

Thai Biodiesel Industry in ASEAN: Opportunities or Threats

Current Biodiesel Standards*

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Outline

- Comparison of various biodiesel standards
 - US: ASTM / EU: EN / Japan: JIS
 - Others including ASEAN
- Issues
 - Feedstock / Method / Parameter range
 - Harmonization?
- Current initiatives on harmonization
 - EN → already successful
 - APEC (Asia Pacific Economic Cooperation)
 - TriPartite (Brazil, EU, US)
 - WWFC (Worldwide Fuel Charter)
 - EAS (East Asian Summit)
 - AAF (Asean Automotive Federation)
- Lesson learned and common ground
 - Difficult to enforce mandatory specification like EU
 - Even mutual agreement on voluntary basis still difficult
 - ✓ Oxidation stability
 - ✓ Blend limit
 - Could be used as
 - ✓ Bargaining power from the region
 - ✓ Non-tariff barrier



Comparison of various BDF standards



American (1)

Table 2: Comparison of biodiesel (blends) in American region

Parameter	CEN	ASTM B10	ASTM B20	Brazil	Argentina	Colombia	Paraguay	Uruguay
	EN 14214 B100	D 6751 Blend	D xxxx:2004 B20	ANP N° 42 B100	IRAM 6515-1³ B100	DE 100-04 B100	PNA 16 018 B100	UNI 1100 B100
Ester content, min.	96,5 % (m/m) EN 14103			() ⁴ EN 14103	96,5 % (m/m) EN 14103	96,5 % (m/m) EN 14103	96,5 % (m/m) EN 14103	96,5 % (m/m) EN 14103
Density at 15 °C	(860 – 900) kg/m ³ EN ISO 3675 EN ISO 12185			() ASTM D 1298 ASTM D 4052	(0,875 – 0,900) g/l EN ISO 3675 EN ISO 12185	(860 – 900) kg/m ³ ASTM D 4052 ISO 3675	(850 – 900) kg/m ³ ISO 3675 ISO 12185 ASTM D 7042	
Viscosity at 40 °C	(3,50 – 5,00) mm ² /s EN ISO 3104	(1,9 – 6,0) mm ² /s ASTM D 445	(1,3 – 4,1) mm ² /s ASTM D 445	() EN ISO 3104	(3,5 – 5,0) mm ² /s EN ISO 3104 ASTM D 445		(3 – 6,5) mm ² /s IRAM-IAP A 6597 ISO 3104 ASTM D 445	(1,9 – 6,0) mm ² /s ISO 3104 ASTM D 445
Flash point, min.	120 °C EN ISO 3679	130 °C ASTM D 93	38 °C ASTM D 93	100 °C EN ISO 3679 ASTM D 93	130 °C EN ISO 3679 ASTM D 93	120 °C ASTM D 93 ISO 2719	120 °C ISO 3679 ASTM D 93	100 °C ISO 3679 ASTM D 93
Sulphur content, max	10,0 mg/kg EN ISO 20846 EN ISO 20884	15 ppm ASTM D 5453	15 ppm ASTM D 5453	() ASTM D 4294 ASTM D 5453	10 mg/kg EN ISO 20846 EN ISO 20884 ASTM D 5453		10,0 mg/kg ASTM D 2622 ASTM D 5453	10,0 mg/kg ASTM D 2622 ASTM D 5453
Carbon residue (on xx % distillation residue), max	0,30 % (m/m) on 10% EN ISO 10370	0,050 % (m/m) on 100% ASTM D 4530 ASTM D 189 ASTM D 524	0,035 % (m/m) on 10% ASTM D 524	0,1 % (m/m) on 100% EN ISO 10370	0,05 g/100g on 100% ASTM D 4530 EN ISO 10370	0,3 % (m/m) on 10% ISO 10370 ASTM D 4530	0,3 g/100g on 10% ASTM D 4530 ISO 10370 ASTM D 189	0,10 % (m/m) on 10% ASTM D 4530 ISO 10370 ASTM D 189 ASTM D 4530
Cetane number, min.	51,0 EN ISO 5165	47 ASTM D 613	40 ASTM D 613	() EN ISO 5165 ASTM D 613		47 ASTM D 613 ISO 5165	45,0 ASTM D 613 ISO 5165	45 ASTM D 613 ISO 5165

American (2)

Parameter	CEN	ASTM B10	ASTM B20	Brazil	Argentina	Colombia	Paraguay	Uruguay
Sulfated ash content, max.	0,02 % (m/m) ISO 3987	0,020 % (m/m) ASTM D 874	0,01 % (m/m) ASTM D482	0,02 % (m/m) ISO 3987	0,02 % (m/m) ISO 3987	0,02 % (m/m) ASTM D 874 ISO 3987	0,05 % (m/m) ISO 3987	0,02 % (m/m) ISO 3987 ASTM D 874
Water content, max.	500 mg/kg EN ISO 12937				0,050 g/100g ASTM D 4928 ISO 12937	500 mg/kg ASTM E 203 EN ISO 12937		500 mg/kg ISO 12937
Water and sediment, max.		0,050 % (V/V) ASTM D 2709 ASTM D 1796	0,050 % (V/V) ASTM D 2709	0,05 % (V/V) NBR 9842			0,05 % (m/m) ASTM D 4928 ISO 12937	0,05 % (m/m) ASTM D 2907
Total contamination max.	24 mg/kg EN 12662			() EN 12662	24 mg/kg EN ISO 12662 ⁵	24 mg/kg EN 12662		
Copper strip corrosion (3 h at 50 °C)	class 1 EN ISO 2160	class 3 ASTM D 130	class 3 ASTM D 130	class 1 EN ISO 2160 ASTM D 130	class 1 IRAM-IAP A 6553 ASTM D 130 ISO 2160	class 1 ISO 2160 ASTM D 130	class 1 IRAM-IAP A 6533 ASTM D 130 ISO 2160	class 3 ASTM D 130 ISO 2160
Oxidation stability at 110°C, min.	6 hours EN 14112	3 hours		6 hours EN 14112	6 hours EN 14112 ASTM D 2274	6 hours EN 14112	6 hours EN 14112 ASTM D 2274	6 hours EN 14112
Acid value, max.	0,5 mg KOH/g EN 14104	0,5 mg KOH/g ASTM D 664 ASTM D 3242 ASTM D 974	0,2 mg KOH/g ASTM D 664	0,8 mg KOH/g EN 14104 ASTM D 664	0,5 mg KOH/g IRAM 6558 EN 14104 ASTM D 664	0,5 mg KOH/g EN 14104 ASTM D 664	0,8 mg KOH/g IRAM 6558 EN 14104 ASTM D 664	0,8 mg KOH/g EN 14104 ASTM D 664
Iodine value, max.	120 g Iodine/100 g EN 14111			() EN 14111	150 g Iodine/100 g EN 14111	120 g Iodine/100 g EN 14111		
Linolenic acid methyl ester, max.	12,0 % (m/m) EN 14103				12 % (m/m) EN 14103	12 % (m/m) EN 14103		12,0 % (m/m) EN 14103
Polyunsaturated methyl esters, max.	1 % (m/m)							1 % (m/m) EN 14103
Methanol content, max.	0,20 % (m/m) EN 14110			0,5 % (m/m) EN 14110		0,20 % (m/m) EN 14110	0,5 % (m/m) EN 14110 ⁶	

American (3)

Parameter	CEN	ASTM B10	ASTM B20	Brazil	Argentina	Colombia	Paraguay	Uruguay
Alcohol content, max.					0,20 % (m/m) EN 14110			0,2 % (m/m) EN 14110
Monoglyceride content, max.	0,80 % (m/m) EN 14105			() EN 14105 EN 14106 ASTM D 6584	0,80 % (m/m) EN 14105	0,80 % (m/m) EN 14105 ASTM D 6584	0,80 % (m/m) EN 14105	0,80 % (m/m) EN 14105 ASTM D 6585
Diglyceride content, max.	0,20 % (m/m) EN 14105			() EN 14105 EN 14106 ASTM D 6584	0,20 % (m/m) EN 14105	0,20 % (m/m) EN 14105 ASTM D 6584	0,20 % (m/m) EN 14105	0,20 % (m/m) EN 14105 ASTM D 6585
Triglyceride content, max.	0,20 % (m/m) EN 14105			() EN 14105 EN 14106 ASTM D 6584	0,20 % (m/m) EN 14105	0,20 % (m/m) EN 14105 ASTM D 6584	0,20 % (m/m) EN 14105	0,20 % (m/m) EN 14105 ASTM D 6585
Free glycerol/glycerine, max.	0,02 % (m/m) EN 14105 EN 14106	0,02 % (m/m) ASTM D 6584		0,02 % (m/m) EN 14105 EN 14106 ASTM D 6584 ⁷	0,02 % (m/m) EN 14105 EN 14106 ASTM D 6584	0,02 % (m/m) EN 14105 EN 14106 ASTM D 6584	0,02 % (m/m) EN 14105 EN 14106 ASTM D 6584	0,02 % (m/m) EN 14105 EN 14106 ASTM D 6584
Total glycerol, max.	0,25 % (m/m) EN 14105	0,240 % (m/m) ASTM D 6584		0,38 % (m/m) EN 14105 EN 14106 ASTM D 6584	0,25 % (m/m) EN 14105 ASTM D 6584	0,25 % (m/m) EN 14105 ASTM D 6584	0,25 % (m/m) EN 14105 ASTM D 6584	0,25 % (m/m) EN 14105 ASTM D 6584
Group I metals (Na+K) , max.	5,0 mg/kg EN 14108 EN 14109	5,0 mg/kg EN 14538		10 mg/kg EN 14108 EN 14109	5,0 mg/kg EN 14108 EN 14109	5,0 mg/kg EN 14108 EN 14109 ASTM D 5863AST M D 5863a	5,0 mg/kg EN 14108 EN 14109	10,0 mg/kg ⁸ EN 14108 EN 14109
Group II metals (Ca+Mg) , max.	5,0 mg/kg EN 14538			() EN 14538		5,0 mg/kg EN 14108 EN 14109 ASTM D 5863AST M D 5863a		5,0 mg/kg ⁷ EN 14538

American (4)

Parameter	CEN	ASTM B10	ASTM B20	Brazil	Argentina	Colombia	Paraguay	Uruguay
Phosphorus content, max.	10,0 mg/kg EN 14107	0,001 % (m/m) ASTM D 4951	0,001 % (m/m) ASTM D 4951	() EN 14107	10,0 mg/kg EN 14107	10,0 mg/kg EN 14107 ASTM D 4951	10,0 mg/kg EN 14107	() EN 14107
Distillation, 90% recovered, max.		360 °C ASTM D1160	343 °C ASTM D1160	360 °C ASTM D1160		360 °C ASTM D1160	360 °C ASTM D1160	
CFPP, max.	climate dependent		climate dependent	- 7 °C ASTM D 6371	climate dependent	() EN 116 ASTM D 6731	0 °C IP 391 EN 116	() ASTM D 6731 EN 116
Pour point, max.						() ASTM D 97		
Cloud point, max.		() ASTM D 2500 ASTM D 3117				() ASTM D 2500 ISO 3015	3 °C ASTM D 2500 ASTM D 3117	() ASTM D 2500
Aromaticity, max.			35 % (V/V) ASTM D1319					
Thermal Stability, 90 min, pad reflectance			70 min ASTM D 6468			70 min ASTM D 6468		
Lubricity, max.					250 µm ISO 12156-1		250 µm ISO 12156-1	

EAS + EU/US/China Taipei (1)



Items		Europe	USA	Japan	Australia	China	China Taipei	India	Indonesia
Properties	unit	EN14214: 2003	ASTM D6751: 2011	JIS K2390		GB/T20828: 2007	CNS 15072	IS 15607: 2005	SNI 04-7182- 2006
Ester content	mass%	96.5 min	-	96.5 min	96.5 min		96.5 min	96.5 min	96.5 min
Density at 15 °C	g/ml	0.86 - 0.90	-	0.86 - 0.90	0.86 - 0.90	0.82 - 0.90 (20 °C)	0.86 - 0.90	0.86 - 0.90	0.85 - 0.89
Kinematic Viscosity	mm ² /s	3.5 - 5.0	1.9 - 6.0	3.5 - 5.0	3.5 - 5.0	1.9 - 6.0 (20 °C)	3.5 - 5.0	2.5 - 6.0	2.3 - 6.0
Flash Point	°C	120 min	130 min	120 min	120 min	130 min	120 min	120 min	100 min
Sulfur	ppm	10 max	500 max	10 max	10 max	50 max	10 max	50 max	100 max
Carbon Residue 10%	mass%	0.3 max	-	0.3 max	0.3 max				0.3 max
Carbon Residue 100%	mass%	-	0.05 max	-				0.05 max	0.05 max
Cetane Number		51 min	47 min	51 min	51 min	49 min	51 min	51 min	51 min
Sulfated Ash	mass%	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max
Ash	mass%	-	-	-					-
Water	ppm	500 max	-	500 max	500 max				500 max
Total Contamination	ppm	24 max	-	24 max	24 max		24 max	24 max	-
Water and Sediment	vol%	-	0.05 max	-					0.05 max
Copper Corrosion		1 max	3 max	1 max	1 max	1 max	1 max	1 max	3 max
Total Acid Number	mgKOH/g	0.5 max	0.5 max	0.5 max	0.8 max	0.8 max	0.5 max	0.5 max	0.8 max
Oxidation Stability	hrs	6 min	3 min	To be agreed	6 min	6 min	6 min	6 min	-
Iodine Number	gI ₂ /100g	120 max	-	120 max			120 max	Report	115 max
Linolenic acid methyl	mass%	12.0 max	-	12.0 max			12.0 max		-
Polyunsaturated acid methyl ester	mass%	1 max	-	-					-
Methanol	mass%	0.20 max	-	0.20 max	0.20 max		0.20 max	0.20 max	-
Mono glyceride	mass%	0.80 max	-	0.80 max			0.80 max		-
Di glyceride	mass%	0.20 max	-	0.20 max			0.20 max		-
Tri glyceride	mass%	0.20 max	-	0.20 max			0.20 max		-
Free glycerine	mass%	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max
Total glycerine	mass%	0.25 max	0.24 max	0.25 max	0.25 max	0.24 max	0.25 max	0.25 max	0.24 max
Metals (Na + K)	ppm	5max	-	5 max	5 max		5 max	Report	-
Metals (Ca + Mg)	ppm	5 max	-	5 max	5 max		5 max	Report	-
Phosphorus	ppm	4 max	10 max	10 max	10 max		10 max	10 max	10 max
T90	°C	-	360 max	-					360 max

EAS + EU/US/China Taipei (2)[†]

Items		Europe	USA	Japan	Korea	Malaysia	New Zealand	Philippines	Thailand	Vietnam
Properties	unit	EN14214: 2003	ASTM D6751: 2011	JIS K2390	PPAFB Act	MS 2008: 2008	Engine Fuel Regulation 2008	PNS/DOE QS 002:2007	DOEB B100 Spec., B.E. 2552 (2009)	TCVN 7717:2007
Ester content	mass%	96.5 min	-	96.5 min	96.5 min.	96.5 min	96.5 min	96.5 min	96.5 min	96.5 min
Density at 15 °C	g/ml	0.86 - 0.90	-	0.86 - 0.90	0.86-0.90	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90
Kinematic Viscosity	mm ² /s	3.5 - 5.0	1.9 - 6.0	3.5 - 5.0	1.9-5.0	3.5 - 5.0	2.0 - 6.0	2.0 - 4.5	3.5 - 5.0	1.9 - 6.0
Flash Point	°C	120 min	130 min	120 min	120 min.	120 min	100 min	100 min	120 min	130 min
Sulfur	ppm	10 max	500 max	10 max	10 max.	10.0 max	10.0 max	0.05 mass%	10 max	500 max
Carbon Residue 10%	mass%	0.3 max	-	0.3 max	0.1 max	0.3 max	0.3 max	-	0.3 max	-
Carbon Residue 100%	mass%	-	0.05 max	-	-	0.05 max	0.05 max	0.05 max	-	0.05 max
Cetane Number		51 min	47 min	51 min	-	51.0 min	47.0 min	55 min	51 min	47 min
Sulfated Ash	mass%	0.02 max	0.02 max	0.02 max	0.01 max.	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max
Ash	mass%	-	-	-	-	-	-	-	-	-
Water	ppm	500 max	-	500 max	500 max.	500 max	500 max	0.05 vol%	500 max	-
Total Contamination	ppm	24 max	-	24 max	24 max.	24 max	24 max	-	24 max	-
Water and Sediment	vol%	-	0.05 max	-	-	-	-	0.05 max	-	0.05 max
Copper Corrosion		1 max	3 max	1 max	1 max	Class 1	Class 1	Class 1	Class 1	Class 1
Total Acid Number	mgKOH/g	0.5 max	0.5 max	0.5 max	0.50 max.	0.5 max	0.5 max	0.5 max	0.50 max	0.5 max
Oxidation Stability	hrs	6 min	3 min	To be agreed	6 min.	6 min	10 min	6 min	10 min	6 min
Iodine Number	gl ₂ /100g	120 max	-	120 max	-	100 max	140 max	-	120 max	120 max
Linolenic acid methyl	mass%	12.0 max	-	12.0 max	-	12.0 max	12.0 max	-	12.0 max	-
Polyunsaturated acid methyl ester	mass%	1 max	-	-	-	1 max	1 max	-	-	-
Methanol	mass%	0.20 max	-	0.20 max	0.20 max.	0.20 max	0.20 max	0.2 max	0.20 max	-
Mono glyceride	mass%	0.80 max	-	0.80 max	0.80 max.	0.80 max	0.80 max	0.8 max	0.80 max	-
Di glyceride	mass%	0.20 max	-	0.20 max	0.20 max.	0.20 max	0.20 max	0.2 max	0.20 max	-
Tri glyceride	mass%	0.20 max	-	0.20 max	0.20 max.	0.20 max	0.20 max	0.2 max	0.20 max	-
Free glycerine	mass%	0.02 max	0.02 max	0.02 max	0.02 max.	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max
Total glycerine	mass%	0.25 max	0.24 max	0.25 max	0.24 max.	0.25 max	0.25 max	0.24 max	0.25 max	0.24 max
Metals (Na + K)	ppm	5max	-	5 max	5.0 max.	5.0 max	5.0 max	5 max	5 max	5 max
Metals (Ca + Mg)	ppm	5 max	-	5 max	5.0 max.	5.0 max	5.0 max	5 max	5 max	-
Phosphorus	ppm	4 max	10 max	10 max	10.0 max.	10.0 max	10.0 max	10.0 max	10 max	10.0 max
T90	°C	-	360 max	-	-	-	-	360 max	-	360 max

Issues

- Feedstock affecting properties
 - US, Brazil: soybean
 - EU: rapeseed
 - Indonesia, Malaysia, Thailand: Palm
 - Philippines: Coconut
 - China, Japan, Korea: Used cooking oil
 - Australia, New Zealand: Beef tallow
 - Vietnam: Cat fish fat
 - India: Jatropha?
- Method for measuring properties
- Range of properties
- Harmonization?



Establishment of the Guidelines for the Development of Biodiesel Standards in the APEC Region

*EWG 02/2007A
APEC 21st Century Renewable Energy
Development Initiative (Collaborative IX)
November 2007*



Final Report Presented to:

Asia Pacific Economic Cooperation
Energy Working Group

Submitted by:

Hart Energy Consulting



**Asia-Pacific
Economic Cooperation**



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- Under APEC 21st Century Renewable Energy Development Initiative (Collaborative IX),
 - Energy Working Group formulate Expert Group on New and Renewable Energy Technologies (EGNRET) under EWG 02/2007A to establish guideline for common BDF standard

EWG 02/2007A, Establishment of the Guidelines for the Development of Biodiesel Standards in the APEC Region (2007),

http://www.biofuels.apec.org/pdfs/ewg_biodiesel_standards.pdf

APEC Harmonization Approach

- Requiring diesel blends that contain biodiesel to comply with:
 - Applicable diesel specification – what extent are APEC or national or global diesel specs aligned.
 - Applicable biodiesel specifications, possibly with certain waivers provided to enable use of varying biodiesels, at varying treat rates; and
 - A new biodiesel blend standard – comply with the EN 14214 and ASTM D6751 standards?
- Establishing a B100 standard that can:
 - Ensure successful use in the market as B100.
 - Ensure a satisfactory product when blended with on specification mineral diesel.
 - Provide a biodiesel blend component that meets an agreed quality standard and has known characteristics

APEC (1)

Table 12: APEC Biodiesel Quality Standard and Harmonization Initiative

	ASTM D6751	EN 14214	Typical APEC Economy	Discussion & Conclusions
Regulatory and Emissions				
Max Sulfur (ppm)	15 / 500	10	10 - 500	Regulatory requirement per economy Buyer-seller specified
Min Flash Point (°C)	130 / 93	120	93 - 130	For non-hazardous classification in U.S. min of 93°C is required. To show methanol controlled certify at >130°C
Max T90 Distillation (°C)	360	-	The Philippines, Australia Indonesia @ 360 °C	Other (performance) tests control contaminants Biodiesel reduces PM and HC emissions so test not required for emissions reasons
Engine and Aftertreatment Performance				
Cetane Number	47	51	47 - 51	Higher than 47 (EN) is required for emissions. This is based on diesel tests, so not necessarily applicable to biodiesel. Higher minimum ambient temperatures reduce start-up emissions. Blending not necessarily linear Additives can be used
Min-Max Density @15 °C, kg/m ³	-	860 – 900	820 - 900	Agreement
Min-Max Viscosity @ 40 °C, cSt	1.9 – 6.0	3.5 – 5.0	1.9 – 3.5 min 4.5 – 6.0 max	Coconut below 3.5, and tallow and palm can exceed 5 Requirement should be for the final blend

	ASTM D6751	EN 14214	Typical APEC Economy	Discussion & Conclusions
Max phosphorus ppm	10	10	10 China no spec	Agreed
Max Alkali metals (Na + K), ppm	5	5	No spec, report, 5	Depends on after-treatment
Max Ca + Mg, ppm	5	5	No spec, report or 5	Depends on after treatment
Max CFPP, °C	-	+5 to - 44	No spec Chinese Taipei =0 Indonesia = +18	Requirement should be for the blend
Max cloud point °C	Report	-	No spec The Philippines = Report	Not needed
Direct Usability and/or Durability				
Max CCR 10%, wt%	-	0.3	0.1 – 0.3 The Philippines no spec	Difficult for biodiesel to fractionate 10 %, so not recommended.
Max CCR 100%, wt%	0.05	-	Korea, Chinese Taipei, Thailand, Japan, China =no spec	Recommended to use
Max water and sediment , vol%	0.05	-	Japan, NZ, Chinese Taipei, Thailand, China =no spec	Agreed to replace by separate testing
Max water, ppm	-	500	Australia, Indonesia, The Philippines, Korea = no spec	Agreed
Max Ash, wt%	0.02	0.02	0.01 – 0.02	Agreed at 0.02 May reduce later
Total Contamination, ppm	-	24	China, Indonesia, The Philippines, Korea = no spec	Agreed

APEC (2)

	ASTM D6751	EN 14214	Typical APEC Economy	Discussion & Conclusions
Max Cu corrosion, 3 hr at 50 °C	3	1	1 Indonesia, The Philippines = 3	Needs further work for alignment. In practice biodiesel complies easily
Max Methanol content, wt%	0.2	0.2	China, The Philippines = no spec	Agreed
Max free glycerine, wt%	0.02	0.02	Korea = no spec	Agreed
Min oxidation stability @ 110 °C, hrs	3	6	No spec, 3 or 6 Japan = 10	Needs further work
Max total glycerin, wt%	0.24	0.25	0.24 – 0.25	Agreed and 0.24 recommended

	ASTM D6751	EN 14214	Typical APEC Economy	Discussion & Conclusions
Max iodine number	-	120	115 - 120 Australia, China, The Philippines, Korea, U.S. = No spec	Limits certain feedstocks without certain reason. Max limit of 130 preferred. No agreement. Prefer direct tests of performance
Mandated detergents & additives	-	-	-	No agreement. Further discussion required

Indirect (Derived) Usability and/or Durability				
Min Ester Content	-	96.5	China, The Philippines, US = No spec	Method developed for RME, so does not show lower molecular weight from CME
Max non-ester	-	None except additives	No spec	Agreed to exclude
Max acid value	0.5	0.5	0.5 – 0.8	Simple test. Agreed to include. Limit not agreed.
Max glycerides – mono, di, tri	-	0.8; 0.2; 0.2	No spec	No agreement. Prefer direct tests of performance
Max linolenic acid methyl ester	-	12	Australia, China, Indonesia, The Philippines, Korea, U.S. = No spec	Limits certain feedstocks with no clear reason. No agreement. Prefer direct tests of performance
Max polyunsaturated methyl ester	-	1	No Spec, Chinese Taipei = 1	No agreement. Prefer direct tests of performance



Remarks

- Lesson learned
 - Difficult to get consensus agreement
 - Imply limited biodiesel trade between economies
 - Wide range of emission regulation among APEC members make harmonization difficult (e.g. Sulfur & Phosphorous)
 - Data testing with mostly RME, SME and PME on Euro 0 to 2 vehicles
- Future work
 - conduct an assessment of testing facilities and laboratories in member economies.;
 - establish accredited test facilities for round-robin testing between APEC economies;
 - review all available test data for feedstock dependant variables, and identify further research work required in support of performance based specifications;

include the FIE manufacturers in further discussion



TriPartite[†]

- Brazil, EU & US started TriPartite Task Force
 - In 2006, Govt of Brazil, EU & US discussed on international trade in biofuel, which would require internationally recognized standard
 - In Feb 2007, conference organized by CEN with US National Institute of Standards and Technology (NIST) and Brazil National Institute of Metrology, Standardization, and Industrial Quality (INMETRO) to discuss on potential barrier from different standard
 - Publish 'white paper on internationally compatible biofuel standards' in Dec 2007
- Classification of biofuel properties
 - Category A: specifications that are already similar;
 - Category B: specifications with significant differences between parameters and methods, but which might be aligned by work on documentary standards and measurement standards; and
 - Category C: specifications with fundamental differences, perhaps due to emissions or environmental regulations within one or more regions, which are not deemed bridgeable in the foreseeable future



Classification of BDF Properties

Category A <i>similar</i>	Category B <i>significant differences</i>	Category C <i>fundamental differences</i>
sulfated ash	total glycerol content	sulfur content
alkali and alkaline earth metal content	phosphorus content	cold climate operability
free glycerol content	carbon residue	cetane number
copper strip corrosion	ester content	oxidation stability
methanol & ethanol content	distillation temperature	mono, di-, tri-acylglycerides
acid number	flash point	density
	total contamination	kinematic viscosity
	water content & sediment	iodine number
		linolenic acid content
		polyunsaturated methyl ester



Rating of Alignment

- A = easily done,
B = feasible with effort,
C = not feasible at the present
- Order:
BR / EU / US

Category A Parameters Misalignment Impact (MI)	Category B Parameters Misalignment Impact (MI)	Category C Parameters Misalignment Impact (MI)
Sulfated ash (A / A / A) MI: very minor	Total glycerol (A / A / A) for limit value (B / B / B) for method MI: minor	Sulfur content (C / C / C) MI: medium to major
Alkali & alkaline earth metals (A / A / A) MI: very minor	Phosphorus content (A / B / A) MI: medium	Cold climate operability (C / C / C) MI: very minor
Free glycerol (A / B / A) MI: minor	Carbon residue (B / B / B) MI: very minor	Cetane number (C / C / C) MI: major
Copper strip corrosion (A / A / B) MI: none	Ester content (B / B / B) MI: very minor	Oxidation stability (B / C / C) MI: medium
Methanol & ethanol content (A / A / A) MI: medium	Distillation temperature (B / B / B) MI: very minor	Mono, di-, tri-acylglycerides (B / B / C) MI: minor
Acid number (A / B / A) MI: very minor	Flash point (B / B / B) MI: minor	Density (C / C / C) MI: very minor
	Total contamination (B / B / B) MI: minor	Kinematic viscosity (C / C / C) MI: very minor
	Water content & sediment (B / B / B) MI: medium/major	Iodine number (A / C / A) MI: major
		Linolenic acid (A / C / A) MI: major
		Polyunsaturated methyl ester (C / C / C) MI: major

Comparison among Tri-partite (1)



Property	Limits			
	Units	USA ASTM D 6751	EU EN 14214	Brazil ANP 42
Sulfated Ash	% mass	0.020 max	0.02 max	0.02 max
Group I Metals (Na + K)	mg/kg	5 max	5 max	10 max
Group II Metals (Ca + mg)	mg/kg	5 max	5 max	Report
Methanol or Ethanol Content	% mass		0.20 max	0.50 max
Acid Number	mgKO H/g	0.50 max	0.50 max	0.80 max
Free Glycerol	% mass	0.02 max	0.02 max	0.02 max
Total Glycerol	% mass	0.24 max	0.25 max	0.38 max
Copper Strip Corrosion	Rating	Class 3	Class 1	Class 1

Property	Units	Limits		
Phosphorus Content	% mass	0.001 max	0.0010 max	Report
Carbon Residue (on 100% Sample)	% mass	0.050 max		0.10 max
Ester Content	% mass	-	96.5 min	Report
Distillation Temperature, 90% Recovered	°C	360 max	-	360 max
Flash Point	°C	130.0 min	120 min	100 min
Total Contamination	mg/kg	-	24 max	Report
Water and Sediment	% volume	0.050 max		0.050 max
Water Content	mg/kg	-	500 max	
Oxidation Stability, 110°C	hours	3.0 min	6.0 min	6.0 min



Comparison among Tri-partite (2)

Property	Units	Limits		
Monoacylglycerol Content	% mass		0.80 max	-
Diacylglycerol Content	% mass		0.20 max	-
Triacylglycerol Content	% mass		0.20 max	-
Sulfur Content	mg/kg	15/500	10	500 (note 3)
Cloud Point	°C	Report		
Cold Filter Plugging Point	°C		(5 max (Grade A) 0 max (Grade B) -5 max (Grade C) -10 max (Grade D) -15 max (Grade E) -20 max Grade F)	
Density at 15°C	kg/m ³		860 - 900	
Density at 20°C	kg/m ³			Report
Linolenic Acid Methyl Ester	% mass	-	12.0 max	-

Property	Units	Limits		
Polyunsaturated (≥ 4 double bonds) Methyl Esters	% mass	-	1 max	-
Cetane Number		47 min	51.0 min	Report
Iodine Value	g iodine/100 g	-	120 max	-



WWFC



ACEA

European Automobile
Manufacturers
Association



BIODIESEL GUIDELINES

MARCH 2009

From the
Worldwide Fuel Charter
Committee

For copies, please visit the association websites.



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- Associated members
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 - AMIA (Asociacion Mexicana de la Industria Automotriz)
 - ANFAVEA (Brazilian Association of Motor Vehicles)
 - CVMA (Canadian Vehicle Manufacturers Association)
 - CAMPI (Chamber of Automobile Manufacturers of the Philippines)
 - CAAI (Chinese Association of Automotive Industry)
 - IAF (Indonesia Automotive Federation)
 - KAMA (Korean Automobile Manufacturers Association)
 - NAAMSA (National Association of Automobile Manufacturers of South Africa)
 - MAA (Malaysian Automotive Association)
 - TAIA (Thai Automotive Industry Association)
 - Vietnam Automobile Manufacturers Association (VAMA)

Definition of Fuel Properties

- **Category 1** fuels represent the lowest quality and can be found in markets with no or first level of emission control.
 - A category 1 diesel fuel is characterized by a cetane number of min. 48.0 and a sulfur content of max. 3000 mg/kg.
- **Category 2** fuels represent an improved quality level and can be found in markets with stringent requirements for emission control (e.g. US Tier 0 or 1, EURO 1 and 2). **Could allow up to 5% blend**
 - A category 2 diesel fuel is characterized e.g. by a cetane number of min. 53.0 and a sulfur content of max. 300 mg/kg.
- **Category 3** fuels represent a further improved quality and can be found in markets with advanced requirements for emission control (e.g. US California LEV, ULEV and EURO 3 and 4).
 - A category 3 diesel fuel is characterized by e.g. a cetane number of min. 55 and a Sulfur content of max. 30 mg/kg.
- **Category 4** fuels represent further advanced requirements for emission control, to enable sophisticated NOx and PM after-treatment technologies (e.g. US California LEV-II, US EPA Tier 2, EURO 4 in conjunction with increased fuel efficiency constraints).
 - A category 4 diesel fuel is characterized by a sulfur content of max. 10



Guideline Summary (1)



Property	Value	Units	Test Methods
Ester content	96.5 min	% m/m	EN 14103 mod Other: ABNT NBR 15342
Linolenic Acid Methyl Ester	12.0 max	% m/m	EN 14103 mod
Polyunsaturated acid methyl ester (≥ 4 double bonds)	1 max	% m/m	prEN 15779
Oxidation Stability: Induction Period	10 min	hr	prEN 15751 or EN 14112 as alternative
Iodine Number	130 max ¹	g I ₂ /100 g	EN 14111
Total Acid Number	0.5 max	mg KOH/g	ISO 6618 ASTM D664, D974 JIS K2501 Other: ABNT NBR 14448
Methanol	0.20 max	% m/m	EN 14110 JIS K2536 Other: ABNT NBR 15343
Glycerides			EN 14105
Mono-glyceride	0.80 max	% m/m	EN 14105 ASTM D6584 Other: ABNT NBR 15342
Di-glyceride	0.20 max	% m/m	EN 14105 ASTM D6584 Other: ABNT NBR 15342
Tri-glyceride	0.20 max	% m/m	EN 14105 ASTM D6584 Other: ABNT NBR 15342
Glycerin (glycerol)			
Free glycerin	0.02 max	% m/m	EN 14105/14106 ASTM D6584 Other: ABNT NBR 15341
Total glycerin	0.25 max	% m/m	EN 14105 ASTM D6584 Other: ABNT NBR 15344
Density	report	g/ml	EN ISO 3675 ASTM D4052 JIS K2249 Other: EN ISO 12185, ABNT NBR 7148/14065
Kinematic Viscosity@40°C	2.0 - 5.0 ²	mm ² /s	EN ISO 3104 ASTMD445 JIS K2283

- %ME, Linolenic acid ME, Polyunsat. acid ME → fuel filter plugging by sludge
- Oxidation stability → peroxide damages part & acid corrodes
- Iodine number → no. of double bond as indicator for oxidation stability
- TAN → acid from process or degradation could harm injection system & metal parts
- Methanol → lower flash point, decrease lubricity, corrode injector
- Mono/di/tri-glycerine & Free/total glycerin → filter plugging, injector deposit; settling glycerin at tank bottom can attract polar compound (water)

¹ This limit may unnecessarily preclude certain feedstocks. Some engine technologies may need a more stringent limit.

² For temperatures at or below -20°C, viscosity should be at or below 48 mm²/s to avoid potentially dangerous loads on the fuel injection pump drive system.

Guideline Summary (2)



Property	Value	Units	Test Methods
Ester content	96.5 min	% m/m	EN 14103 mod Other: ABNT NBR 15342
Linolenic Acid Methyl Ester	12.0 max	% m/m	EN 14103 mod
Polyunsaturated acid methyl ester (≥ 4 double bonds)	1 max	% m/m	prEN 15779
Oxidation Stability: Induction Period	10 min	hr	prEN 15751 or EN 14112 as alternative
Iodine Number	130 max ¹	g I ₂ /100 g	EN 14111
Total Acid Number	0.5 max	mg KOH/g	ISO 6618 ASTM D664, D974 JIS K2501 Other: ABNT NBR 14448
Methanol	0.20 max	% m/m	EN 14110 JIS K2536 Other: ABNT NBR 15343
Glycerides			EN 14105
Mono-glyceride	0.80 max	% m/m	EN 14105 ASTM D6584 Other: ABNT NBR 15342
Di-glyceride	0.20 max	% m/m	EN 14105 ASTM D6584 Other: ABNT NBR 15342
Tri-glyceride	0.20 max	% m/m	EN 14105 ASTM D6584 Other: ABNT NBR 15342
Glycerin (glycerol)			
Free glycerin	0.02 max	% m/m	EN 14105/14106 ASTM D6584 Other: ABNT NBR 15341
Total glycerin	0.25 max	% m/m	EN 14105 ASTM D6584 Other: ABNT NBR 15344
Density	report	g/ml	EN ISO 3675 ASTM D4052 JIS K2249 Other: EN ISO 12185, ABNT NBR 7148/14065
Kinematic Viscosity@40°C	2.0 - 5.0 ²	mm ² /s	EN ISO 3104 ASTMD445 JIS K2283

- Density → used as indicator of contamination by unwanted compounds
- Kinematic viscosity → injector lubrication & fuel atomization

¹ This limit may unnecessarily preclude certain feedstocks. Some engine technologies may need a more stringent limit.

² For temperatures at or below -20°C, viscosity should be at or below 48 mm²/s to avoid potentially dangerous loads on the fuel injection pump drive system.

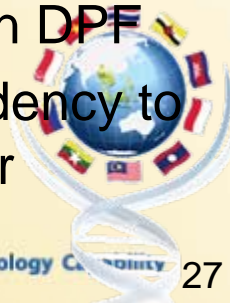


Guideline Summary (3)



Property	Value	Units	Test Methods
Flash Point	100 min	°C	Other: ABNT NBR 10441 ISO 3679 ASTM D93
Cetane Number	51 min		ISO 5165 ASTM D613 JIS K2280
Water	500 max	mg/kg (ppm)	EN 12937
Water and Sediment	0.05 max	% v/v	ASTM D2709
Total Contamination	24 max	mg/kg	EN 12662 ASTM D2276, D5452, D6217
Ash Content	0.001 max	% m/m	ISO 6245 ASTM D482 JIS K2272
Sulfated Ash	0.005 max	% m/m	ISO 3987 ASTM D874 Other: ABNT NBR 984
Carbon Residue: Ramsbottom, on 100% distillation residue	0.05 max	% m/m	ASTM D4530
Corrosion: Ferrous	light rusting, max	Rating	ASTM D665 Procedure A
Sulfur	10 max	ppm	EN 20846/20884 ASTM D5453/D2622 JIS K3541-1, -2, -6 or -7
Phosphorus	4 max	mg/kg	EN 14107 ASTM D4951, D3231
Alkali metals (Na+K)	5 max	mg/kg	EN 14108/14109, EN 14538
Alkaline metals (Ca+Mg)	5 max	mg/kg	EN 14538
Trace Metals	no addition		ASTM D7111

- Flash point → safety handling (storage & transport), also indicator for methanol contamination
- Cetane → too low cetane causes hard starting, rough operation & increased smoke
- Water/Water and sediment/
Total contamination → water ↑ oxidation & corrosivity, promote microbial growth, filter plugging
- Ash content/Sulfate ash → measure of metal/inorganic contaminant, engine deposit, filter plugging & shorten DPF
- Carbon residue → tendency to form deposit on injector



Guideline Summary (4)



Property	Value	Units	Test Methods
			Other: ABNT NBR 10441
Flash Point	100 min	°C	ISO 3679 ASTM D93
Cetane Number	51 min		ISO 5165 ASTM D613 JIS K2280
Water	500 max	mg/kg (ppm)	EN 12937
Water and Sediment	0.05 max	% v/v	ASTM D2709
Total Contamination	24 max	mg/kg	EN 12662 ASTM D2276, D5452, D6217
Ash Content	0.001 max	% m/m	ISO 6245 ASTM D482 JIS K2272
Sulfated Ash	0.005 max	% m/m	ISO 3987 ASTM D874 Other: ABNT NBR 984
Carbon Residue: Ramsbottom, on 100% distillation residue	0.05 max	% m/m	ASTM D4530
Corrosion: Ferrous	light rusting, max	Rating	ASTM D665 Procedure A
Sulfur	10 max	ppm	EN 20846/20884 ASTM D5453/D2622 JIS K3541-1, -2, -6 or -7
Phosphorus	4 max	mg/kg	EN 14107 ASTM D4951, D3231
Alkali metals (Na+K)	5 max	mg/kg	EN 14108/14109, EN 14538
Alkaline metals (Ca+Mg)	5 max	mg/kg	EN 14538
Trace Metals	no addition		ASTM D7111

- Corrosion → metal compatibility
- Sulfur → compatibility with emission control system
- Phosphorous → could come from fertilizer or natural phospholipid, which affect emission control system
- Group I&II metals → residual metals form deposit. Possible ash formation by Na&K
- Trace elements → no metal or other contaminants



ERIA-EAS Biodiesel Standard (EEBS: 2008)



Palm



Jatropha



Coconut



Rapeseed



Soybean

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Output of the Activity in 2007/2008

EAS-ERIA Biodiesel Fuel Benchmark Standard



Items	Units	U.S.	EU	Japan	EAS-ERIA BDF Standard (EEBS):2008
		ASTM D6751-07b	EN14214:2003	JIS K2390:2008	
Ester content	mass%	-	96.5 min.	96.5 min.	96.5 min.
Density	kg/m ³	-	860-900	860-900	860-900
Viscosity	mm ² /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 Carbon residue (10%)	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.

(*) 130deg.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 hrs.

Output of the Activity in 2008/2009 onwards

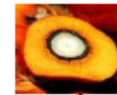
ERIA Biodiesel Fuel Trade Handbook - 1st edition for comments with subsequent update-



1. Introduction
2. Energy Situation in the World
3. Biodiesel Fuel Standardization Activities
4. Biodiesel Fuel Quality
5. Potential of Other Sustainable Feedstocks
6. Importance of Quality Control and Market Acceptance
7. Current Status of Biodiesel Fuel in East-Asian Countries
8. Trade and Market Dynamics of Biodiesel Fuel
9. Future Vision

Biodiesel Fuel Trade Handbook

(The First Edition for Comments)



Palm



Jatropha



Coconut



Rapeseed



Soybean

July 2009



Edited by ERIA Research Project Working Group on

**"Benchmarking of Biodiesel Fuel
Standardization in East Asia"**





History

- ASEAN Automotive Federation (AAF) was first established in 1976, but activities ceased in 1983 (each focus on national auto industry)
- In 1996 with the implementation of AFTA and its schemes, the ASEAN Automotive Federation was revived as a common platform to work with ASEAN Governments and ASEAN Secretariat towards achieving AFTA.

Vision

- "ASEAN with a strong and integrated vehicle and parts & components market supported by globally competitive automotive manufacturing industry".

Mission

- "To promote automotive market integration and growth, cooperation and investments in the ASEAN region".

Goal

- "To increase ASEAN market share and industry capability in the global automotive business".



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- BRUNEI
- CAMBODIA
- INDONESIA
- LAOS
- MALAYSIA
- MYANMAR
- PHILIPPINES
- SINGAPORE
- THAILAND
- VIETNAM



ASEAN AUTOMOTIVE FEDERATION TECHNICAL COMMITTEES



Name	TC - 1	TC - 2	TC - 3	TC - 4	TC - 5
Scope	Economic Cooperation	Supporting Industries & Human Resource	Technical Development	Statistics & Information	Motorcycle
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Biofuel standard



PROPOSED **AAF** SPEC FOR B100 (FAME) FOR UP TO B5 BLEND

Items		AAF Recommend	
Properties	unit		Priority
Ester content	mass%	96.5 min	★★
Density	g/ml	Report	★
Kinematic Viscosity	mm ² /s	2.0 - 5.0	★
Flash Point	°C	100 min	★
Sulfur	ppm	10 max	★★
Carbon Residue 10%	mass%	0.3 max	★
Carbon Residue 100%	mass%	0.05 max	★
Cetane Number		51 min	★
Sulfated Ash	mass%	0.02 max	★★
Ash	mass%	-	
Water	ppm	500 max	★★
Total Contamination	ppm	24 max	★★
Water and Sediment	vol%	-	
Copper Corrosion		1 max	★
Total Acid Number	mgKOH/g	0.50 max	★★
Oxidation Stability	hrs	10 min	★★★
Iodine Number	gl ₂ /100g	120 max	★★
Linolenic acid methyl ester	mass%	12.0 max	★
Polysaturated acid methyl ester	mass%	-	
Methanol	mass%	0.20 max	★
Mono glyceride	mass%	0.80 max	★★
Di glyceride	mass%	0.20 max	★★
Tri glyceride	mass%	0.20 max	★★
Free glycerine	mass%	0.02 max	★★
Total glycerine	mass%	0.25 max	★★
Metals (Na + K)	ppm	5 max	★★★
Metals (Ca + Mg)	ppm	5 max	★★★
Phosphorus	ppm	4 max	★★



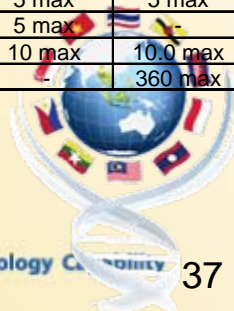
Comparison of all Harmonization Initiatives (1)

Items		AAF Recommend		WWFC	ERIA	Europe	USA	Japan	Australia	China	China Taipei	India	Indonesia	Korea
	unit	JAMA Proposal	Priority	Guideline for B5 Blend	Benchmark Standard	EN14214: 2003	ASTM D6751: 2011	JIS K2390		GB/T20828: 2007	CNS 15072	IS 15607: 2005	SNI 04-7182-2006	PPAFB Act
Ester content	mass%	96.5 min	★★	96.5 min	96.5 min	96.5 min	-	96.5 min	96.5 min	0.82 - 0.90 (20 °C)	96.5 min	96.5 min	96.5 min	96.5 min.
Density at 15 °C	g/ml	Report	★	Report	0.86 - 0.90	0.86 - 0.90	-	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90	0.85 - 0.89	0.86-0.90
Kinematic Viscosity	mm2/s	2.0 - 5.0	★	2.0 - 5.0	2.0 - 5.0	3.5 - 5.0	1.9 - 6.0	3.5 - 5.0	3.5 - 5.0	1.9 - 6.0 (20 °C)	3.5 - 5.0	2.5 - 6.0	2.3 - 6.0	1.9-5.0
Flash Point	°C	100 min	★	100 min	100 min	120 min	130 min	120 min	120 min	130 min	120 min	120 min	100 min	120 min.
Sulfur	ppm	10 max	★★	10 max	10 max	10 max	500 max	10 max	10 max	50 max	10 max	50 max	100 max	10 max.
Carbon Residue 10%	mass%	0.3 max	★	-	0.3 max	0.3 max	-	0.3 max	0.3 max				0.3 max	0.1 max
Carbon Residue 100%	mass%	0.05 max	★	0.05 max	0.05 max	-	0.05 max	-				0.05 max	0.05 max	
Cetane Number		51 min	★	51 min	51 min	51 min	47 min	51 min	51 min	49 min	51 min	51 min	51 min	-
Sulfated Ash	mass%	0.02 max	★★	0.005 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.01 max.
Ash	mass%	-		0.001 max	-	-	-	-	-				-	
Water	ppm	500 max	★★	500 max	500 max	500 max	-	500 max	500 max				500 max	500 max.
Total Contamination	ppm	24 max	★★	24 max	24 max	24 max	-	24 max	24 max		24 max	24 max	-	24 max.
Water and Sediment	vol%	-		0.05 max	-	-	0.05 max	-					0.05 max	
Copper Corrosion		1 max	★	1 max	1 max	1 max	3 max	1 max	1 max	1 max	1 max	1 max	3 max	1 max
Total Acid Number	mgKOH/g	0.50 max	★★	0.5 max	0.5 max	0.5 max	0.5 max	0.5 max	0.8 max	0.8 max	0.5 max	0.5 max	0.8 max	0.50 max.
Oxidation Stability	hrs	10 min	★★★	10 min	10 min	6 min	3 min	To be agreed	6 min	6 min	6 min	6 min	-	6 min.
Iodine Number	gI2/100g	120 max	★★	130 max	Report	120 max	-	120 max			120 max	Report	115 max	-
Linolenic acid methyl	mass%	12.0 max	★	12.0 max	12.0 max	12.0 max	-	12.0 max			12.0 max		-	-
Polyunsaturated acid methyl ester	mass%	-		1 max	-	1 max	-	-					-	-
Methanol	mass%	0.20 max	★	0.20 max	0.20 max	0.20 max	-	0.20 max	0.20 max		0.20 max	0.20 max	-	0.20 max.
Mono glyceride	mass%	0.80 max	★★	0.80 max	0.80 max	0.80 max	-	0.80 max			0.80 max		-	0.80 max.
Di glyceride	mass%	0.20 max	★★	0.20 max	0.20 max	0.20 max	-	0.20 max			0.20 max		-	0.20 max.
Tri glyceride	mass%	0.20 max	★★	0.20 max	0.20 max	0.20 max	-	0.20 max			0.20 max		-	0.20 max.
Free glycerine	mass%	0.02 max	★★	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max.
Total glycerine	mass%	0.25 max	★★	0.25 max	0.25 max	0.25 max	0.24 max	0.25 max	0.25 max	0.24 max	0.25 max	0.25 max	0.24 max	0.24 max.
Metals (Na + K)	ppm	5 max	★★★	5 max	5 max	5max	-	5 max	5 max	5 max	5 max	Report	-	5.0 max.
Metals (Ca + Mg)	ppm	5 max	★★★	5 max	5 max	5 max	-	5 max	5 max	5 max	5 max	Report	-	5.0 max.
Phosphorus	ppm	4 max	★★	4 max	10 max	4 max	10 max	10 max	10 max		10 max	10 max	10 max	10.0 max.
T90	°C	-		-	-	-	360 max	-					360 max	



Comparison of all Harmonization Initiatives (2)

Items	unit	AAF Recommend JAMA Proposal	Priority	WWFC Guideline for B5 Blend	ERIA Benchmark Standard	Europe EN14214: 2003	USA ASTM D6751: 2011	Japan JIS K2390	Malaysia MS 2008: 2008	New Zealand Engine Fuel Regulation 2008	Philippines PNS/DOE QS 002:2007	Thailand DOEB B100 Spec., B.E. 2552 (2009)	Vietnam TCVN 7717:2007
Properties	unit	96.5 min	★★	96.5 min	96.5 min	96.5 min	-	96.5 min	96.5 min	96.5 min	96.5 min	96.5 min	96.5 min
Ester content	mass%	96.5 min	★★	96.5 min	96.5 min	96.5 min	-	96.5 min	96.5 min	96.5 min	96.5 min	96.5 min	96.5 min
Density at 15 °C	g/ml	Report	★	Report	0.86 - 0.90	0.86 - 0.90	-	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90	0.86 - 0.90
Kinematic Viscosity	mm ² /s	2.0 - 5.0	★	2.0 - 5.0	2.0 - 5.0	3.5 - 5.0	1.9 - 6.0	3.5 - 5.0	3.5 - 5.0	2.0 - 6.0	2.0 - 4.5	3.5 - 5.0	1.9 - 6.0
Flash Point	°C	100 min	★	100 min	100 min	120 min	130 min	120 min	120 min	100 min	100 min	120 min	130 min
Sulfur	ppm	10 max	★★	10 max	10 max	10 max	500 max	10 max	10.0 max	10.0 max	0.05 mass%	10 max	500 max
Carbon Residue 10%	mass%	0.3 max	★	-	0.3 max	0.3 max	-	0.3 max	0.3 max	0.3 max	-	0.3 max	-
Carbon Residue 100%	mass%	0.05 max	★	0.05 max	0.05 max	-	0.05 max	-	0.05 max	0.05 max	0.05 max	-	0.05 max
Cetane Number		51 min	★	51 min	51 min	51 min	47 min	51 min	51.0 min	47.0 min	55 min	51 min	47 min
Sulfated Ash	mass%	0.02 max	★★	0.005 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max
Ash	mass%	-		0.001 max	-	-	-	-	-	-	-	-	-
Water	ppm	500 max	★★	500 max	500 max	500 max	-	500 max	500 max	500 max	0.05 vol%	500 max	-
Total Contamination	ppm	24 max	★★	24 max	24 max	24 max	-	24 max	24 max	24 max	-	24 max	-
Water and Sediment	vol%	-		0.05 max	-	-	0.05 max	-	-	-	0.05 max	-	0.05 max
Copper Corrosion		1 max	★	1 max	1 max	1 max	3 max	1 max	1 max	1 max	1 max	1 max	1 max
Total Acid Number	mgKOH/g	0.50 max	★★	0.5 max	0.5 max	0.5 max	0.5 max	0.5 max	0.5 max	0.5 max	0.5 max	0.50 max	0.5 max
Oxidation Stability	hrs	10 min	★★★	10 min	10 min	6 min	3 min	To be agreed	6 min	10 min	6 min	10 min	6 min
Iodine Number	gI ₂ /100g	120 max	★★	130 max	Report	120 max	-	120 max	100 max	140 max	-	120 max	120 max
Linolenic acid methyl	mass%	12.0 max	★	12.0 max	12.0 max	12.0 max	-	12.0 max	12.0 max	12.0 max	-	12.0 max	-
Polyunsaturated acid methyl ester	mass%	-		1 max	-	1 max	-	-	1 max	1 max	-	-	-
Methanol	mass%	0.20 max	★	0.20 max	0.20 max	0.20 max	-	0.20 max	0.20 max	0.20 max	0.2 max	0.20 max	-
Mono glyceride	mass%	0.80 max	★★	0.80 max	0.80 max	0.80 max	-	0.80 max	0.80 max	0.80 max	0.8 max	0.80 max	-
Di glyceride	mass%	0.20 max	★★	0.20 max	0.20 max	0.20 max	-	0.20 max	0.20 max	0.20 max	0.2 max	0.20 max	-
Tri glyceride	mass%	0.20 max	★★	0.20 max	0.20 max	0.20 max	-	0.20 max	0.20 max	0.20 max	0.2 max	0.20 max	-
Free glycerine	mass%	0.02 max	★★	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max
Total glycerine	mass%	0.25 max	★★	0.25 max	0.25 max	0.25 max	0.24 max	0.25 max	0.25 max	0.25 max	0.24 max	0.25 max	0.24 max
Metals (Na + K)	ppm	5 max	★★★	5 max	5 max	5max	-	5 max	5.0 max	5.0 max	5 max	5 max	5 max
Metals (Ca + Mg)	ppm	5 max	★★★	5 max	5 max	5 max	-	5 max	5.0 max	5.0 max	5 max	5 max	5 max
Phosphorus	ppm	4 max	★★	4 max	10 max	4 max	10 max	10 max	10.0 max	10.0 max	10.0 max	10 max	10.0 max
T90	°C	-		-	-	-	360 max	-	-	-	360 max	-	360 max



Lesson learned and common ground

- Difficult to enforce mandatory specification like EU
- Even mutual agreement on voluntary basis still difficult
 - Oxidation stability
 - Blend limit
- Could be used as
 - Bargaining power from the region
 - Non-tariff barrier



Thank you very much
Questions or Comments?

