DELPHI BOSCH SIEMENS VDO Automotive

DENSO STANADYNE

Fatty Acid Methyl Ester Fuels
As a Replacement or Extender for Diesel Fuels

Diesel Fuel Injection Equipment Manufacturers
Common Position Statement

Please note that this statement supersedes all previous joint statements

Background:

Diesel fuel injection equipment (FIE) manufacturers fully support the development of alternative sources of fuel for compression ignition engines. In Europe and in the United States of America, as well as in other countries, fuel resources such as rapeseed methyl ester (RME) and soybean methyl ester (SOME), collectively known as fatty acid methyl esters (FAME), are being used as alternatives and extenders for mineral oil derived fuels. Furthermore, the EU Biofuels Directive 2003/30/EC requires member states to ensure that a minimum proportion of biofuels or other renewable fuels are placed on the market.

The FIE manufacturers are aware of issues particular to FAME fuels, and have been active in the generation of standards for these fuels. At the time of the last common position statement in 2000 there existed national standards for vegetable oil methyl esters (VOME) in Austria, Italy, Germany and France. The European FAME standard EN14214 was ratified in 2003 and supersedes these national standards.

EN14214 provides the minimum requirements for FAME quality whether used as pure FAME or as a blend component. FAME may be blended in quantities of up to 5% in European diesel fuel according to the EN590 specification. **In order to reduce the risk of premature failure of the fuel system, FAME must conform to EN 14214.**

To date, experience in Europe has been mainly associated with the methyl esters of rapeseed oil. Whether or not the service experience with these fuels will apply/extend to all FAMEs (like those derived from soybean, tallow and used frying oil) has yet to be determined. FAMEs tested to date appear to have good lubricity and cetane numbers, but have risks which are discussed below.

FIE Manufacturers Concerns:

FAMEs are derived from a wide range of base stocks, resulting in a similarly wide range of finished fuel characteristics.

Amongst the concerns of the FIE manufacturers are the following fuel characteristics:

- free methanol

- **water**
- **free glycerine**
- **mono, di- and triglycerides**
- **free fatty acids**
- **total solid impurity level**
- **alkali/alkaline earth metals**
- **oxidation stability**

All FAMEs are less stable than mineral oil derived fuels. FAMEs are readily "bio-degradable" in the event of accidental spillage or leakage, which is claimed to be a marketing advantage. On the other hand, the reduced thermal oxidative stability is of major concern to the FIE manufacturers, as the products of fuel ageing can be potentially harmful to the fuel system.

Tests have shown that fuel deterioration can take place in the fuel supply chain and in the vehicle fuel system. Fuel ageing is accelerated in the presence of heat, oxygen, water, metal ions and other impurities. The products of oxidative ageing have been shown to be corrosive (e.g. organic acids like formic and acetic acids and acids of higher molecular weight). Polymerisation products are also formed and can drop out.

A detailed list of potential problems for FIE systems from FAME is presented in the attachment to this document.

Blends with FAME :

A particular concern is the oxidation stability of FAME blends with sulphur-free diesel fuel (S <10 ppm), which is already available in some parts of Europe and will become more widely used step by step. The oxidation stability of blends as low as B5 can greatly reduce when using sulphur-free diesel or 15 ppm sulphur diesel such as that planned for introduction in U.S.A. in June 2006.

The FIE manufacturers request their customers to support their efforts to obtain good oxidation stability for 5% FAME blends in Europe or for any other blends worldwide.

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Common Position Statement on Fatty Acid Methyl Ester (FAME) Fuels as a Replacement or Extender for Diesel Fuels
June 2004

The FIE manufacturers position:

FIE manufacturers encourage the development of renewable compression ignition fuels.

Experience to date with Rapeseed Methyl Ester fuels in Europe suggests that RME conforming to the European standard EN14214 at the point of sale used in mixtures of up to 5% by volume with mineral diesel fuel complying with the EN590 diesel fuel standard should not give end-users any serious problems. **The currently agreed position of all FIE manufacturers undersigned is to limit release of injection equipment for admixtures up to a maximum of 5% FAME (meeting the EN14214 standard) with unadulterated diesel fuel (meeting the EN590 standard). The final product B5 must also comply with EN 590.**

The required quality of the FAME fuel is defined in European standard EN14214, which covers relevant impurities and tramp chemicals from the processing. Suppliers of FAME fuels must be able to demonstrate compliance to this standard at the filling station. There are several risks associated with possible supply chains.

For the FIE manufacturers a key property of any FAME fuel is the resistance to oxidation. Aged or poor quality FAME contains organic acids like formic and acetic acids and acids of higher molecular weight as well as polymerisation products which attack many components, drastically reducing the service life of the FIE. A list of issues which have been witnessed in service is detailed in the attachment to this document.

The ASTM specification for FAME fuel (D6751) does not to date contain a requirement for oxidation stability. The ASTM diesel fuel specification (D975) makes no provision for the inclusion of FAME, although there are currently proposals to define a specification for blends up to B20. The FIE manufacturers are concerned both with the missing oxidation stability in the specification and the lack of sufficient safeguards against blend quantity.

The FIE manufacturers can accept no legal liability for failure attributable to operating their products with fuels for which the products were not designed, and no warranties or representations are made as to the possible effects of running these products with such fuels.

Non-compliance of the fuel to standards agreed by the FIE manufacturers, whether being evident by appearance of the known degradation products of these fuels, or their known effects within the fuel injection equipment, (see attached list of known issues) will render the FIE Manufacturers' guarantee null & void.

Attachment

Fuel Injection Equipment – Potential Problems with FAME

(non-exhaustive list)

Fuel Characteristic	Effect	Failure Mode
Fatty acid methyl esters (general)	Softening, swelling or hardening and cracking of some elastomers including nitrile rubbers (physical effect depends upon elastomer composition) Displacement of deposits from diesel operation	Fuel leakage Filter plugging
Free methanol in FAME	Corrosion of aluminium & zinc Low flash point	Corrosion of FIE
FAME process chemicals	Entry of potassium & sodium and water hardness (alkaline earth metals) Entry of free fatty acids hastens the corrosion of non ferrous metals, e.g. zinc Salt formation with organic acids (soaps) Sedimentation	Filter plugging Corrosion of FIE Filter plugging Sticking moving parts
Free water	Reversion (Hydrolysis) of FAME to fatty acid and methanol Corrosion Sustainment of bacterial growth Increase of electrical conductivity of the fuel	 Corrosion of FIE Filter plugging
Free glycerine	Corrosion of non-ferrous metals Soaking of cellulose filters Sediment on moving parts and lacquering	 Filter plugging Injector coking
Mono-, di- and tri-glyceride	Similar to glycerine	Injector coking
Higher modulus of elasticity	Increase of injection pressure	Potential for reduced service life
High viscosity at low temperature	Generation of excessive heat locally in rotary type distributor pumps Higher stressing of components	Fuel delivery problems Pump seizures Early life failures Poor nozzle spray atomization
Solid impurities / particles	Potential lubricity problems	Reduced service life Nozzle seat wear Blocked nozzles
Ageing products		
Corrosive acids (formic & acetic)	Corrosion of all metal parts May form simple cell	Corrosion of FIE
Higher molecular organic acids	Similar to fatty acid	
Polymerisation products	Deposits, precipitation especially from fuel mixes	Filter plugging Lacquer formation by soluble polymers in hot areas

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The views contained in this Common Position Statement are those of the Joint FIE Manufacturers, which comprises the following companies :-

Signed on behalf of
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Signed on behalf of
ROBERT BOSCH GmbH DIESEL SYSTEMS..... 09.07.04
Dr.-Ing. Ulrich Dohle, President

Signed on behalf of
SIEMENS VDO DIESEL SYSTEMS..... 10.8.04
Mr Johann Warga, CEO

Signed on behalf of
STANADYNE CORPORATION..... 26 Aug 04
Mr William W Kelly, Sr. Vice President & General Manager

Signed on behalf of
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Mr Masahiko Miyaki, Managing Officer, Fuel Injection Product Division