Implications of Biofuel Quality Analysis and Standards for SME producers

Tatang H. Soerawidjaja

Head of Center for Research on Sustainable Energy, Institut Teknologi Bandung, and Chairman of Indonesian Biodiesel Forum

Research Workshop on Sustainable Biofuel Development in Indonesia : Progress So Far and Future Applied Research Opportunities
Hotel Sultan, Jakarta, 4 – 5 February 2009

Current trend in energy sector

- Crude petroleum oil is becoming more and more scarce, whereas due to the economic development of all countries in this world, its demand & consumption is continually increasing.

CONSEQUENTLY :

- Our Earth planet is becoming warmer and warmer due to the increasing emission of greenhouse gases.
- Crude oil is becoming more expensive and thus jeopardizing energy security of those developing countries with unfavourable financial position.

➢ **Biofuel development is most appropriate solution !.**

Main reason for developing/utilizing biofuels

Developed countries :

- Greenhouse (CO_2) gas emission abatement.

Developing countries :

- Energy security
- Improving balance of payment.
- Jobs creation.
- Poverty alleviation.

➔ These objectives should be kept in mind in every facet of biofuel industry development !.

3

Thus, for developing countries :

- Domestic market/utilization is more important than export.
- Local electricity generation and household cooking are also important usage of biofuels.
- Continued participation of small scale farmers in medium or large scale biofuel production should be ensured.
- Leaving biofuel development solely to the private sector (B to B) will not match their environmental and social potential.
- Biofuel industry structure and development scenario should be carefully designed through involvement of all stakeholders.

4

Consequently, biofuel quality standards :

☑ Should be simple but effective.

- Simple : do not contain too many quality parameters.
- Effective : compliance to it ensure adequate quality.

☑ Without jeopardizing/sacrificing the quality and accuracy of the results

- the test methods and apparatus of should be affordable and doable to small and medium enterprises (Large producers could, of course, choose the sophisticated and expensive alternatives).
- allow inclusion of any potential raw material (Remember : compared to many developed countries (e.g. EU, USA, Australia, Japan), Indonesia has much larger biodieversity, i.e. stock of potensial raw materials).

5

Remarks :

- Fuel grade bioethanol is almost a pure compound (≥ 99 % ethanol in undenatured form).

➢ standards are almost identical from country to country.
➢ has been utilized since 1970s (in Brazil, USA);
→ more experiences !

- Biodiesel is a mixture of alkyl ester of fatty acids (especially FAME).

➢ More recent fuel product than bioethanol.
➢ Most countries developed quality standards based on the experiences with biodiesels made from the most readily available raw material in their own regions.
➢ Attempts to improve & harmonize standards are in progress !.

6

Example of biodiesel standards

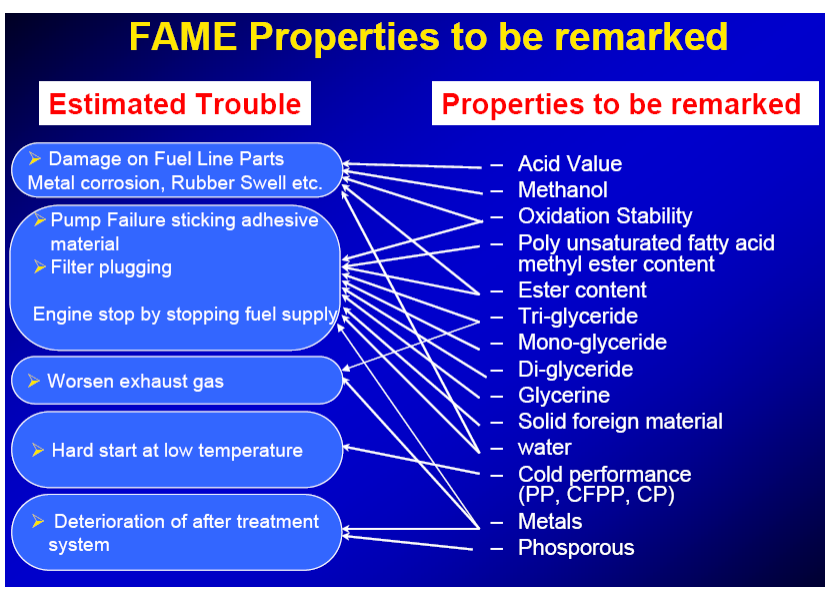
Items	Units	U.S. ASTM D6751-07b	EU EN142142:2003	Japan JASO M360:2006	EAS-ERIA BDF Benchmark Standard: 2008
Ester content	mass%	–	>96.5	>96.5	>96.5
Density	kg/m3	–	0.86-0.9	0.86-0.9	0.860 - 0.900
Viscosity	mm2/s	1.9-6.0	3.5-5.0	3.5-5.0	2.0-5.0
Flashpoint	℃	>130	>120	>120	>100
Sulfur content	mass%	<0.0015	<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	<0.3	<0.05 <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.

Why require measurements of so many 'contaminants' concentrations ?.

7



Direct mesurement of the tendencies to produce the trouble is much better than measuring individual concentration of every contaminant suspected to cause the trouble !.

8

- The test methods adopted in EU, Japan, and EAS-ERIA benchmark standards to measure ester content and concentrations of methyl linolenate, polyunsaturated FAME, mono-, di-, and triglycerides etc used sophisticated and capital intensive analytical instruments.
- ➢ Not affordable and doable by SME (Small and Medium Enterprise) producers !.
- Formal adoption of EAS-ERIA Benchmark Standard in Indonesia would 'kill' (or prevent/hamper the participation of) SME producers.

9

My comments on EAS-ERIA BDF Benchmark Standard

The proposed common biodiesel fuel specification, which is mainly based on JASO Standard and JAMA recommendation, imbalancely represents more the concerns of user industry in developed countries than those of (medium scale) producers in developing countries, who desire a relatively simple but quite effective standard. The proposed specification is considered too complicated, contain too many parameters, and 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 a direct thermal stability test and an satisfactory 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, could be developed, then these two tests would probably replace such quality parameters as iodine value and concentrations of methyl linolenate, polyunsaturated FAME, mono-, di-, and triglycerides. ERIA Working Group is suggested to cooperatively develop these two stability test methods.

10

The Indonesian Standard SNI-04-7182-2006

- Resembles more the US (ASTM D6751-02) and Australian standards than the more complicated EU standard.
- Wet analytical methods (based on American Oil Chemists Society [AOCS] standard methods) have been chosen for some of the quality parameters, to allow small and medium industries participate in biodiesel production.
- The alkyl ester content (min. 96.5 %-w) is calculated from saponification value, acid value, and bound glycerol (i.e. total glycerol – free glycerol) by assuming that all of the bound glycerol is present as triglyceride.

➢ Very conservative but obviating the need to determine mono-, di-, and triglycerides.

11

SNI-04-7182-2006 Biodiesel Quality Requirements in Indonesia

Quality parameter dan units	Limit	Test Method	Altern. Method
Density at 40 °C, kg/m^3	850 – 890	ASTM D 1298	ISO 3675
Kinem. Visc. at 40 °C, 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), °C	min. 100	ASTM D 93	ISO 2710
Cloud point, °C	max. 18	ASTM D 2500	-
Cu strip corrosion (3 hr, 50 °C)	max. no. 3	ASTM D 130	ISO 2160
Carbon residue (%-b), - in original sample - in 10 % distillation residue	 max. 0.05 (max. 0.3)	ASTM D 4530	ISO 10370
Water and sediment, %-vol.	max. 0.05	ASTM D 2709	-
90 % distillation temperature, °C	max. 360	ASTM D 1160	-
Sulfated ash, %-w	max. 0.02	ASTM D 874	ISO 3987

12

SNI-04-7182-2006
Biodiesel Quality Requirements in Indonesia (cont.)

Quality parameter and units	Limit	Test method	Altern. Method
Sulfur, ppm-w (mg/kg)	max. 100	ASTM D 5453	prEN ISO 20884
Phosphorous, ppm-w (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, %-w	max. 0.02	AOCS Ca 14-56	FBI-A02-03
Total glycerol, %-w	max. 0,24	AOCS Ca 14-56	FBI-A02-03
Alkyl ester content, %-w	min. 96.5	calculated	FBI-A03-03
Iodine value, %-b (g-I_2/100 g)	max. 115	AOCS Cd 1-25	FBI-A04-03
Halphen test*)	negative	AOCS Cb 1-25	FBI-A06-03

*) Biodiesels/fatty oils that give positive reaction to this test are presumed will cause engine trouble due to gum or polymer formation. Some Indonesian fatty-oil raw materials (e.g. kapok seed oil, sterculia oil) give definitively positive reaction to this test.

13

- The FBI methods are Indonesian translation (+ adaptation for biodiesel) of the AOCS methods [FBI ≡ Forum Biodiesel Indonesia ≡ Indonesian Biodiesel Forum].
- Development of simple but comprehensive thermal and oxidation stability test methods are necessary for future improvement.
- The government is urged/appealed to establish (or give support/insentive to the establishment of) biofuel quality analysis service labotarories in various big cities (or provincial capitals)

14

Conclusions

- Developing country's objectives in establishing biofuel industry are different from that of developed countries.
- Include job creation and poverty alleviation.
- Continued participation of small and medium biofuel producers should be ensured to achieve these objectives.
- Biofuel quality standards should be formulated to allow the participation of SME producers. The standards should be simple but effective and affordable as well as doable by the SME producers.

15

THANK YOU VERY MUCH

for your kind attention

tatanghs@che.itb.ac.id , hstatang@yahoo.com