World Wide Fuel Charter
- Recommended Biofuel Specifications -

February 18, 2009 @Ho Chi Minh

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Fuels and Lubricants Committee
Japan Automobile Manufacturers Association

WWFC (World Wide Fuel Charter)

- **Activity objectives;**
  - Cleaner fuels for low emission vehicles to achieve cleaner environment
  - Global fuels harmonization
  - Fulfill customer requirements

- **History;**
  - Early 1990s: “CCMC Fuel Charter” in Europe
    1994: “AAMA National Gasoline Spec.” in US & JAMA also supported
  - **1998: 1st WWFC published through co-effort of ACEA, AAM & JAMA --- 4th Edition in 2006**

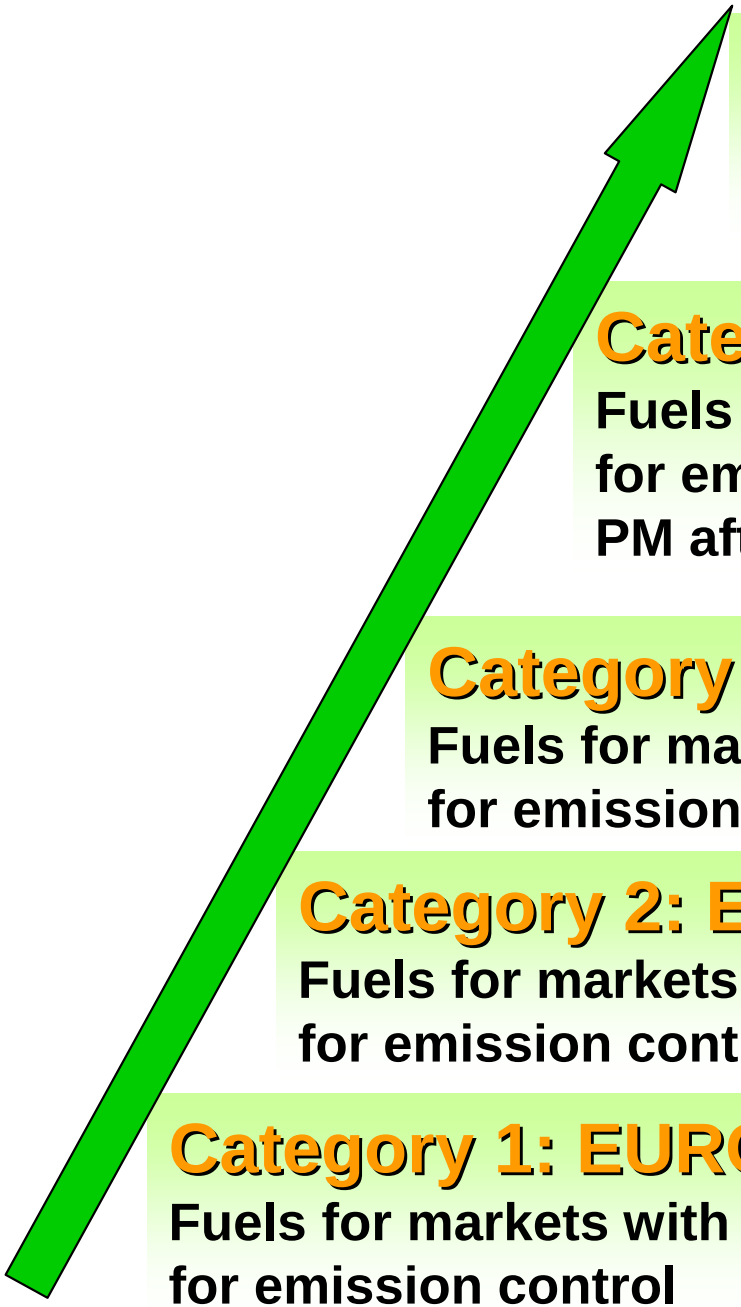
WWFC Committee

Countries represented:

- Brazil (ANFAVEA)
- Canada (AIAMC, CVMA)
- China (CAAM)
- Europe (ACEA)
- India (SIAM)
- Indonesia (IAF)
- Japan (JAMA)
- Korea (KAMA)
- Malaysia (MAA)
- Mexico (AMIA)
- Philippines (CAMPI)
- South Africa (NAAMSA)
- Thailand (TAIA)
- US (Alliance, AIAM, EMA)
- Vietnam (VAMA)

Supporting: International (OICA)

Outline of The Categories in WWFC



Category 5?
Fuels needed to achieve future emission levels and emission control

Category 4: EUROⅣ-Ⅴ
Fuels for markets with further advanced requirements for emission control, to enable sophisticated NOx and PM after-treatment technologies

Category 3: EUROⅢ
Fuels for markets with advanced requirements for emission control

Category 2: EUROⅡ-Ⅲ
Fuels for markets with stringent requirements for emission control

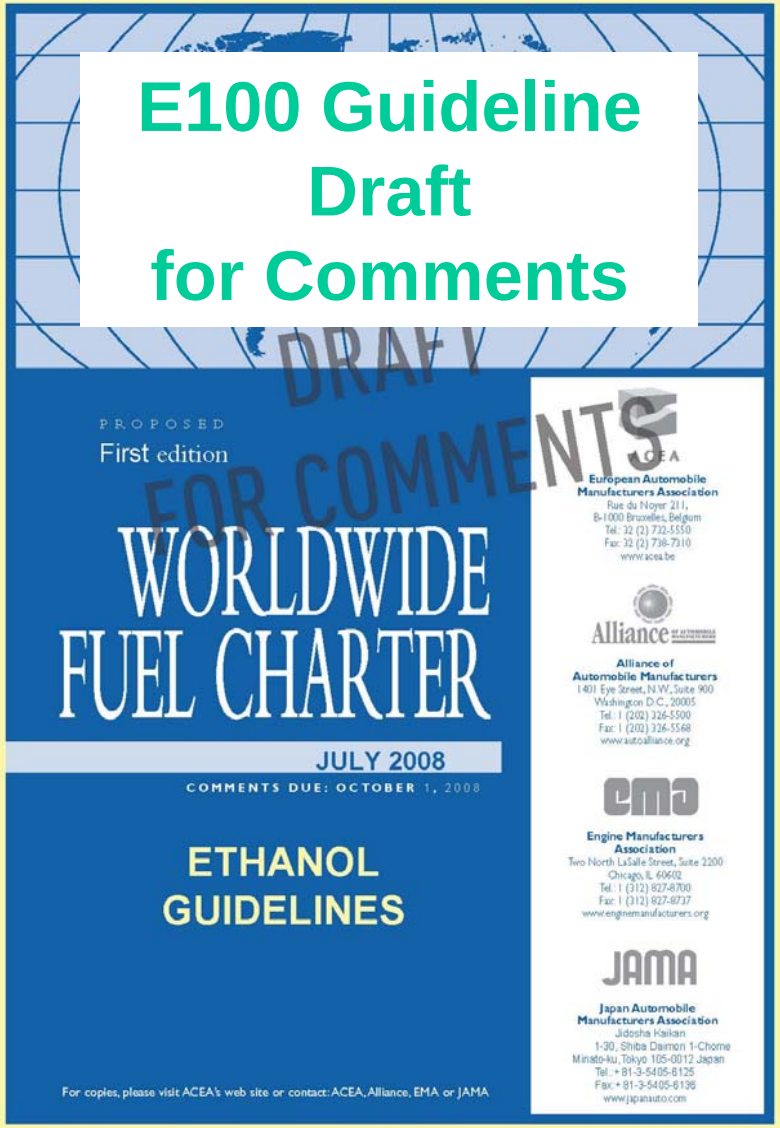
Category 1: EUROⅠ
Fuels for markets with minimal requirements for emission control

Biofuels: First Growth

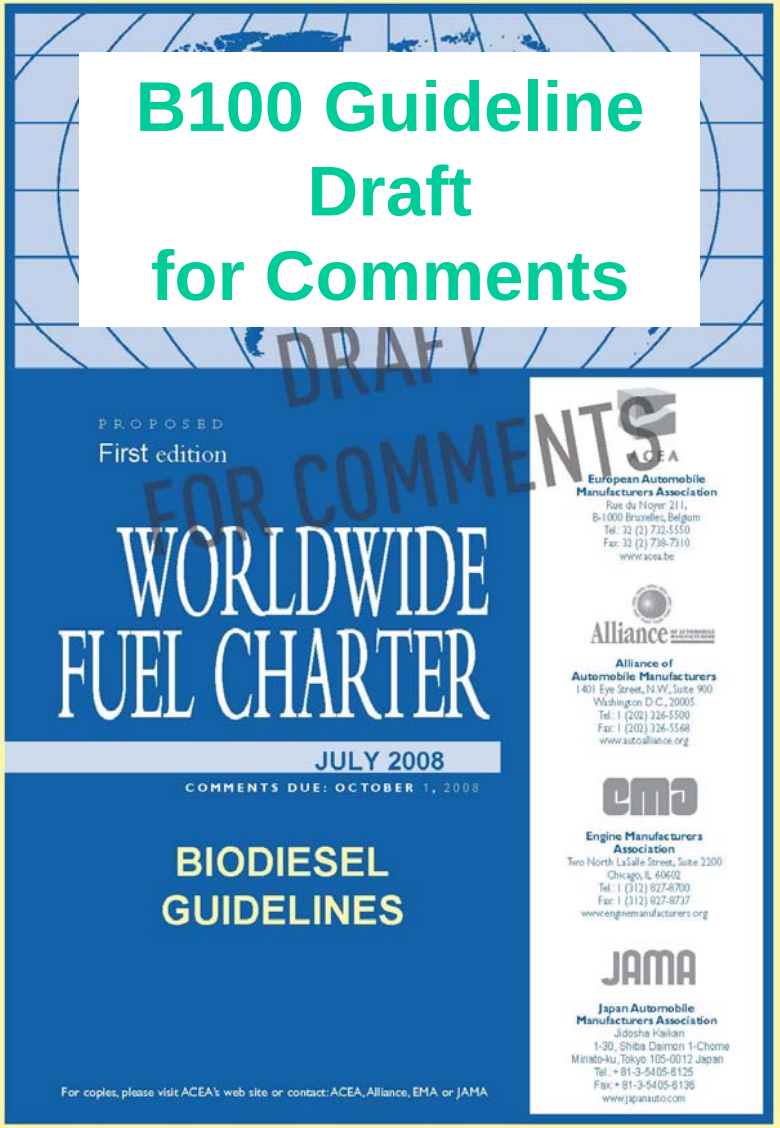
- **Vehicle & Engine makers strongly support**
  - **Reduce petroleum use**
  - **Improve energy security**
  - **Reduce greenhouse gas emissions**
- **Changing vehicle technologies, regulations**
- **Complex mixtures, new to market**
- **Guidance needed**

E100 & B100 Guidelines for E10 & B5 Blends

E100 Guideline Draft for Comments



B100 Guideline Draft for Comments



Guideline Objectives

- **Benefit consumers**
- **Simplify fuel markets**
- **Facilitate international trade**
- **Help governments meet public policy goals**

Target: Producers, Blenders and Distributors

- **E100 & B100 specs for E10 & B5 blends**
  - **Performance based**
  - **Feedstock neutral**
- **Test methods**
- **Good management practices**
  - **4th WWFC still applies to retail gasoline & diesel fuel quality**
  - **Fuel supplier responsible for final product**

E100 Specs and Test Methods

Property	*Value*	*Units*	*Test Methods*
Ethanol plus C3-C5 saturated alcohols (anhydrous)	99.2 min	% m/m	ISO: EN 15721 ASTM: D5501 Other: JAAS001-6.2
C3-C5 saturated alcohols (anhydrous)	2 max	% m/m	ISO: EN 15721
Methanol	0.5 max	% m/m	ISO: EN 15721 ASTM: D5501
Water	0.3 max	% m/m	ISO: EN 15489 ASTM: D203 JIS: K8101
Density @ 20° C	791.5 max	kg/m^3	ASTM: D 4052 Other: ABNT NBR 5992
Electrical conductivity	500 max	µS/m	ASTM: D 1125 JIS: K0130 Other: ABNT NBR 10547:2006
Inorganic chloride	10.0 max	mg/l	ISO: EN 15484 or prEN 15492 ASTM: D7319; D7328 Other: ABNT NBR 10894/10895
Sulfate Sulfate in finished blend (≤E10 v/v)	4 max 1 max	mg/kg	ISO: prEN 15492 ASTM: D7318, D7319, D7328 Other: ABNT NBR 10894/12120
Copper	0.100 max	mg/kg (ppm)	ISO: EN 15488:2007 ASTM: D1688 modified, Method A JIS: K 0101 Other: ABNT NBR 10893
Organic impurities	10 max (1) max	mg/l (% m/m)	JIS: JAAS001 – 6.4

E100 Specs and Test Methods *(cont'd)*

Property	*Value*	*Units*	*Test Methods*
Phosphorus	0.50 max	mg/l	ISO: EN 15487 ASTM: D3231
Sulfur	10 max	mg/kg or ppm	ISO: EN 15486:2007 ASTM: D5453 (< 20 ppm) JIS: K2541
Heavy metals	Non-detectable; No intentional addition		Other: ICP-AES
Non-volatile material	5 max	mg/100 ml	ISO: prEN 15691 ASTM: D381 JIS: JAAS001-6.3 Other: ABNT NBR 8644
pHe	6 – 8		ASTM: D 6423 *Methods that produce "pHe-like" results:* ISO: EN 15490:2007 JIS: JASO M361-6.10 Other: ABNT NBR 10891:2006
Acidity (as acetic acid)	0.007 max	% m/m	ISO: EN 15491:2007 ASTM: D 1613 Other: ISO 1388/2; ABNT NBR 9866:2006
Appearance	clear, no visible impurities		
Color	local requirement		

B100 Specs and Test Methods

Property	Value	Units	Test Methods
Ester content	96.5 min	% m/m	ISO: EN 14103 mod; EN 14078 Other: ABNT NBR 15342
Linolenic acid methyl ester	12.0 max	% m/m	ISO: EN 14103 mod
Polyunsaturated acid methyl ester (≥4 double bonds)	1 max	% m/m	ISO: prEN 15799
Oxidation stability			
Induction period	10 min	hr	ISO: EN 14112 or prEN 15751 as alternative
Insolubles	2.5 max	mg/100 mL	ISO: EN 12205 ASTM: D2274
Iodine number	130 max* *May unnecessarily preclude certain feedstocks.	g I_2/100 g	ISO: EN 14111 (for use on B100 only, not blends)
Total acid number	0.5 max	mg KOH/g	ISO: EN 6618, EN 14104 ASTM: D664, D974 JIS: K 2501 Other: ABNT NBR 14448
Methanol	0.20 max	% m/m	ISO: EN 14110 JIS: K 2536 Other: ABNT NBR 15343
Glycerides			
Mono-glyceride	0.80 max	% m/m	ISO: EN 14105 Other: ABNT NBR 15342
Di-glyceride	0.20 max	% m/m	ISO: EN 14105 Other: ABNT NBR 15342
Tri-glyceride	0.20 max	% m/m	ISO: EN 14105 Other: ABNT NBR 15342
Glycerin (glycerol)			
Free glycerin	0.02 max	% m/m	ISO: EN 14105/14106 ASTM: D6584 Other: ABNT NBR 15341
Total glycerin	0.24 max	% m/m	ISO: EN 14105 ASTM: D6584 Other: ABNT NBR 15344

B100 Specs and Test Methods *(cont'd)*

Property	*Value*	*Units*	*Test Methods*
Density	0.86 - 0.90	g/ml @15° C	ISO: EN 3675 ASTM: D4052 JIS: K 2249 Other: EN 12185, ABNT NBR 7148/14065
Kinematic viscosity	2.0 - 5.0	mm^2/s @40° C	ISO: EN 3104 ASTM: D445 JIS: K2283 Other: ABNT NBR 10441
Flash point	100 min	° C	ISO: 2719 ASTM: D93
Cetane number	51 min		ISO: 5165 ASTM: D613 JIS: K2280
Water	500 max	mg/kg (ppm)	ISO: EN 12937
Water and Sediment	0.05 max	% v/v	ASTM: D2709
Total contamination	24 max	mg/kg	ISO: EN 12662 ASTM: D2276, D5452, D6217
Ash content	0.001 max	% m/m	ISO: EN 6245 ASTM: D482 JIS: K2272
Sulfated ash	0.005 max	% m/m	ISO: EN 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	ISO: EN 20846/20884 ASTM: D5453/D2622 JIS: K3541-1, -2, -6 or -7
Phosphorus	4 max	ppm	ISO: EN 14107 ASTM: D4951, D3231
Alkali metals (Na+K) Alkaline metals (Ca+Mg)	5 max 5 max	ppm ppm	ISO: EN 14108/14109, EN 14538 ISO: EN 14538
Trace metals	no addition		ASTM D7111
Injector coking	2% max	permitted power loss	CEC F-98-08

Discussion in WWFC B100 Guideline for B5 Blend

Property	Value	Issues
Kinematic viscosity	2.0 - 5.0 mm^2/s	Feedstock neutral
Flash point	100 deg.C min	Feedstock neutral
Ash	0.001 mass% max	Impact on DPF
Sulfated ash	0.005 mass% max	Impact on DPF
Oxidation stability	10 hrs min	Corrosion, Inj. deposits, etc.
Iodine number	130 max	Feedstock neutral Oxidation stability (sludge) and engine oil degradation
Phosphorous	4 ppm max	Impact on catalyst
Metals (Na + K)	5 ppm max	Inj. deposits, Impact on cat.
Metals (Ca + Mg)	5 ppm max	Pump stick, etc.

Remaining Issues

- **Sludge (and also soap) formation tendency**
  - **No adequate test method** for sludge formation
    ⇒ **iodine number** & **poly-unsaturated FAME**
  - **Relation to oxidation stability** besides influence on corrosion is under investigation in Japan
- **Impact on advanced engine & emission control system (fuel injector, catalyst . . .)**
  - **Severe control of metals content** is essential
    ⇒ incl. **ash / sulfated ash** & **phosphorous**
- **Filter plugging issue**
  - **Lower mono-glyceride content limit** is under discussion in Europe

Status of Guideline Finalization

- **Draft for comments issued in July, 2008**
  - **Posted at committee member websites**
- **Submission: deadline, October 1, 2008**
  - **Total 15 commenters from US, Europe & Asia**
  - **Received comment from MPOB, Malaysia**
- **WWFC Committee held on November 7, 2008 (@Chicago) to review comments**
  - **Almost done & reflected to the guideline**
- **Finalization: target, by March, 2009**

Approach for Harmonization of Biofuel specification

- **WWFC is common world-wide recommendation for "quality fuels" to meet its activity objective of global fuel harmonization**

- **Another efforts besides WWFC;**
  - ERIA Energy Project
  (Working Group for the Standardization of Bio-diesel Fuel in East Asia)
  Objective: develop common agreement for BDF standardization & support its formulation

EAS-ERIA Biodiesel Fuel Benchmark Standard

EAS: East Asia Summit ERIA: Economic Research Institute for ASEAN and East Asia

Items	Units	U.S. ASTM D6751-07b	EU EN14214:2003	Japan JIS K2390:2008	EAS-ERIA BDF Standard (EEBS):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 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.

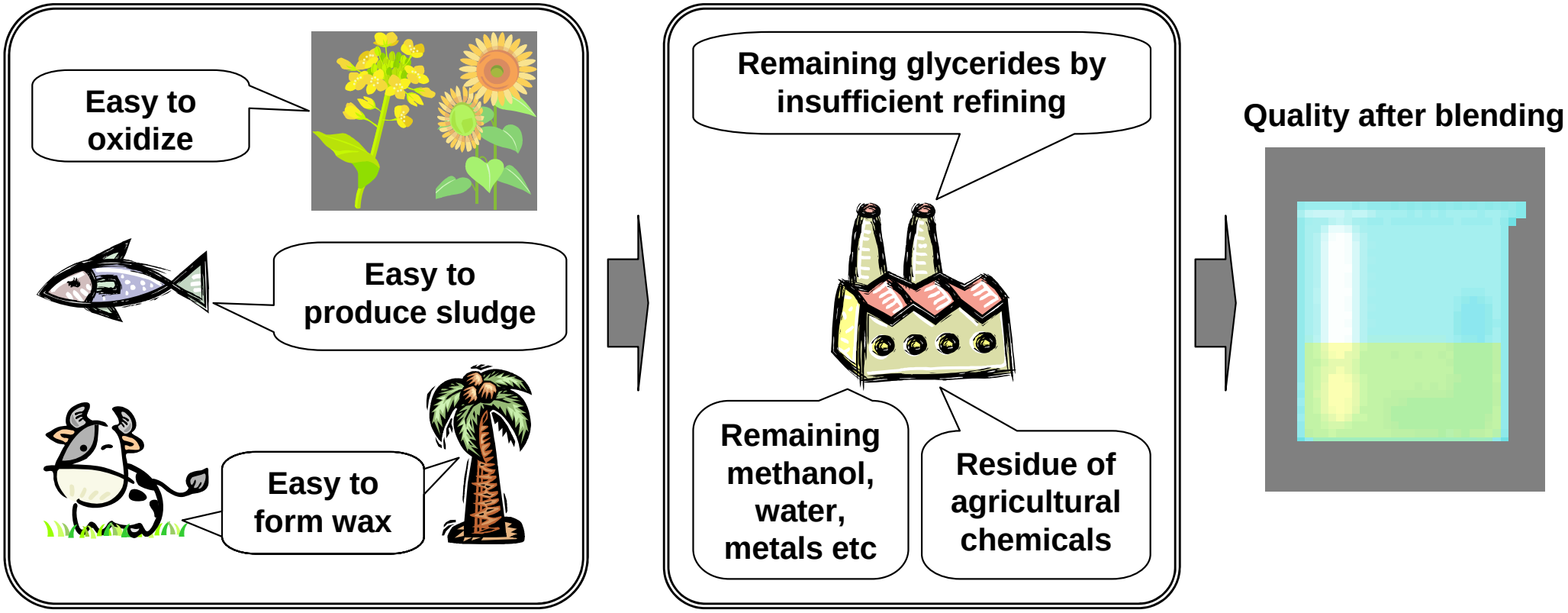
(*) Meet diesel oil specification

JAMA's position on Biofuels

- **From view point of energy security & CO_2 reduction, biofuels become more important**
- **JAMA positively corresponds to introduction of biofuels from view point of technical perspective for our customers**
- **Issues to be solved;**
  - **Quality control at pump to prevent problem**
  - **Competition with food, land development and water pollution**
  - **Cost, etc.**

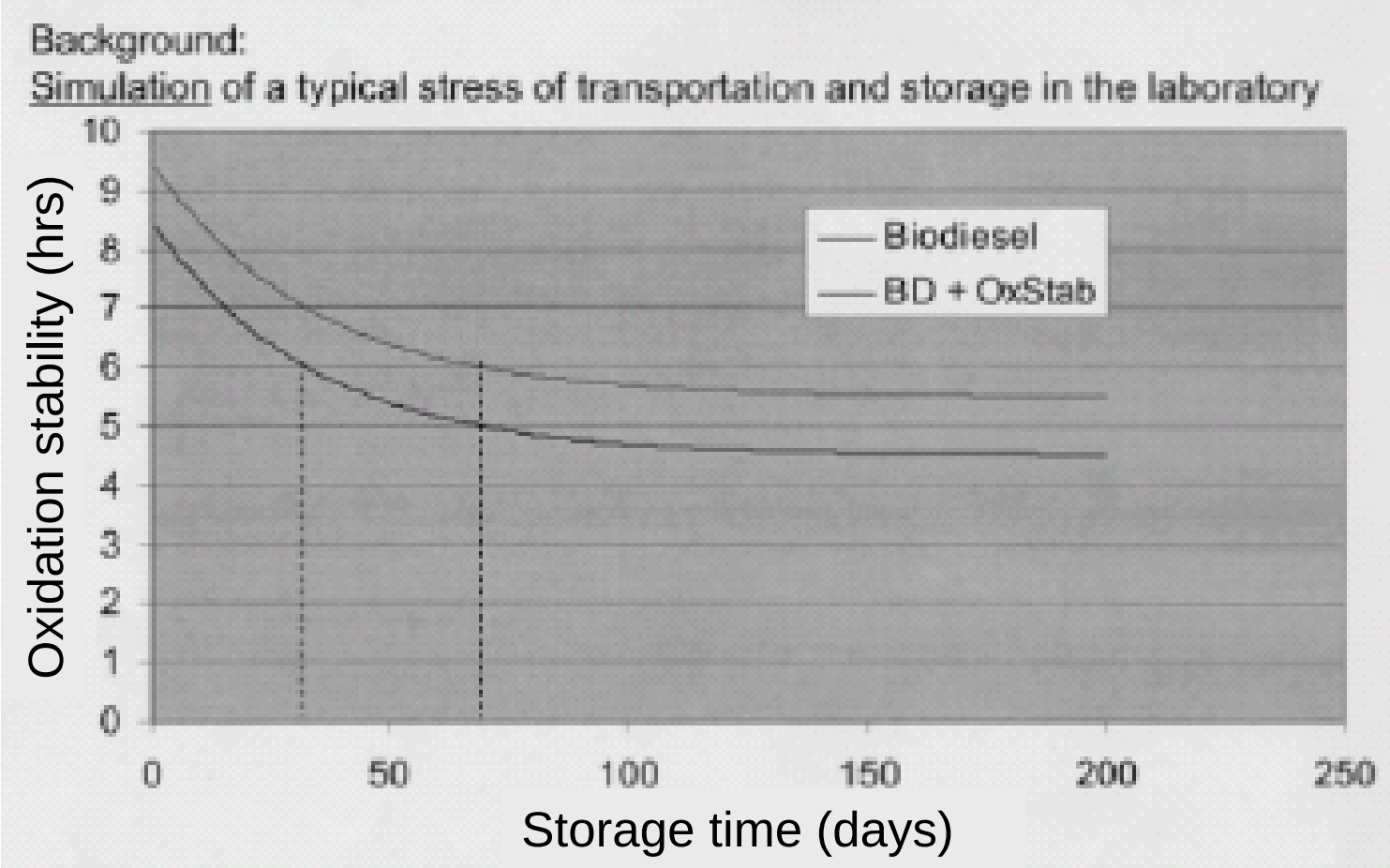
Characteristics of Bio Diesel (FAME)

Difference in raw material & impacts of refining process



- Bio diesel is mixture of several types of FAMEs
- Characteristics of FAME depend on raw materials and refining process
- **Both FAME to be blended** and **base diesel fuel affects** quality of FAME blended diesel fuel

Disadvantages of Bio Diesel (FAME)



Source: AGQM

- FAME has **poor oxidation stability** and it decreases as storage time goes by
- **Anti-oxidant maintains oxidation stability** to some extent

Disadvantages of Bio Diesel (FAME)

Test Fuel: Commercial diesel fuel blended with FAME meets EN14214 by 5vol%

B100, oxi. stability of **6hrs**

Test Fuel: Same FAME with 400ppm of anti-oxidant (20ppm as B5)

B100, oxi. stability of **10hrs**

Source: METI - FAME conformity test

(Lower)

(Upper)

Example of Market Experiences

Influence on FIE (pump, filter & injector);

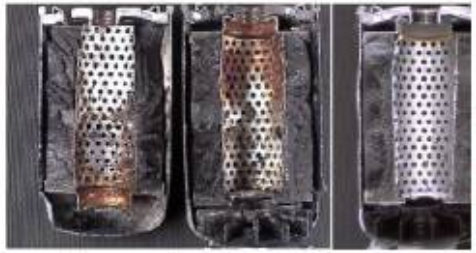
BOSCH

Biodiesel Properti
Influence on the Fuel Injection

Seminário Internacional de Biodiesel
Curitiba, 24.- 26. October 2002

Carlos A. Boldo (Diesel Systems, RBBR/EPD1,

2.1. Alkaline- and Alkaline-earth Ion



Car fuel filter: Deposit formation

Operation with RME of insufficient quality

Operation with F

2.3. Glycerine/Glycerides (1)

above: Nozzle coking from RME-operation

right: Nozzle coking from Diesel-operation

In nozzle coking deposits from RME-operation, glycerides and sodium carbonate (Na_2CO_3) are proven to be present. Na_2CO_3 is formed from sodium ions and CO_2 from the combustion chamber atmosphere.

Biodiesel Properties - Influence on the FIE

BOSCH

2.2. Fatty Acids

VE L649 FD: 771 P-Nr.:
002455 functional failure
20 Tkm field Sweden

High pressure axial piston distributor pump:

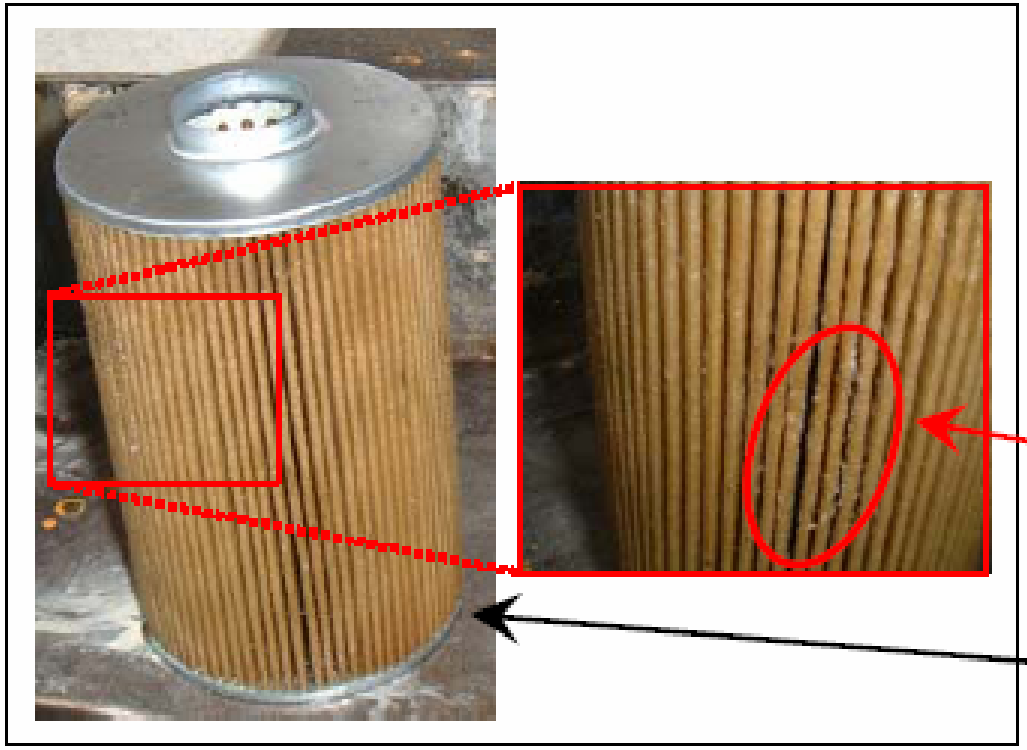
Intensive soap formation in the setting device

FV/FLA

Source: Ford presentation at World Fuels Conference, Oct. 27, 2003 @Sydney

Example of Market Experiences *(cont'd)*

Fuel filter plugging (B5);



- Residue of un reacted raw material (palmitic acid mono-glycerides) was gelated and crystallized
- **Removal of un reacted species** & **adequate spec.** to prevent these contaminations are necessary

Source: Tokyo government bio diesel bus project mid-report, issued in July, 2008

Summary – Request from JAMA

- **Properties of bio diesel (FAME) are quite different from fossil derived diesel fuel ⇒ adequate spec. & quality control at pump is essential**

- **WWFC guidelines for "quality fuels" to be issued;**
  - **Keep oxidation stability of more than 10 hrs**
  - **Need to pay attention to sludge formation**
  - **Metals should be eliminated to minimize impact on advanced E/G, emission control system**

- **Our goal is global fuel spec. harmonization;**
  - **Top priority should be given on end users**
  - **In-use vehicles must be considered**
  - **Discussion should be based on technical data**

Thank you for your kind attention !