

Current Issues & Advances & FAME Analyzers

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- New developments

FAME – QUICK FACTS

- Fatty Acid Methyl Ester, also known as biodiesel
- Manufactured by esterification of vegetable and animal fats
- Usable as a fuel by burning in a diesel engine
- Can also be blended with traditional 'crude oil' derived diesel
- Has different properties to diesel – can affect performance of final blend
- Blended into crude oil derived diesel at varying rates due to local legislation
 - Specifications for 5%, 7%, 10%, 20%, 30% etc.



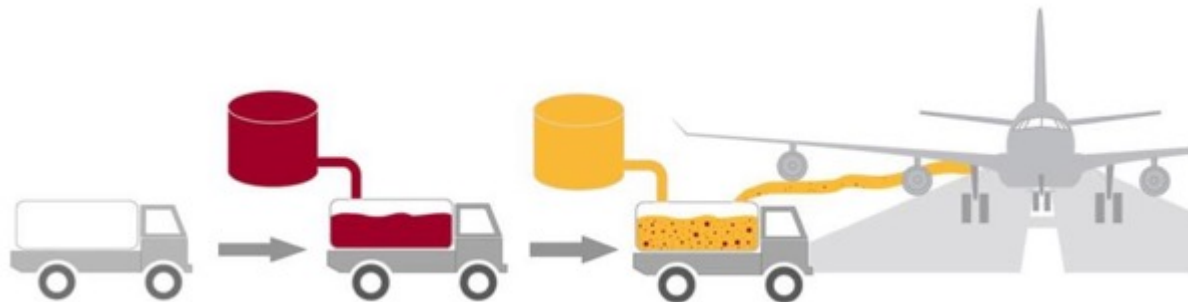
KEY INDUSTRY ISSUES

Storage	During storage, chemical and physical changes in the properties may occur as a result of degradation processes, leading to increase in acidity, potential corrosion, and formation of sediment
Microbial growth	Microbial growth in stored fuel may lead to economic losses due to blockage of filters, increase of water content, and fuel instability, as well as clogging of fuel nozzles and damage to the engines
Contamination in Aviation Fuel	FAME is not allowed at trace levels above 50 ppm
Emergency power	Long term storage affects performance
Ships & Vessels	Ageing fleets now required to have multiple fuels on board – access may be limited for tank cleaning

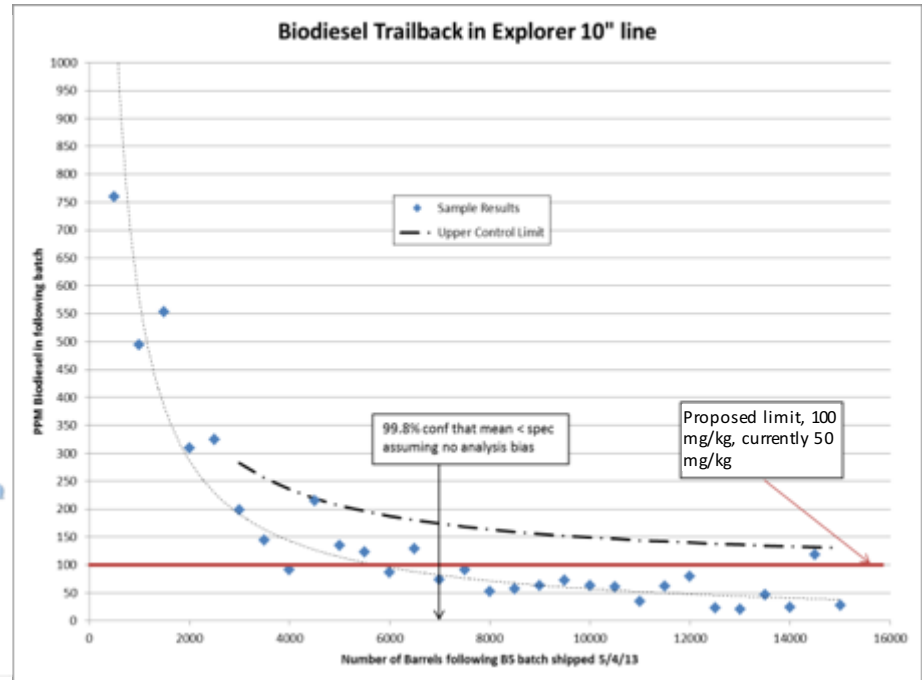


MULTIPRODUCT DISTRIBUTION

- Shared distribution networks
- Multiproduct pipelines – FAME sticks to the side walls, dead legs, valves, pumps etc.
- Storage Tanks – Biodiesel products stored in same tankage
- Vessels (Barges) – previous cargo was Biodiesel
- Tankers



Pipeline Trail Back Data



Data courtesy of Explorer Pipelines

- Houston to Dallas
- Typically after 2000 barrels the level has dropped to 300ppm
- After 7000 barrels the level trends below 100 ppm
- 1 barrel is 159 litres
- 14500 car fill ups!

Specification	Fuel	Comments
ASTM D1655	AVTUR	Not allowed, incidental material, max permitted 50 ppm
DEF STAN 91-091	AVTUR	Not allowed, incidental material, max permitted 50 ppm
MIL-DTL-16884N (F-76)	AVTUR	Not allowed, max allowed through accidental contamination 0.1%
MIL-DTL-83133J (JP-8, F-35, JP-8+100)	AVTUR	Not allowed, incidental contaminants, max permitted 50 ppm
MTL-5624W (Jp-4,JP-5,F44)	AVTUR	Not allowed, incidental contaminants, max permitted 50 ppm
MIL-DTL-STD-3004D Change 1	All	Quality assurance and surveillance standard practice for fuels, lubricants, etc.
ASTM D396	Fuel Oil	Permits up to 5% biodiesel, specific grades up to 20%
ASTM D975	Diesel/Fuel Oil	Permits up to 5%
ASTM D6751	FAME	B100, as a blend component
ASTM D7467	Diesel	B6 to B20
ISO 8217	Marine Fuel	Introducing biodiesel in next edition, current no harm limit 0.1%

MIL-DTL-16884N (F-76)

3.2.3 FAME. The recent mandatory and voluntary introduction of FAME (commonly known as biodiesel) in the commercial middle distillate marketplace has resulted in the potential for trace amounts of FAME in F-76 fuel.

Fuel supplied under this specification **shall not intentionally be blended with FAME**. In the event of contamination with FAME, the fuel supplied under this specification **shall not contain more than 0.1 volume percent** FAME as determined by BS EN 14078 or IP 579.

In light of ISO 8217 (SEE LATER), it might be good to propose to add ASTM D7963 as a possible method. Data is available demonstrating good correlation.

MIL-STD-3004D - a few quotes

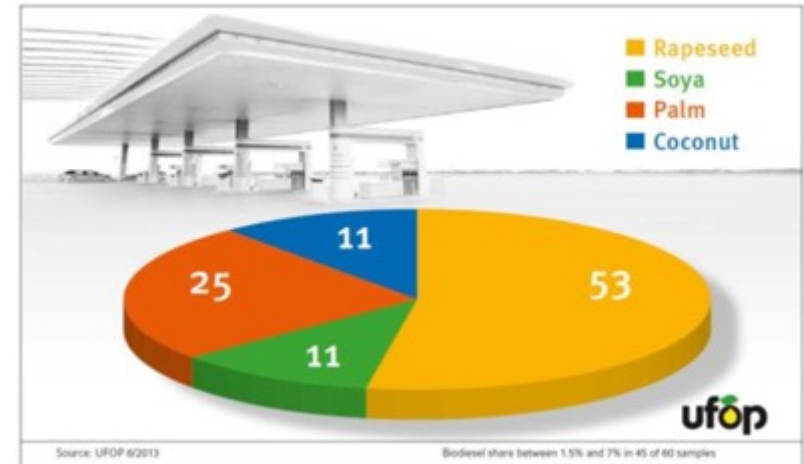
It should be noted **biodiesel blends have not been approved for use in tactical/combat** vehicles deploying for overseas combat areas.

Marine Gas Oil (MGO) - A distillate fuel, containing no residuals, used for vessel propulsion. It may also be called Distillate Marine Fuel. **Some grades of MGO may contain FAME which could be detrimental to marine propulsion systems.**

Prior to Loading the aviation fuels listed, the conveyance must have carried a previous non-FAME cargo and then be steam cleaned and dried. **Trucks that have previously carried biodiesel create a risk of cross-contamination of Jet Fuel with residual biodiesel components.** Diesel Fuel may contain up to 5% FAME without reporting it as Biodiesel. Because of the difficulties in making a determination at the load rack of the presence of FAME in the previous load, the more stringent “Steam/Dry” is required.

THAT IS WHY IT'S IMPORTANT

- All of this means that it is important to know what FAME level is present in many types of fuel
- Some analytical techniques, such as GC-MS or HPLC will not measure all types of FAME, such as Coconut derived
- Infra-red is non-discriminating – it measures all types of FAME
- In Germany in 2012 there was a wide variety due to pricing constraints



CHEMICAL ANALYSIS METHODS

- Stanhope-Seta are specialists in infra-red technologies for FAME measurement in the lab
- Developed 3 test methods
 - IP 583 / ASTM D7797 FAME in Aviation Fuel
 - ASTM D7963 FAME in Marine Fuels
- All methods designed to be **simple to use** without analytical chemists and measure all types of FAME

SIMPLE OPERATION



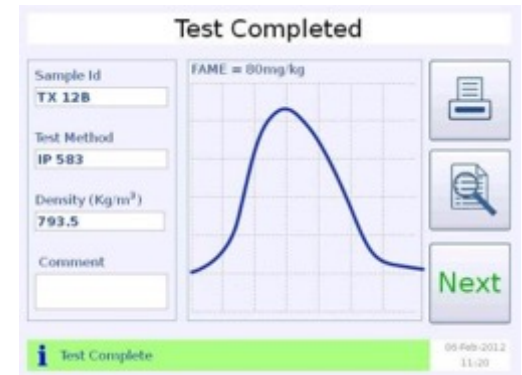
Place Cartridge



Load Sample



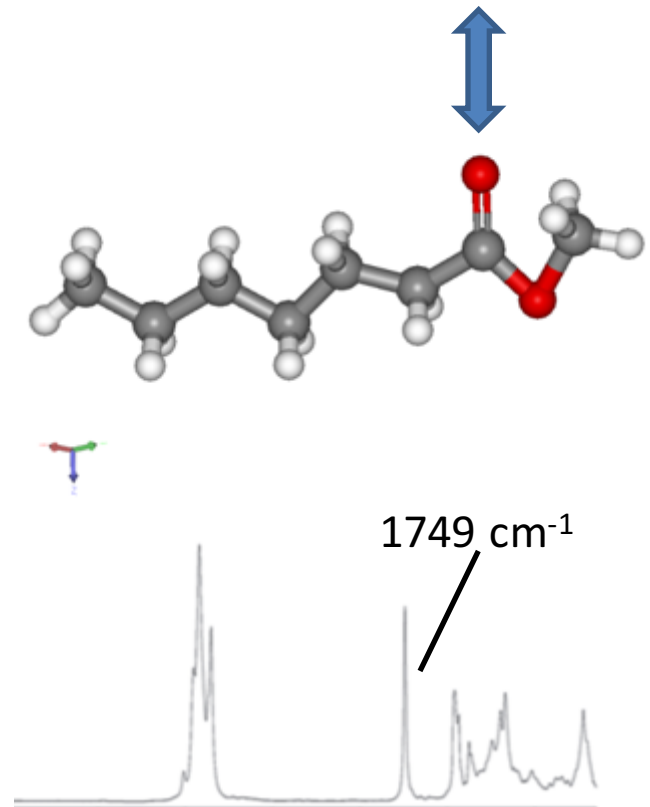
Press 'GO'



Test Completed!

- Very specifically looking at carbonyl stretching frequency in methyl ester configuration – this is what FTIR is good at!
- Excited by infra red at a very specific frequency
- FIJI capitalises on this specificity
- Detects all methyl esters

Fatty Acid	Significant Sources
4:0	butter, dairy fats
6:0	(coconut, palm kernel)
8:0	(coconut, palm kernel)
10:0	(coconut, palm kernel)
12:0	coconut, palm kernel
14:0	coconut, palm kernel
16:0	cottonseed, palm
18:0	cocoa butter, tallow
18:1 9c	cottonseed, olive, palm, rape
18:2 9c12c	corn, sesame, soybean, sunflower
18:3 9c12c15c	linseed
20:1 13c	high erucic rape
20:5 5c8c11c14c17c	fish and animal fats
22:6 4c7c10c13c16c19c	fish and animal fats



Marine Fuel Specifications – ISO 8217 6th Ed *expected early 2017*

- Biodiesel containing grades are being included
- ASTM D7963 is cited as a measurement technique
- ASTM D7963 is the only test method which can measure DMB (distillate marine grade which is a blend of residual and DMA) and RMG (residual marine grades)

ISO/CD 8217

Table 1 — Distillate marine fuels

Characteristics	Unit	Limit	Category ISO-F-							Test method reference
			DMX	DMA	DFA	DMZ	DFZ	DMB	DFB	
Kinematic viscosity at 40°C	mm ² /s ^a	Max	5,500	6,000	6,000	6,000	11,00			ISO 3104
		Min	1,400	2,000	3,000	2,000				
Density at 15°C	kg/m ³	Max	-	890,0	890,0	900,0			ISO 3675 or ISO 12185 - see 6.1	
Cetane index		Min	45	40	40	35			ISO 4284	
Sulfur ^b	mass %	Max	1,00	1,00	1,00	1,50			see 6.3	
Flash point	°C	Min	43,0	60,0	60,0	60,0			ISO 2719 - see 6.4	
Hydrogen sulphide	mg/kg	Max	2,00	2,00	2,00	2,00			IP 570 - see 6.5	
Acid number	mg KOH/g	Max	0,5	0,5	0,5	0,5			ASTM D664 or IP 177 - see 6.6	
Total sediment by hot filtration	mass %	Max	-	-	-	0,10 ^c			ISO 10307-1 - see 6.8	
Oxidation stability	g/m ³	Max	25	25	25	25 ^d			ISO 12205	
Fatty acid methyl ester (FAME) ^e	volume %	Max	-	-	7,0	-	7,0	-	7,0	ASTM D7963 or IP 579 - see 6.10



Summary

- Biodiesel is in the supply chain and is used all over the world as a fuel or as a constituent of fuels, supported by specifications and legislation
- Specifications state specific limits or requirements or where it is not required or allowed
- Analysis of biodiesel % v/v is an important parameter, and also mg/kg trace levels
- Infra-red techniques continue to keep pace and advance the measurement capability to give users knowledge

Thank you – Questions ?

