, diesel blended with biodiesel must conform to the diesel standard. The standard setting mandate is provided in the Clean Air Act, while its enforcement is provided in the Oil Deregulation Law. The Biofuels Law also provided for a mandate to establish technical fuel quality standards for biofuels and biofuel-blended gasoline and diesel which comply with the PNS

Technical Committee for Standards. Undertaking the mandate is the Technical Committee on Petroleum Products and Additives (TCPPA) created by virtue of the Clean Air Act. The TCPPA took over the role of the Technical Committee on Petroleum Products & Lubricants (TC 12) of the Bureau of Product Standards (BPS). The TCPPA is co-chaired by the DOE and the Department of Environment and Natural Resources (DENR), with members coming from concerned government agencies, fuel sector, engine/vehicle suppliers, consumers, non-government organizations, and the academe. The TCPPA follows the standards development and review procedure of the BPS. A BPS representative is a regular member of the TCPPA.

For the biodiesel standards, the TCPPA membership is expanded to include chemists from the oleochemical industry.

Bureau of Product Standards (BPS). As the main standards body, the BPS promulgates the draft prepared by the TCPPA into a Philippine National Standard (PNS), pursuant to the Clean Air Act.

Department of Energy. The PNS, while providing specifications, can only be enforced with a regulation issued by the pertinent authority. For fuels, a DOE regulation, usually in the form of a Department Circular, is issued to require compliance to the PNS.

B. **Standards.** The Philippines has recently modified the standard for conventional diesel to consider the mandated 1% biodiesel for diesel. Because the biodiesel manufacturers are different for the petroleum companies, the country deemed it appropriate to also set standards for the blending components, i.e., pure biodiesel (B100). Thus, there are standards for the pure biofuels, the biofuel blends, and as necessary, the base petroleum fuels. For biodiesel, there are PNS for the mandated 1% CME blended diesel (B1), and for Coco-Methyl Ester (CME).

PNS/DOE QS 004:2007- Fatty Acid Methyl Ester (FAME)-Blended Diesel Oils specification. This year, pursuant to the mandatory requirement for 1%biodiesel in all diesel fuels sold in the country, the standard for FAME-blended diesel or B1 was promulgated. The requirement for compliance to this standard is contained in the rules and regulations implementing the Biofuels Law (DOE Department Circular No. DC 2007-05-0006 – Rules and Regulations Implementing Republic Act No. 9367). The standard covers both automotive and industrial diesel fuel. The summary of properties and limits are attached as Annex "A".

PNS/DOE QS 002:2007- Coconut Methyl Ester (B100) specification. As early as 2003, a standard for biodiesel CME was promulgated (PNS 2020:2003, renamed PNS/DOE QS 002:2003 as the DOE got the mandate for petroleum fuels). While patterned after ASTM D6751 (2002) for B100, the PNS took cognizance of the fact that ASTM considered a set of biodiesel which has composition and properties different from coconut oil. A technical working group was created, led by oleo-chemical sector representatives. Thus for the properties of Free glycerin and Total glycerin, for which the ASTM standard noted their non-applicability to B100 using coconut oil feedstock, the test methods of the American Organization of Chemical Scientists (AOCS) were adopted, modified accordingly, and interim limits set, pending further studies.

In 2005, review of the standard started, this time considering EN 14214 and studies, findings and suggestions from JAMA. Moreover, the advent of other potential feedstocks in the country caused the TCPPA to initiate standards for Jatropha, as well as for a generic B100 standard. However, due to the shortage of sustainable jatropha samples, as well as the undertaking of this ERIA BDF standardization project for the East Asia Region, the TCPPA agreed to just update the CME standard. The updated standard was officially promulgated by BPS in 2007. Other than the modified AOCS methods already adopted in the previous version, applicable ASTM and EN methods for FAME, Methyl Laurate, Glycerins and glycerides were also incorporated, modified accordingly, and interim limits set, pending further studies. Highlights of this update include: provisions on 96.5% mass, min. FAME Content, 45 % mass, min. Methyl Laurate (C12 ME) content, and JAMA / EN 14214 specs on oxidation stability, glycerides, group metals, density, methanol content & water. Summary table of the PNS is attached as Annex B.

4.6.5. Thrust Towards Harmonization

In the Philippines, no less than our President Gloria Macapagal Arroyo has been advocating for harmonization. The country has thus been involved in projects towards harmonization. It is worth-noting that the thrust towards harmonization is actually not only limited to fuel quality, but also on facilities (including vehicles, engines and parts) giving due consideration on the issue of compatibility. The harmonization thrust also covers codes of practice.

This ERIA BDF Standardization Project is a very welcome development, it being a positive reaction to the call of President Arroyo during the January 2007 East Asian Summit in Cebu City, Philippines for the harmonization of standards for biodiesel.

While there are ASTM and EN standards, there are contentions of them being international since they have been based on select feedstocks, besides being in a different climate and other local conditions. It has been established that properties and behaviors of different biodiesel feedstocks vary, thus supposed standards and test methods cannot just be adopted for different feedstocks. This situation became more obvious as the Working Group Meetings progressed.

Theoretical and empirical data show excellent results for coconut as a feedstock for the blending component (CME) of diesel, with its carbon chain composition closely resembling petroleum diesel. However, since only the Philippines is basically using CME, studies outside the country hardly, if at all, take CME into consideration. Thus CME cannot completely meet the EN 14214 standard, and the Japan guide specification for biodiesel, particularly for iodine number, viscosity and flash point. It is understood, though, that the recognized international standards setting bodies are reviewing these properties and the allowable limits vis-à-vis other more critical specs as oxidation stability.

With coconut as a major agricultural product of the country, and the establishment and accreditation of CME manufacturers, the high export potential of the country cannot be argued. A harmonized standard would thus facilitate trade across boarders, ensuring supply availability and better economics, not only for the fuel, but also for the vehicles. A harmonized fuel standard would also provide better access to improvements in technology, leading to improved air quality, mitigating, if not arresting, global warming and climate change.

4.7. South Korea

4.7.1. Policy and measure of BDF

i) Target and strategy from energy and environment point of view

In Korea, biodiesel has been introduced the following view points.

- Reduction of greenhouse gas
- Energy security
- Utilization of waste cooking oil
- Air quality improvement by reducing soot in diesel vehicles.

To promote biodiesel, "Petroleum Business Act" was changed to "Petroleum & Petroleum Alternative Fuels Business Act" by MOCIE (Ministry of Commerce, Industry and Energy).

ii) Concrete target and strategy for BDF

Figure 4.7.1 shows the sales and targets of biodiesel in Korea. From 2002 to 2005, only BD20 was soled. And from middle of 2006, BD0.5 in diesel oil was introduced by agreement between government and petroleum company, and in that year, 46,000kL was sold for BD0.5. But only few thousand kL of biodiesel was sold for BD20. In this year, more than 90,000 kL of biodiesel will be sold for BD0.5. In September of this year, MOCIE announced that from 2008 to 2012 the mixing ratio of biodiesel in diesel oil will be increased 0.5% per every year, therefore total amount of biodiesel in 2012 will reach 540,000kL which is equivalent to BD3 in diesel oil. But, BD20 will be introduced for fleet vehicles without target. Further increasing toward BD5 in diesel oil will be discussed in 2010

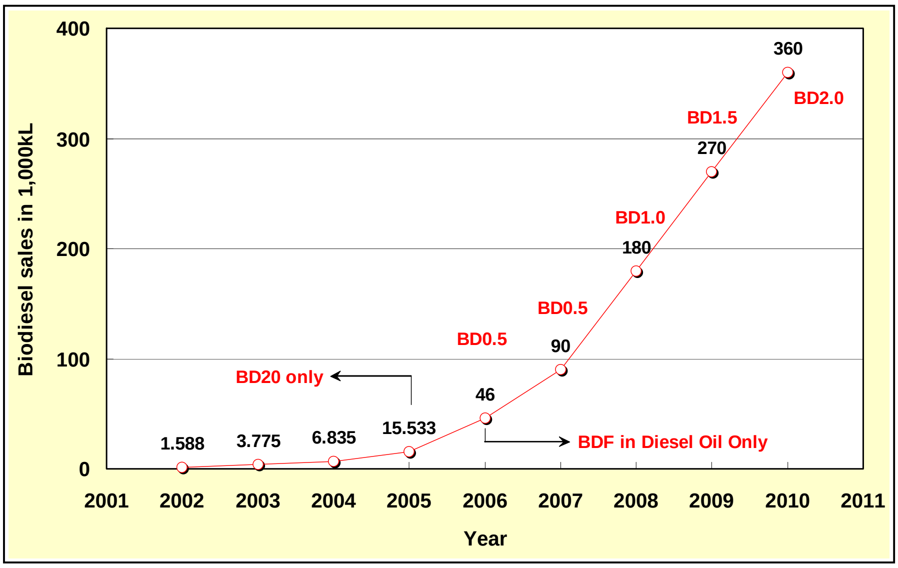


Fig. 4.7.1 Sales and target of biodiesel in Korea

iii) Main crops for BDF and its production planning

In korea, main feedstocks of biodiesel are imported soybean oil and waste cooking oil. In 2006, about 30% of biodisel was made from waste cooking oil. To solve the dependence of the imported feedstock, demo-plantation of rapeseed was started in this year by Ministry of Agriculture and Forestry. And overseas plantation such as Jatropa and soybean oil is now increasing by Korean biodiesel company in Miyanma, Malaysia, Indonesia and so on. There were 2 biodiesel companies in 2002, and now it is increased 19 companies, and current production capacity is above 700,000 tons.

iv) Regulations and incentives to promote BDF utilization

To promote the biodiesel, government has been updated the regulations and incentives. BD20 demonstration program was started from May 2002, but BD20 has been permitted now for fleet vehicles only from 2006 because of warranty problem for automobile. And today, government prefer to introduce biodiesel in shape of diesel oil additive. Therefore, law on the quality standard of diesel oil was changed from 2006, and now FAME can be blended up to 5% in diesel oil and it is treated as ordinary diesel oil.

In current state, the manufacturing cost of biodiesel is higher than diesel oil about 0.3 dollar per liter.

Therefore, government decided tax exemption for Biodiesel from 2002. In the present, sales price of BD100 is lower than diesel oil about 0.2 dollar. However, this taxation policy will be re-examined in 2010.

4.7.2. Standardization of BDF

i) Concept of BDF standards and regulations

In Korea, qualities of BD5(diesel oil), BD20 and BD100 is regulated by government. BD100 is treated as only blend stock. BD5 is treated as diesel oil, BD20 can be used for fleet vehicle only.

Diesel fuel is controlled both BDF produce and blend phase but also sales phase by Petroleum & Petroleum Alternative Fuels Business Act

In Korea, only petroleum company can sell BD5, and only biodiesel company can sell BD20, and they make mixture before selling the products. BD100 selling to other sides is prohibited.

ii) Standards of BDF

In 2002, ASTM D 6751 was used for B100 standard. But, because of warranty problem of automobiles, standard of BD100 has been updated a number of times. And, in the present, standard of BD100 is very close to the European standard of EN 14214 except some items. However, government is now considering to adapt full EN14214 in this year.

Differences between Korean standard and EN 14214 are as followings.

I. Mono-, Di-, Tri-glyceride, free glycerol are omitted now, but they will be included in standard of BD100.

II. Water and contamination is treated in same category, but they will be divided just like EN 14214.

III. However, about the value of iodine number, 120 used in EN 14214 is not suitable for soy bean oil, then another value will be adapted in Korean standard such as 130.

Table 4.7.1. Fuel Specifications (BD100)

Item	Unit	Specification	
		Limit	Test Method
Ester content	mass %	96.5 min	EN 14103 (KS M 2413)
Density (@15 deg.C)	g/cm3	0.86-0.90	ISO 3675 (KS M 2002) ISO 12185
Kinematic viscosity (@40 deg.C)	mm2/s	1.9-5.0	ISO 3104 (KS M 2014)
Flash point	deg.C	120 min	ISO 3679 (KS M 2010)
Sulfur content	mg/kg	10 max	ISO 20846,ISO 20884 (KS M 2027)
10% carbon residue	mass %	0.1 max	KS M ISO 10370
Cetane number		-	-
Ash content	mass %	0.01 max	KS M ISO 6245
Water & contamination	vol. %	500 max	(KS M 2115)
Copper corrosion (100 deg.C, 3h)	rating	1 max	ISO 2160 (KS M 2018)
Oxidation stability (@40 deg.C)	hours	6 min	EN 14112
Acid value	mgKOH/g	0.5 max	KS M ISO 6618
Iodine value	gl/100g	-	-
Linolenic acid methyl ester	mass %	-	-
Methanol content	mass %	0.20 max	EN 14110
Monoglyceride content	mass %	-	-
Diglyceride content	mass %	-	-
Triglyderide content	mass %	-	-
Free glycerol content	mass %	-	-
Total glycerol content	mass %	0.25 max	EN 14105 (KS M 2412)
Metals (Na+K)	mg/kg	5 max	EN 14108 EN 14109
Metals (Ca+Mg)	mg/kg	5 max	EN 14538
Phosporous	mg/kg	10 max	EN 14107
CFPP	deg.C	0 max	KS M 2411
Pour point	deg.C	-	

Table 4.7.2. BD20 standard.

Item	Unit	Specification	
		Limit	Test Method
Ester content	mass %	20 +/- 3	EN 14078
Density (@15 deg.C)	g/cm3	0.815-0.845	ISO 3675 (KS M 2002)
Kinematic viscosity (@40 deg.C)	mm2/s	1.9-5.5	ISO 3104 (KS M 2014)
Flash point	deg.C	40 min	ISO 3679 (KS M 2010)
Sulfur content	mg/kg	30 max	ISO 20846,ISO 20884 (KS M 2027)
10% carbon residue	mass %	0.15 max	ISO 10370 (KS M ISO 10370)
Cetane number (Cetane Index)		45 min	KS M ISO 5165, 4264
Ash content	mass %	0.02 max	KS M ISO 6245
Water & contamination	vol.%	0.02 max	(KS M 2115)
Copper corrosion (100 deg.C, 3h)	rating	1 max	(KS M 2018)
Acid value	mgKOH/g	0.1 max	EN 14104 (KS M ISO 6618)
T90	deg.C	360 max	KS M ISO 3045
Pour point	deg.C	0.0 max (winter -17.5 max)	KS M 2016
CFPP	deg.C	-16 max (winter)	KS M 2411
HFRR(@60 deg.C)	micron	460 max	KS M ISO 12156-1

Table 4.7.3 BD5(diesel oil) standard.

Density	kg/m3	815-845
Kinematic viscosity @40 deg.C	mm2/s	1.9 – 5.5
Flash point	deg.C	40 min
Sulfur content	ppm	30 max
T90	deg.C	360 max
Carbon residue (on 10% distillation residue)	mass%	0.15 max
Cetane index		45 min
Water and Contamination	vol. %	0.02 max
Copper corrosion (100 deg.C, 3h)	rating	1 max
HFRR @60 deg.C	micron	460 max
Poly-aromatics	mass %	11 max
FAME	vol. %	5 max
Pour point	deg.C	0 max - 17.5 max (winter)
CFPP	deg.C	- 16 max (winter)

4.8. Singapore

4.8.1. Policy and measure of BDF

i) Target and strategy from energy and environment point of view

Singapore is a small island state at a size of 25 × 15 miles and area of 699 km2. It has a population of 4.3 millions. Singapore's GDP was US$124 billion in 2006 and with a GDP per-capita of US$28,000. There are more than 7000 multinational corporations in Singapore, attributing to its high rate in competitiveness and globalization indices. Singapore is also a major oil & gas hub in the world, with activities covering exploration and production support services, refining (>1.3 billion bpd), petrochemical and chemical industries, storage, trading, etc.

The energy situation in Singapore is summarized as the followings: the energy needs are almost entirely (>99%) imported as oil and gas for electricity and also feedstocks for refining, petrochemical and chemical industries. The power generation capacity of Singapore is about 10 GW with peak demand at 5.6 GW as at 30 June 07. The electricity market was liberalized with the key restructuring involving the separation of the contestable and non-contestable parts of the electricity market, establishment of an independent system operator and the liberalization of the retail market.

Competition in the electricity market has lead to the introduction of more cost-effective, energy efficient and cleaner natural gas into the market. Natural gas is imported via pipelines from Malaysia and Indonesia and contributes to >70% of power generation output. To diversify its energy sources, Singapore will import LNG and the building of an LNG terminal of capacity 3 mtpa is expected to be completed by around 2012.

As a small city-state with limited indigenous resources, a strong and growing economy is the only means to provide Singapore with the resources to meet the challenges of rising energy prices and climate change. Singapore accounts for ~ 0.15% of the world's CO2 emissions and the government announced to do its fair share as part of the global effort to mitigate greenhouse gas emissions. Singapore acceded to the Kyoto Protocol in 2006 and has been actively looking at "climate change strategy" through improving energy efficiency, setting up carbon trading market, offering CDM projects etc. under the National Climate Change Committee (NCCC) and Climate Change Working Group (CCWG). In 2006, the Energy Policy Group (EPG) was set up to formulate and coordinate Singapore's energy policies and strategies in a more holistic way.

Singapore's energy strategies: The national energy policy framework outlines six key strategies to bring together the Government, industries, business and households to adopt practical and effective measures to strength Singapore's competitiveness, enhance energy security, and protect the environment. They are elaborated as below:

First, to **promote competitive markets**. The Energy Market Authority (EMA) is now piloting the Electricity Vending System, to enable full contestability in the electricity retail market.

Second, to **diversify the energy sources**. Singapore is building a liquefied natural gas terminal to diversify the source of NG. The government is promoting further energy diversification by supporting R&D, test-bedding and demonstration of promising new energy technologies.

The third strategy is to **improve energy efficiency**. The government has developed a comprehensive national energy efficiency plan to promote the adoption of energy efficiency measures, raise public awareness, and build capability in energy efficiency.

Forth, to **develop the energy industry**. Besides growing its oil refining and energy trading sector, Singapore is also pursuing growth opportunities in clean energy, including solar energy, biofuels and fuel cells. The government has committed more than S$300 million to build up its energy R&D capabilities. The goal is to increase the value-added of the energy industry from S$20 billion to S$34 billion by 2015, and to triple the employment in the industry from 5,700 to 15,300. There are some early successes in the clean energy sector in Singapore. In Oct. 2007, Norway's Renewable Energy Corporation announced that they will build a $6.3 billion solar manufacturing complex in Singapore. When completed, it will be the world's largest solar manufacturing facility. In November 2007, Neste Oil also announced their plans to build a biorefinery that will produce NExBTL renewable fuel. With a capacity of 800,000 metric tonnes per annum, the plant will be the largest renewable fuel refinery in the world. In addition, Singapore has attracted investments in biofuels production from Nexsol (joint venture between Peter Cremer and Kulim Group), Continental Bioenergy and Natural Fuels. Singapore will have a biodiesel production capacity of 1,650,000 metric tonnes per annum when these projects are completed.

The fifth strategy is to **set up international cooperation**. Singapore is developing closer relations with key energy producers, and participating actively in energy and energy-related discussions in major fora such as ASEAN, the East Asia Summit, the Asia-Pacific Economic Cooperation, and the United Nations Framework Convention on Climate Change.

Strategy Six is to **take a whole-of-Government approach**. Apart from the Energy Policy Group, several government agencies have formed new units to manage the energy challenges. The Ministry of Trade and Industry now has an Energy Division. The economic Development Board and the National Environment Agency have set up inter-agency programme offices for clean energy and energy efficiency respectively.

The Energy Market Authority has also set up an Energy Policy and Planning Division to plan and review Singapore's energy policies; and develop scenarios for formulation of strategic plans to secure Singapore's energy needs.

ii) Concrete target and strategy for BDF

According to Mr. S. Iswaran, the Minister of State for Trade & Industry of Singapore, in a speech given on 11th September 2007 at the 23rd Asia-Pacific Petroleum Conference in Singapore, it was important to recognize that biofuels have a material role within the Singapore oil industry. Sustained high oil prices have increased the attractiveness of biofuels as an alternative fuel for transportation. Although biofuels might account for only one to two per cent of overall energy demand, its future potential should not be underestimated. Biofuels are likely to be an enduring aspect of the oil industry. Singapore will endeavor to integrate biofuels into its oil industry. However, blending will not be mandated in Singapore, nor are there currently any plans to do so. Nevertheless, Singapore does not rule out any energy options for the future.

In the last 3 years (2004-2006), the Economic Development Board (EDB) of Singapore has made considerable headway in the biofuels sector by jump-starting biodiesel manufacturing on Jurong Island. A number of new biodiesel plants on Jurong Island are close to commencing operations. Singapore’s biodiesel production output is expected to exceed one million tons per annum by 2010, and reach three million tons per annum by 2015. Most of these plants will use palm oil as feedstocks, and increasingly diversifying into non-food feedstocks such as jatropha oil, algal oils and waste cooking oil.

With a baseload of biofuels production in Singapore, we are well-positioned to develop a trading platform for Asia. Today, companies such as Platts, ICIS and Argus Media have set up price assessment for biofuels produced in Singapore and regional countries. Knowing the price of biodiesel is vital to exporters who are planning to establish their production bases here in Singapore to serve both regional and global markets. However, until now, there has been an acute lack of biofuels pricing information, which has hindered the development of the biofuels industry in Southeast Asia. Singapore will be one of the first locations in Asia where biodiesel price assessment will be launched. Singapore's well-established, stable, transparent and reputable trading market, coupled with the robust price assessment processes of companies such as Platt's, would provide investors with a reliable benchmark for the price of biodiesel. This will enable investors to accelerate the development of this new and important industry. Consumers, too, will have a clearer picture of the cost of biodiesel, fostering a more open trading environment. Consequently, the mix, diversity and hedging opportunities for the energy trading community in Singapore will become more vibrant.

The government has committed more than S$300 million to build up its energy R&D capabilities, particularly on clean energy technology (including biofuel). In the following 5-10 years, the 3rd phase biofuel development in Singapore will focus on the 2nd generation biofuel technology for sustainability and differentiation of feedstock supply. The Singapore basic strategies in biomass/bio-fuel R&D are based on (1) leverage on existing strengths in RI's and experiences in working with refining, petrochemicals, chemicals and pharmaceutical companies; (2) whenever possible, adopt holistic, "bio-refinery" approach and environmentally benign processes to process and convert biomass feedstocks to produce fuels, drugs, chemicals and materials; (3) also considering looking at bio-based carbon capture and sequestration. Singapore is confident that these initiatives – growing refinery capacity, entrenching biofuels and advancing technologies – will position Singapore competitively in the global industry landscape.

iii) Main crops for BDF and its production planning

Due to strategic location, well-developed port and terminalling facilities, and proximity to abundant feedstock (palm oil) from Indonesia and Malaysia, Singapore is developing a biofuel hub. The produced biodiesel will be mostly for export.

Biodiesel plants built/building in Singapore:

– Small plants already in operation (e.g. **Biofuel Research Pte Ltd,** 1500 tonnes/month, waste cooking oil as feedstock). The company sells only B100 biodiesel, no blends.

– **Continental Bioenergy** (150,000T per year) started running 2006, multi-feedstock (palm/soy/ jatropha).

– **Nexsol**, joint venture between Germany's **Peter Cremer** and **Kulim Group** from Malaysia, built 100,000 tonne/year biodiesel plant on Jurong Island, using palm oil feedstock. The company plans two additional plants within five years.

– Australia's **Natural Fuel** building a S$199.95 million (US$130 million) state-of-the-art biodiesel production facility, with annual production capacity of 600,000 metric tons (700 million litres) of biodiesel in first phase slated for end 2007.

(Announced in Oct 07 that it will be looking to use jatropha oil instead of palm oil as feedstock).

- **Neste Oil** also announced their plans to build a biorefinery that will produce NExBTL renewable fuel. With a capacity of 800,000 metric tonnes per annum, the plant will be the largest renewable fuel refinery in the world.

iv) Regulations and incentives to promote BDF utilization

There is no government mandate to regulate the use of biofuel in Singapore and therefore the adoption of bio-diesel is highly dependent on free market forces.

The National Environment Agency (NEA) of Singapore is in charge of promoting clean air and setting vehicular emissions standards. NEA allows the use of bio-diesel for vehicles so long as the vehicle operators can demonstrate via certification by reputable independent testing bodies that vehicles using such fuel will be able to meet the prevailing vehicle emission standards.

4.8.2. Standardization of BDF

i) Concept of BDF standards and regulations

In Singapore, bio-diesel can be used for vehicles so long as the vehicle operators can demonstrate via certification by reputable independent testing bodies that vehicles using such fuel will be able to meet the prevailing vehicle emission standards.

Emission standards currently adopted in Singapore for new and in-use motor vehicles:-

The current emission standards for new vehicles and the implementation dates are:

Vehicle Type	**Emission Standard**	**Implementation Date**
Petrol vehicles	EURO II	1 Jan 2001
Diesel vehicles	EURO IV	1 Oct 2006
Motorcycles/scooters	97/24/EC	1 Jul 2003

With effect from 1 Aug 2000, all off-road diesel engines would be required to comply with either Japan, US or EU off-road diesel exhaust emission standards. All in-use vehicles are subject to mandatory inspections periodically to ensure that they comply with the prescribed standards as follows:

(a) Petrol-driven vehicles:

Carbon Monoxide (CO)

- 6% by vol (registered before Oct 1986)

- 4.5% by vol (registered between Oct 1986 and Jul 1992)
- 3.5% by vol (registered on or after Jul 1992)

(b) Diesel-driven vehicles:

Smoke Opacity Limit: 50 HSU

(c) Motorcycles/scooters:

CO - 6% by vol (registered before Oct 1986)
- 4.5% by vol (registered on or after Oct 1986)

ii) Standards of BDF

(1) Current status of BDF standardization

Singapore does not have any National Standards for biodiesel. There is currently negligible biodiesel market in Singapore. Only
three commenced biodiesel producers - Continental Bioenergy, Peter Cremer and Natural Fuel, and their products are for export. International standards are followed for biodiesel producers: European EN14214 and/or ASTM 6751 specifications, depending on the buyer.

(2) Reference standards

European EN14214 and ASTM 6751 specifications are followed.

(3) Remarkable items

Nil.

iii) Specification values

Details of values can be seen in European EN14214 and ASTM 6751 specifications Singapore has the Intertek Testing Services (S) Pte Ltd, Singapore Technical Centre set up on Jurong Island. The methods used for testing biodiesel fuels are provided by Intertek, in the separated sheets.

Intertek

Biodiesel Test Capability Data Sheet

NO.	TEST ITEMS	METHOD
	ASTM D6751	
1	Flash point (closed cup)	D93
2	Water and sediment	D2709
3	Kinematic viscosity, 40°C	D445
4	Sulfated ash	D874
5	Sulfur	D5453
6	Copper strip corrosion	D130
7	Cetane number	D613
8	Cloud point	D2500
9	Micro carbon residue	D4530
10	Total acid number	D664
11	Free glycerine	D6584
12	Total glycerine	D6584
13	Phosphorus content	D4951
14	Distillation temperature, atmospheric equivalent temperature, 90% recovered	D1160
15	Sodium and potassium, combined	EN14538
16	Calcium and magnesium, combined	EN14538
17	Oxidation stability	EN14112
18	Methanol content	EN14110
19	Cetane Number by IQT	D6890

Intertek

Biodiesel Test Capability Data Sheet

NO.	TEST ITEMS	METHOD
	EN 14214	
1	Ester content	EN14103
2	Density at 15°C	EN ISO 12185
3	Kinematic viscosity at 40°C	EN ISO 3104
4	Flash point	EN ISO 3679
5	Sulfur	EN ISO 20846
6	Sulfated ash	ISO 3987
7	Water content	EN ISO 12937
8	Acid value	EN14104
9	Iodine value	EN14111
10	Methanol content	EN14110
11	Monoglyceride content	EN14105
12	Diglyceride content	EN14105
13	Triglyceride content	EN14105
14	Free glycerol	EN14105
15	Total glycerol	EN14105
16	Group 1 metals (Na+K)	EN14108/9
	Group 2 metals (Ca+Mg)	pr EN14538
17	Carbon residue (on 10% distillation residue)	D1160/ EN ISO 10370
18	Cetane number	EN ISO 5165
19	Total contamination	EN12662
20	Copper strip corrosion (3hrs at 50°C)	EN ISO 2160
21	Oxidation stability, 110°C	EN14112
22	Linolenic acid methyl ester	EN14103
23	Phosphorus content	EN 14107

4.9. Thailand

4.9.1. Policy and measure of BDF

i) Target and strategy from energy and environment point of view

In 2006, Thailand final energy consumption accounted about 15.6 % of the Gross Domestic Product (GDP), which had been decreasing gradually from the average of 16.4 % in 2002. The fossil fuel resources in Thailand are limited and inadequate to meet the national energy demand and rely over 90 percent on imported energy. The final energy consumption amounted to 63,257 thousand tons of oil equivalent (ktoe) with the import of 58,753 ktoe. In 2006 the energy import value was 873,565 million Baht which had been increasing continuously in the past 5 years. Table 4.9.1 shows the final energy consumption, energy imported, and its value during 2002-2006.

Table 4.9.1. Final energy consumption, energy imported and its value.

Description	Year				
	2002	2003	2004	2005	2006
Final energy consumption, ktoe	52,979	56,289	61,262	62,395	63,257
Energy imported, ktoe	47,455	51,316	57,714	57,333	58,753
Value of energy imported, million Baht	336,388	407,752	560,702	753,842	873,565

Source: Energy report 2006, http://www.dede.go.th

The country's high dependence on fossil fuel affects the national energy security and the increasing of environmental problems. Consequently, the Ministry of Energy has set up Energy Strategy for Competitiveness to strengthen the national energy security and competitiveness. The National Energy Policy Council (NEPC) and the Cabinet approved the recent national energy policy and development plan for the short term and long term strategies in November 2006. The implementation under the plan will be carried out in the following aspects:

Short term

1. Restructure and improve the energy industry management
2. Procure energy
3. Promote energy conservation and energy efficiency
4. Promote alternative energy suitable for Thailand
5. Establish the energy price structure
6. Establish measures pertaining to clean energy

7. Promote the private sector and general public participation in policy making

Long term

1. Energy supply
2. Sustainable energy development
3. Energy efficiency
4. Promote competition in the energy business

The promotion of alternative energy for Thailand includes the use of natural gas for vehicles or NGV, gasohol, and biodiesel instead of using fossil oil in the transport sector. Statistics show that over 72% of the energy was mainly consumed by manufacture and transportation sectors during 2002-2006 as shown in Table 4.9.2.

Table 4.9.2. Final Energy Consumption by Economic Sector.

Unit: ktoe

Economic sectors	Year				
	2002	2003	2004	2005	2006
Agriculture	3,032	3,308	3,520	3,207	3,312
Manufacture	18,679	19,988	21,961	22,643	23,442
Transportation	19,636	20,927	22,812	23,491	22,985
Residential and Commercial	11,377	11,799	12,667	12,779	13,249
Others	255	267	302	275	269
Total, ktoe	**52,979**	**56,289**	**61,262**	**62,395**	**63,257**

Source: Energy report 2006, http://www.dede.go.th

The use of renewable energy shared about 3 % of the commercial primary energy consumption in 2005. The strategic plan for renewable energy has set up a target to 8% of the commercial primary energy consumption by the year 2011. Of this amount, 1% is set for the electricity generation by solar, wind, micro-hydro, municipal solid waste (MSW) and biomass, 3% is set for biofuel and 4% is set for heat generation by MSW and biomass as shown in Fig.4.9.1. In order to meet the target, such several measures as renewable portfolio standard (RPS), feed-in tariff, incentives, and R&D are actively provided.

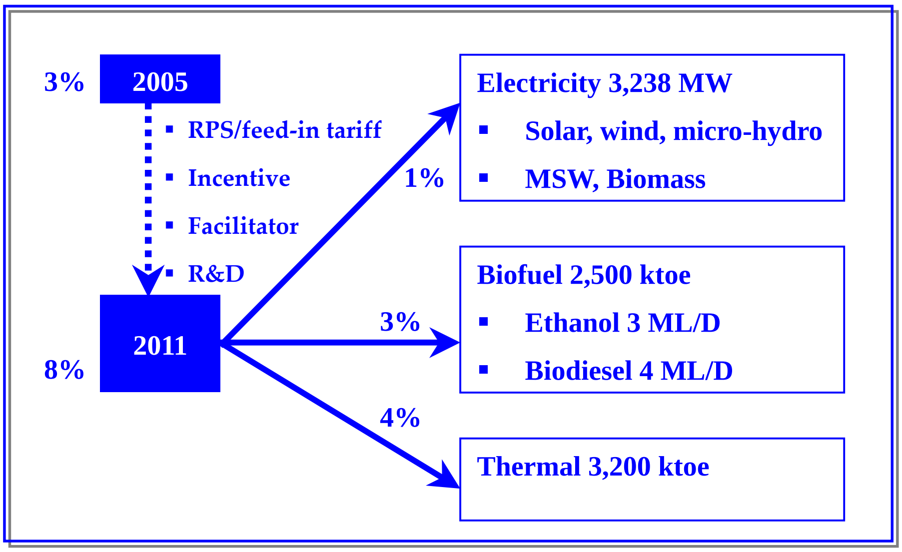


Fig.4.9.1 Strategy for renewable energy development

ii) Concrete target and strategy for BDF

In 2005, Thailand developed the strategic plan for biodiesel promotion and development. Under the national biodiesel policy, biodiesel is promoted to be produced domestically and targeted to replace diesel consumption by 10% in 2012. The national strategic plan for development and promotion on the use of biodiesel fuel classifies biodiesel production into 2 categories, which are community-based biodiesel production and commercial-based biodiesel production. The community-based biodiesel is used for agricultural machines in the communities, while commercial biodiesel is used to be blended with normal diesel for selling at gasoline service stations.

The action plan on biodiesel promotion and development was set in May 2005 as the following:

- Promotion of oil palm plantation by 0.8 million hectares by 2009.
- Promotion of community-based biodiesel production and use during 2005-2006
- Promotion of commercial biodiesel production and B5 use from 2007
- Enforcement of B2 nationwide by April 2008, while B5 is optionally used.
- Enforcement of B5 nationwide in 2011.
- Enforcement of B10 nationwide in 2012.

iii) Main crops for BDF and its production planning

Oil crops in Thailand are oil palm, soybean, coconut, castor, and sunflower.

Recently, the Office of Agricultural Economics reported the harvesting area and production volume of oil crops in Thailand during 2004-2006 as shown in Table 4.9.3. In 2006, oil palm presented as the main oil crop in which its harvesting area and production were 379,840 hectares and 6,241,000 tons. Palm oil shows its potential to be the feedstock for commercial biodiesel production for Thailand.

Table 4.9.3. Harvesting area and production volume of oil crops during 2004-2006.

Oil crops	2004		2005		2006	
	Harvested area (Hectares)	Production (Tons)	Harvested area (Hectares)	Production (Tons)	Harvested area (Hectares)	Production (Tons)
Oil Palm	309,120	5,182,000	324,160	5,003,000	379,840	6,241,000
Soybean	144,320	218,000	144,160	226,000	143,840	225,000
Coconut	270,400	2,126,000	265,440	1,871,000	225,760	1,561,000
Castor	13,280	10,000	13,440	10,000	13,440	11,000
Sunflower	28,640	49,000	42,080	38,000	33,280	24,000

Source: Office of Agricultural Economics 2006, http://www.oae.go.th

Oil palm is the main feedstock for biodiesel production for Thailand. To meet the target of the national strategic plan for biodiesel development and promotion on the use of biodiesel fuel, the feedstock supplied for the biodiesel production is promoted accordingly. It is planned to promote oil palm plantation area to 5 million rais or 0.8 hectares by 2009. According to the plan, in addition, its productivity will be improved to be 3.0-3.5 ton/rai or 18.75-21.87 ton/hectare

Beside oil palm, jatropha and waste cooking oil also shows its potential to be the feedstocks for community-based biodiesel production. At present, several R&D studies report the production of biodiesel from jatropha or physic nut oil (*Jatropha curcas* Linn) in Thailand. However, there are no report on harvesting area and production of jatropha. It is only planted in the experimental stations.

iv) Regulations and incentives to promote BDF utilization

The National Energy Policy Council (NEPC) has established measures to promote biodiesel utilization in Thailand. The measure includes regulations and incentives for biodiesel production and blends. Prior to getting the permission to sell B100 from the facility, it is necessary for the biodiesel producer to register or get approval from the Department of Energy Business (DOEB). The incentives provided to the oil blender are the tax exemption and payment exemption to the Oil Fund for B100. In addition, oil blender or oil trader get compensation for the price of biodiesel B100 from the Oil Fund. The DOEB also sets the retail price for 5% FAME blended diesel oil or so-called diesel oil B5, which is cheaper than high speed diesel by 0.70 baht/Litre.

4.9.2. Standardization of BDF

i) Concept of BDF standards and regulations

The Department of Energy Business under the Ministry of Energy set up the standard specifications for commercial-based and community-based biodiesel. The standard of commercial biodiesel, Fatty Acid Methyl Ester or so-called B100 was established by using EN 14214:2003 as a guideline. The FAME standard has been enforced since October 1, 2006. The B100 is used to be a FAME blend stock in high speed diesel oil. As of January 2007, there are 500 oil service stations selling B5 nationwide.

The community-based biodiesel is used for agricultural engines in the communities and not allowed to be sold at any gasoline service stations. Its standard specifications were notified on July 21, 2006.

ii) Standards of BDF

(1) Current status of BDF standardization

(2) Reference standards EN 14214:2003

(3) Remarkable items

iii) Specification values

Thailand has set the specification for FAME or commercial biodiesel for blend stock while the specifications of blended diesel fuel are determined to be the same as the high speed diesel fuel. Test methods for the determination fuel properties follow both EN and ASTM standards as shown in the Table 4.9.4 shows the standard specifications of biodiesel, fatty acid methyl esters or known as commercial-based biodiesel.

Table 4.9.4. Thailand standard specification of biodiesel B100-FAME.

Item	Fuel properties,	Unit	Specification		
			Limit		Test method
1.	Methyl ester	% wt	Min	96.5	EN 14103
2.	Density at 15° C	kg/m^3	Min Max	860 900	ASTM D 1298
3.	Viscosity at 40°C	CSt	Min Max	3.5 5.0	ASTM D 445
4.	Flash Point	°C	Min	120	ASTM D 93
5.	Sulphur	% wt.	Max	0.0010	ASTM D 2622
6.	Carbon Residue on 100% distillation residue	% wt	Max	0.30	ASTM D 4530
7.	Cetane Number		Min	51	ASTM D 613
8.	Sulfated Ash	% wt.	Max	0.02	ASTM D 874
9.	Water	% wt.	Max	0.050	EN ISO 12937
10.	Total Contamination	% wt.	Max	0.0024	EN 12662
11.	Copper Strip Corrosion		Max	No. 1	ASTM D 130
12.	Oxidation Stability at 110°C	hours	Min	6	EN 14112
13.	Acid Number	mg KOH/g	Max	0.50	ASTM D 664
14.	Iodine Value	g Iodine/100 g	Max	120	EN 14111
15.	Linolenic Acid Methyl Ester	% wt.	Max	12.0	EN 14103
16.	Methanol	% wt.	Max	0.20	EN 14110
17.	Monoglyceride	% wt.	Max	0.80	EN 14105
18.	Diglyceride	% wt.	Max	0.20	EN 14105
19.	Triglyceride	% wt.	Max	0.20	EN 14105
20.	Free glycerin	% wt.	Max	0.02	EN 14105
21.	Total glycerin	% wt.	Max	0.25	EN 14105
22.	Group I metals (Na+K) Group II metals (Ca+Mg)	mg/kg mg/kg	Max Max	5.0 5.0	EN 14108 and EN 14109 prEN 14538
23.	Phosphorus	% wt.	Max	0.0010	ASTM D 4951
24.	Additives	Approved by DG of DOEB			

Source: Government Gazette, Volume 122, Special Section 70, 24 August 2005, p 12.

5. BENCHMARK STANDARD OF BIODIESEL FUEL IN EAST ASIA

5.1. Concepts of Harmonized Specification

To harmonize the specification of biodiesel fuel, the concepts were discussed as follows.

(1) Based on European standard (EN14214)

The subject of this WG is only focused on FAME (Fatty Acid Methyl Ester) as a biodiesel fuel. EN14214 is recognized as a comprehensive specification for FAME, and so this WG discussed the harmonized specification based on EN14214.

(2) Consideration of various oils

EN14214 is set for rapeseed oil only. There is a need to consider other feedstocks used in the East region, such as:

Coconut: low viscosity and flashpoint

Soybean: Iodine number

(3) Oxidation stability

Oxidation stability has critical impact on fuel tanks made of metals. In Europe, fuel tanks of vehicle are mainly made of plastics or resin. However in Asia, metal tanks are popular for vehicles. Oxidation stability value of "10 hours", which was recommended by Japan Automobile Manufacturers Association, Inc. (JAMA), is based to prevent metal tank corrosion.

(4) Polyunsaturated FAME

Polyunsaturated FAME was mainly included in fish oil. It accelerates oxidation degradation and sludge production, however, the measurement method has not been developed. Polyunsaturated (more than 4 double bonds) FAME need to be excluded.

5.2. Benchmark Standard of Biodiesel Fuel in East Asia

WG for Standardization of Biodiesel Fuel for Vehicles in East Asia made an "EAS-ERIA Biodiesel Fuel Benchmark Standard". This is a benchmark standard suggested for member countries for the purpose of harmonizing biodiesel standards in East-Asia.

This standard is for B100 aimed for low level blending with diesel fuel. In case of the use as a final fuel, further considerations are necessary, especially in regards to oxidation stability.

(1) Specification of Benchmark Standard of Biodiesel Fuel in East Asia

Table 5.2.1 shows "EAS-ERIA Biodiesel Fuel Benchmark Standard" compared to other existing standards.

Table 5.2.1 EAS-ERIA Biodiesel Fuel Benchmark Standard compared to other existing standards

Items	Units	U.S.	EU	Japan	EAS-ERIA Biodiesel Fuel
		ASTM D6751-07b	EN14214:2003	JIS K2390:2008	Benchmark Standard:2008
Ester content	mass%	-	96.5 min.	96.5 min.	96.5 min.
Density	kg/m3	-	860-900	860-900	860-900
Viscosity	mm2/s	1.9-6.0	3.50-5.00	3.50-5.00	2.00-5.00
Flashpoint	deg. C	93 min.	120 min.	120 min.	100 min.
Sulfur content	mass%	0.0015 max.	0.0010 max.	0.0010 max.	0.0010 max.
Distillation, T90	deg. C	360 max.	-	-	-
Carbon residue (100%) or	mass%	0.05 max. -	- 0.30 max.	- 0.3 max.	0.05 max. 0.3 max.
Cetane number		47 min.	51.0 min.	51.0 min.	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.02 max.	0.02 max.
Water content	mg/kg	0.05[vol%] max.	500 max.	500 max.	500 max.
Total contamination	mg/kg	-	24 max.	24 max.	24 max.
Copper corrosion		No.3	Class-1	Class-1	Class-1
Acid value	mgKOH/g	0.50 max.	0.50 max.	0.50 max.	0.50 max.
Oxidation stability	hrs.	3 min.	6.0 min.	(**)	10.0 min. (****)
Iodine value		-	120 max.	120 max.	Reported (***)
Methyl Linolenate	mass%	-	12.0 max.	12.0 max.	12.0 max.
Polyunsaturated FAME (more than 4 double bonds)	mass%	-	1 max.	N.D.	N.D. (***)
Methanol content	mass%	0.2 max. (*)	0.20 max.	0.20 max.	0.20 max.
Monoglyceride content	mass%	-	0.80 max.	0.80 max.	0.80 max.
Diglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.
Triglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.
Free glycerol content	mass%	0.020 max.	0.02 max.	0.02 max.	0.02 max.
Total glycerol content	mass%	0.240 max.	0.25 max.	0.25 max.	0.25 max.
Na+K	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.
Ca+Mg	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.
Phosphorous content	mg/kg	10 max.	10.0 max.	10.0 max.	10.0 max.

“JIS K2390:2008” was established based on “JASO M360:2006” in Feb. 20, 2008. These specifications using in JIS K2390:2008 are same values to JASO M360:2006.

(*) 130 deg.C of flashpoint is available instead of measuring methanol content

(**) Meet diesel oil specification

(***) Need data check and further discussion

(****) Need more data & discussion from 6 to 10 hours

(2) General comments for the standard

Oxidation stability

More data and discussion is necessary to determine the actual induction period, which will be between 6 to 10 hours. The oxidation stability of biodiesel fuel may vary to the climate and environment. So, engine test is needed to support and set the hours required for the oxidation stability. (In Thailand, tests concerning to the oxidation stability are conducted, right now.)

Cetane number

Normally, in case of which a specification value is set into a standard, the property

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Items	Units	U.S.	EU	Japan	EAS-ERIA Biodiesel Fuel
		ASTM D6751-07b	EN14214:2003	JIS K2390:2008	Benchmark Standard:2008
Ester content	mass%	-	96.5 min.	96.5 min.	96.5 min.
Density	kg/m3	-	860-900	860-900	860-900
Viscosity	mm2/s	1.9-6.0	3.50-5.00	3.50-5.00	2.00-5.00
Flashpoint	deg. C	93 min.	120 min.	120 min.	100 min.
Sulfur content	mass%	0.0015 max.	0.0010 max.	0.0010 max.	0.0010 max.
Distillation, T90	deg. C	360 max.	-	-	-
Carbon residue (100%) or	mass%	0.05 max. -	- 0.30 max.	- 0.3 max.	0.05 max. 0.3 max.
Cetane number		47 min.	51.0 min.	51.0 min.	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.02 max.	0.02 max.
Water content	mg/kg	0.05[vol%] max.	500 max.	500 max.	500 max.
Total contamination	mg/kg	-	24 max.	24 max.	24 max.
Copper corrosion		No.3	Class-1	Class-1	Class-1
Acid value	mgKOH/g	0.50 max.	0.50 max.	0.50 max.	0.50 max.
Oxidation stability	hrs.	3 min.	6.0 min.	(**)	10.0 min. (****)
Iodine value		-	120 max.	120 max.	Reported (***)
Methyl Linolenate	mass%	-	12.0 max.	12.0 max.	12.0 max.
Polyunsaturated FAME (more than 4 double bonds)	mass%	-	1 max.	N.D.	N.D. (***)
Methanol content	mass%	0.2 max. (*)	0.20 max.	0.20 max.	0.20 max.
Monoglyceride content	mass%	-	0.80 max.	0.80 max.	0.80 max.
Diglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.
Triglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.
Free glycerol content	mass%	0.020 max.	0.02 max.	0.02 max.	0.02 max.
Total glycerol content	mass%	0.240 max.	0.25 max.	0.25 max.	0.25 max.
Na+K	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.
Ca+Mg	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.
Phosphorous content	mg/kg	10 max.	10.0 max.	10.0 max.	10.0 max.

"JIS K2390:2008" was established based on "JASO M360:2006" in Feb. 20, 2008. These specifications using in JIS K2390:2008 are same values to JASO M360:2006.

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(2) General comments for the standard

Oxidation stability

More data and discussion is necessary to determine the actual induction period, which will be between 6 to 10 hours. The oxidation stability of biodiesel fuel may vary to the climate and environment. So, engine test is needed to support and set the hours required for the oxidation stability. (In Thailand, tests concerning to the oxidation stability are conducted, right now.)

Cetane number

Normally, in case of which a specification value is set into a standard, the property has to be measured. However, cetane numbers of FAME are almost always higher than 51. There were some comments about the necessity to set the cetane number into the standard.

(3) Additional opinions

From Indonesia

The proposed specification is considered

- too complicated
- contain too many parameters
- is presumed still not very effective

It requires the measurements of the individual concentration of many substances ‘accused’ to cause a few deleterious effects of the biodiesel rather than the direct measurements of the tendencies to result in those few deleterious effects.

As such, the proposed standard also neglects the possibility of synergistic and antagonistic interactions between those undesirable substances/contaminants.

If the following two test methods could be developed, these would probably replace such quality parameters as iodine value and concentrations of methyl linolenate, polyunsaturated FAME, mono-, di-, and triglycerides.

- a direct thermal stability test
- a satisfactory oxidation stability test

ERIA Working Group is suggested to cooperatively develop these two stability test methods.

From Philippines

- It is need to provide test methods for the different properties/parameters. As earlier indicated, the Philippines have developed a modified method for tests using the AOCS as base standard.
- It is also need to categorize items/parameters as mandatory or suggested (periodic, for information/record purposes only). This will avoid very high cost for the biodiesel producers because tests shall be required for all mandatory items for all batches of production.

6. MINUTES OF EACH MEETING

6.1. Minutes of the 1st Meeting

Minutes of 1st Meeting of ERIA Working Group for the Standardization of Biodiesel Fuel for Vehicles in East Asia

ERIA Working Group
for the Standardization of Biodiesel Fuel for Vehicles in East Asia
Minutes of the 1st Meeting

July 17-18, 2007 in Tsukuba, Japan

1. Date July 17, 18, 2007

Venue Network Meeting Room, AIST Tsukuba HQ bldg. 1F,
National Institute of Advanced Industrial Science and Technology AIST

2. Participants

7Countries: Australia, Indonesia, Japan, Malaysia, New Zealand, Philippine, Thailand
Unregistered: China, India, Korea, Vietnam

3. Opening ceremony

Opening speech by Dr. Goto WG Leader
Opening address by Dr. Kamimoto (Research Coordinator for Environment and Energy, AIST))

4. Outline of ERIA Energy Project & Introduction of Biofuels Utilization Trend

Explanation of outline of ERIA Energy Project by Dr. Goto

5. Japan: Quality control of FAME blended diesel oil and FAME standard in Japan

Presentation about concepts and regulation value of Japanese regulation by Dr. Shiotani

6. Introduction of Biofuels Utilization Trend

Introduction of Biofuels Utilization Trend in each country by oversea members
The amount of introduction and the outline of a standard are referring to Closing Address.

7. How to control the fuel qualities of FAME

"Oxidation stability of FAME" by Prof. Yamane

"JAMA's Recommendation on Bio Diesel Specification" by Mr. Takei

Mr. Takei explained about Idea for Harmonized B100 Spec. by JAMA.

All members recognized the need of harmonized specification

8. Special Lecture

"The global rend of bio fuels" and "A general overview of combustion research activities in the University of Wisconsin" by Prof. Foster (University of Wisconsin)

9. Next generation Technologies of Biodiesel Fuels

"Upgrading of FAME by hydrogenation" by Dr. Yoshimura (AIST)

"The development of Bio Hydro-fined diesel "BHD"" by Mr. Saitou (Nippon Oil Corporation)

"Synthesis of BTL Fuel from Woody Biomass" by Dr. Murata (AIST)

10. Schedules of next WG's

Future meetings will be held at following schedule

2nd meeting : late September at Thailand

3rd meeting : early Novemver at Japan

4th meeting : February at Thailand

Harmonized FAME Specification will be discussed in 2nd meeting

Proposal of common statement about FAME standard will be considered as accomplishment of this WG.

6.2. Minutes of the 2nd Meeting

ERIA Working Group
for the Standardization of Biodiesel Fuel for Vehicles in East Asia
Minutes of the 2nd Meeting
October 2-3, 2007 in Bangkok, Thailand

Participating Countries:
Australia, Indonesia, Japan, Malaysia, New Zealand, Philippines, Korea, Thailand
(without the participation of China, India and Vietnam)

October 2: Tour of Thailand Institute of Scientific and Technological Research (TISTR)
The working group members visited TISTR to see BDF related facilities which arranged by Ms. Peesamai, Deputy Governor of TISTR.

Main facilities
BDF analysis equipment
BDF production facility (pilot plant)
Equipment for biomass gasification and thermal decomposition (charcoal, piece of wood)
Methane fermentation and hydrogen decomposition system by using waste product

October 3: Working Group Meeting

1. Opening address

Dr. Shinichi Goto, the working group leader, reported that the importance of BDF standards was mentioned in the joint statement at the 1st EAS Energy Ministers' Meeting (EMM1) held on 23 August in Singapore. He also insisted that the working group should accelerate discussion on common BDF standards as ISO and APEC started such activities. Lastly, he explained the preparation of a final report and asked the members' cooperation.

2. Introduction of the check points for BDF standardization

Dr. Hitoshi Shiotani of AIST made a presentation on the idea for BDF common specification and explained the draft standard proposed by Japan.

3. Introduction of current status on BDF

Introduction of current status on BDF was made from each member, along the template informed beforehand.

4. Discussion on FAME standardization

A lot of feedback about the proposed standard presented by Japan was seriously examined by all members, and the tentative target value was set as follows. The members agreed to review it with the relevant people in their countries.

Item	Unit	EN14214	JASO M360	Specification on ERIA PJ Oct.3.2007 (Tentative)
Ester content	mass%	96.5 min.	96.5 min.	96.5 min.
Density	g/cm^3	0.860 - 0.900	0.860 - 0.900	0.860 - 0.900
Viscosity	mm^2/s	3.50 - 5.00	3.50 - 5.00	2.00 - 5.00
Flash point	deg C.	120 min.	120 min.	100 min.
Sulfur content	mass%	0.0010 max.	0.0010 max.	0.0010 max.
Carbon residue (10%)	mass%	0.3 max.	0.3 max.	0.3 max.
Cetane number		51.0 min.	51.0 min.	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.02 max.
Water content	mg/kg	500 max.	500 max.	500 max.
Total contamination	mg/kg	24 max.	24 max.	24 max.
Copper strip corrosion		1	1	1
Oxidation stability	hr.	6 min.	Meet diesel oil specification	10 min. (*1)
Total acid number	mgKOH/g	0.50 max.	0.50 max.	0.50 max.
Iodine number		120 max.	120 max.	Reported
Methyl linolenate	mass%	12.0 max.	12.0 max.	12.0 max.
Polyunsaturated FAME	mass%	1.0 max.	Not Detected	Not Detected (*2)
Methanol content	mass%	0.20 max.	0.20 max.	0.20 max.
Monoglyceride	mass%	0.80 max.	0.80 max.	0.80 max.
Diglyceride	mass%	0.20 max.	0.20 max.	0.20 max.
Triglyceride	mass%	0.20 max.	0.20 max.	0.20 max.
Free glycerol	mass%	0.02 max.	0.02 max.	0.02 max.
Total glycerol	mass%	0.25 max.	0.25 max.	0.25 max.
Na+K	mg/kg	5.0 max.	5.0 max.	5.0 max.
Ca+Mg	mg/kg	5.0 max.	5.0 max.	5.0 max.
Phosphorous	mg/kg	10.0 max.	10.0 max.	10.0 max.

*1 JAMA and AIST will check the data

*2 need further discussion

Tentative target value on the WG

Viscosity: 2.00-5.00

Flash point: over 100 deg. C

Oxidation stability: over 10 Hr

Polyunsaturated FAME : Need further discussion

Iodine number: Just report (not to be fixed)

1. Future work for ERIA project

The members discussed further activities next year and agreed to work for;

Measurement of FAME contents (applicable to coconuts oil FAME)

Measuring method of sludge

Quality control at fueling stations

2. Next meeting Schedule

The third meeting: 29-30 November, 2007 in Kyoto, Japan

The forth meeting: February, 2008 in Australia (Tentative)

3. Participating countries

The involvement of Singapore in the working group is desirable. Ms. Monsada will recommend an appropriate representative by the next meeting.

6.3. Minutes of the 3rd Meeting

ERIA Working Group
for the Standardization of Biodiesel Fuel for Vehicles in East Asia
Minutes of the 3rd Meeting
November 29-30, 2007 in Kyoto/Osaka, Japan

Participating Countries:
Australia, China, Indonesia, Japan, Malaysia, New Zealand, Philippines, Singapore and Thailand
(-without participation from India and South Korea)

November 29: Tour of Kyoto Municipal Waste Edible Oil Fuel Production Facility
DVD-based introduction of the facility and the tour were conducted, and many inquiries came up from foreign members.
They seemed to obtain useful information on the actual production process through the tour.

November 30: Working Group Meeting
1. **Session I –Introduction of status of BDF in China and Singapore-**
China: Dr. Wugao Zhang
Since 2006, biodiesel fuel suddenly booming, many private and state-owned enterprises, even foreign countries, have entered this field. The production ability is more than 100 thousand tons/year, but the real production scale is less than 20 thousand tons/year.
The raw materials are mainly waste industry oil and waste cocking oil, which have more economic advantages than fossil oil.
The national specifications for B5 or B10 are under discussion, and will be published next year.
Un-compulsory standard for FAME blended diesel fuel have been established this year.
Singapore: Dr. Rong Yan
Singapore is major oil and gas hub in East Asia.
Large scaled biodiesel fuel production facilities are built by cooperate initiative.
However a rise of the price of palm oil cause various problems.
Singapore does not have any national standard even for conventional fuels. It is important to meet EN or ASTM Standards, and it is also essential to comply with exhaust emission regulation, EURO-IV.

2. **Session II –Oxidative and thermal degradations of biodiesel and possible methods for determining related stabilities -**

Indonesia: Dr. Tatang Hernas Soerawidjaja

The mechanism of oxidative degradations and thermal degradations was explained, and the current and alternative test methods of sludge formation and thermal degradations were introduced.

3. **Session III –Benchmarking of BDF standards in EAST Asia-**

Japan (AIST): Mr. Shingo Ozawa

This presentation was made for the main theme of the working group, “common BDF specification ” .

The Japanese opinion “Oxidation stability and unsaturated FAME”, which was a pending issue of the 2^{nd} meeting’s, was reported.

Oxidation stability:

As explained heretofore, 10Hr is necessary to prevent metal tank corrosion.

Mr. Takei, a representative of JAMA, informed that EU auto-manufacturers had the same opinion because of many injector deposit problem occurred since this year.

Polyunsaturated FAME:

Polyunsaturated FAME is contained in only fish oil, and the result of conformity test by METI showed that 1% unsaturated FAME caused a significant increase of sludge formation.

Discussion on common BDF specification:

With regard to improvement of oxidation stability 6Hr of EN standard to 10Hr of Japanese proposal, there were some opinions from foreign members.

All members agreed to summarize this WG’s common biodiesel fuel specification in “One table with note”.

As for unsaturated FAME, Japanese Proposal “Not detected” was accepted.

< Proposed common BDF specification on WG >

Items	Units	U.S. ASTM D6751-07a	EU EN14214	JASO JASO M360	Specification on ERIA PJ Nov.30.2007
Ester content	mass%	–	>96.5	>96.5	>96.5
Density	kg/m3	–	0.860-0.900	0.860-0.900	0.860 - 0.900
Viscosity	mm2/s	1.9-6.0	3.50-5.00	3.50-5.00	2.00-5.00
Flashpoint	℃	>130	>120	>120	>100
Sulfur content	mass%	<0.0015	<0.0010	<0.0010	<0.0010
Distillation property	℃	<360 (T90)	–	–	–
Carbon residue (100%)	mass%	<0.05	–	–	–
Carbon residue (10%)	mass%	–	<0.30	<0.3	<0.3
Cetane number		>47	>51.0	>51.0	>51.0
Sulfated ash	mass%	<0.02	<0.02	<0.02	<0.02
Water content	mg/kg	<0.05[vol%]	<500	<500	<500
Total contamination	mg/kg	–	<24	<24	<24
Copper corrosion		No.3	Class-1	Class-1	Class-1
Acid value	mgKOH/g	<0.5	<0.50	<0.50	<0.50
Oxidation stability	hr.	>3	>6.0	(*)	>10
Iodine value		–	<120	<120	Reported
Methyl Linolenate	mass%	–	<12.0	<12.0	<12.0
Polyunsaturated FAME	Mass%	–	<1	(**)	N.D.
Methanol content	mass%	<0.2	<0.20	<0.20	<0.20
Monoglyceride content	mass%	–	<0.80	<0.80	<0.80
Diglyceride content	mass%	–	<0.20	<0.20	<0.20
Triglyceride content	mass%	–	<0.20	<0.20	<0.20
Free glycerol content	mass%	<0.02	<0.02	<0.02	<0.02
Total glycerol content	mass%	<0.24	<0.25	<0.25	<0.25
Na+K	mg/kg	<5	<5.0	<5.0	<5.0
Ca+Mg	mg/kg	<5	<5.0	<5.0	<5.0
Phosphorous content	mg/kg	<10	<10.0	<10.0	<10.0

* To meet diesel fuel specifications

** Mentioned in requirement as "Should not included"

4. Making Database –Energy and Automobile Situations in East Asia Countries-

Japan (AIST): Dr. Mitsuharu Oguma

He explained the necessity to make a database, asked the members to collect the data of energy and automobile situations.

It is desirable to use prepared templates.

<u>Date for data submission from each countries: 19th Jan. 2008</u>

AIST will organize the data gathered from the members.

5. Schedule of Next meeting (the forth meeting)

Date: the week of 19th Feb, 2008.

Venue: Manilla, Philippines. Ms. Zenaida Ygnacio Monsada will inform Dr. Goto of the possibility.

Agenda: final report and database.

6. Future work for ERIA project

The following items were proposed,

New raw materials and new production method

Study for test method for sludge and oxidation stability

Evaluation method for thermal degradation

Study for Fatty Acid Ethyl Ester (FAEE)

6.4. Minutes of the 4th Meeting

ERIA Energy Project

Working Group for Standardization of Biodiesel Fuel for Vehicles in East Asia

Minutes of the 4th Meeting

February 21-22, 2008 in Manila, Philippines

Written by Mitsuharu OGUMA, AIST, Japan

Participating Countries:

China, Indonesia, Japan, Malaysia, New Zealand, Philippines, Singapore and Thailand (Absence: Australia and South Korea)

February 21: Technical Tour "Coconut Oil Production Facility"

Venue: Chemrez Technologies Inc. (65 Industria St., Bagumbayan Quezon City, 1110 MM, Pilippines

- 60 million litters/year of coco-biodiesel producer's Plant was visited.
- A lot of information of coco-biodiesl was introduced, using ppt slides from the staffes.
- A few chemical analysis rooms were shown.
- In front of the plant facilities, the outlines of the facility were explained.

February 22: Working Group Meeting

1. "Information of Project leaders Meeting and ECTF" from Dr. Goto, Japan

- Dr. Goto informed the progress of ERIA energy project leaders meeting as this WG leader.
- Our progresses were usually reported to Energy Ministers Meeting, Economic Ministers Meeting and Energy Cooperation Task Force (ECTF) of East Asia Summit (EAS).
- Japan would like to finalize the Standard of Biodiesel Fuel for Vehicles in East Asia as a Benchmark in this meeting.

2. "Progress of Final Report and Discussion on Each Country's Comments for EAS-ERIA BDF Benchmark Standards" from Dr. Oguma, Japan

- Which countries did not submit the final report, annotation for the benchmark standard and data for database were checked, then, modified schedules of making final report and database were explained from Dr. Oguma.
- Each country's comments for the benchmark standard were discussed in detail.
- The final style of our "EAS-ERIA Biodiesel Fuel Benchmark Standard" in the final report was decided as follows;

(1) The following sentences should be explained clearly in the final report.

- Working Group for Standardization of Biodiesel Fuel for Vehicle in East Asia made an "EAS-ERIA Biodiesel Benchmark Standard". This is a benchmark standard suggested for member countries for the purpose of harmonizing biodiesel standards in East-Asia.
- This standard is B100 aimed for blending in diesel fuel.
- In case of the use as a final fuel for B100.......

(2) The final style of our "EAS-ERIA Biodiesel Fuel Benchmark Standard" in the final report as follows.

Items	Units	U.S. ASTM D6751-07b	EU EN142142:2003	Japan JASO M360:2006	EAS-ERIA BDF Benchmark Standard:2008
Ester content	mass%	–	>96.5	>96.5	>96.5
Density	kg/m3	–	0.86-0.9	0.86-0.9	0.860 - 0.900
Viscosity	mm2/s	1.9-6.0	3.5-5.0	3.5-5.0	2.0-5.0
Flashpoint	℃	>130	>120	>120	>100
Sulfur content	mass%	<0.0015	<0.001	<0.001	<0.0010
Distillation property	℃	<360 (T90)	–	–	–
Carbon residue (100%)	mass%	<0.05	–	–	-
Carbon residue (100%) or Carbon residue (10%)	mass%	–	–	–	<0.05 <0.3
Carbon residue (10%)	mass%	–	<0.3	<0.3	-
Cetane number		>47	>51	>51	>51
Sulfated ash	mass%	<0.02	<0.02	<0.02	<0.02
Water content	mg/kg	<0.05[vol%]	<500	<500	<500
Total contamination	mg/kg	–	<24	<24	<24
Copper corrosion		No.3	Class-1	Class-1	Class-1
Acid value	mgKOH/g	<0.5	<0.5	<0.5	<0.5
Oxidation stability	hr.	>3	>6	(**)	≧10 (****)
Iodine value		–	<120	<120	Reported (***)
Methyl Linolenate	mass%	–	<12	<12	<12
Polyunsaturated FAME (≧4 double bond)	Mass%	–	<1	N.D.	N.D. (***)
Methanol content	mass%	<0.2	<0.2	<0.2	<0.2
Monoglyceride content	mass%	–	<0.80	<0.80	<0.80
Diglyceride content	mass%	–	<0.2	<0.2	<0.2
Triglyceride content	mass%	–	<0.2	<0.2	<0.2
Free glycerol content	mass%	<0.02	<0.02	<0.02	<0.02
Total glycerol content	mass%	<0.24	<0.25	<0.25	<0.25
Na+K	mg/kg	<5	<5	<5	<5
Ca+Mg	mg/kg	<5	<5	<5	<5
Phosphorous content	mg/kg	<10	<10	<10	<10

(*) Equivalent to diesel oil
(**) Meet diesel oil specification
(***) Need data check and further discussion
(****) Need more data & discussion from 6 to 10 hrs.

(3) Explaining more details about Oxidation stability, for example,

- General comments-
  - (i) Oxidation stability
  - (ii) Cetane number
  - (iii) ....
- Additional information such as; -
  - (i) Japanese situation
  - (ii) Europe situation

(iii) ....

- Indonesia’s general comments seem to be fixed in this part.

7. POLICY IMPLICATIONS (SUMMARY)

WG for Standardization of Biodiesel Fuel for Vehicles in East Asia made an "EAS-ERIA Biodiesel Fuel Benchmark Standard" which is for B100 aimed for blending in diesel fuel. This is a benchmark standard suggested for member countries for the purpose of harmonizing biodiesel standards in East-Asia.

There are still some remaining topics which need to be worked through for making the benchmark standard effective, which are as follows;

- Oxidation stability: Need more data & discussion on induction periods between 6 to 10 hours
- Development of new test methods: Direct thermal stability test, satisfactory oxidation stability test and so on.
- Practical use of BDF in the market: Keep the enough Quality, Inspection Methods, and so on.)

All WG members hope to discuss about these topics continuously.