

Our tests have shown that fuel degradation can take place in the fuel supply chain and in the vehicle fuel system; it is accelerated by the presence of oxygen, water, heat and impurities. The products of bio-degradation have been shown to be corrosive (e.g. formic, acetic and organic acids, water and methanol) and polymerisation products drop out within mixes with mineral fuels.

During extensive field trials conducted by the FIE Manufacturers in collaboration with end-users, the following injection equipment and engine problems have been identified as being caused by these fuel characteristics:-

- **Corrosion of FIE components.**
- **Low pressure fuel system blockage**
- **Increased dilution and polymerisation of engine sump oil**
- **Pump seizures due to high fuel viscosity at low temperatures**
- **Increased injection pressure**
- **Elastomeric seal failures**
- **Fuel injector spray hole blockage**

The incidence of these effects is likely to be increased when the engine is in irregular use, in applications such as stand-by generator units, automatic plant and seasonally used vehicles. (A list of potential problems is attached at the end of this document)

Fuel Quality Control Requirements:

Several initiatives are currently underway, to define Standards for fatty acid methyl ester fuels. For vegetable oil methyl esters (VOME), Austrian, Italian, German and French Standards already exist as well as a draft European Standard, but it is recognised that these do not fully specify the fuel requirements to a sufficient level to protect the end-user. In particular the fuel ageing propensity is poorly defined and few controls are implemented.

Within the European Community, CEN technical committee TC19 has been given the responsibility to evolve Standards of FAME for diesel engine use, viz.,

- a) 100% FAME as a complete replacement for diesel fuel
- b) FAME fuel as a blending component for use with mineral diesel fuel to comply with EuroNorme EN590 with up to 5%(vol) FAME.

International Standards Organisation committee TC28 will liaise with this group with regard to an eventual world-wide standard. ASTM in the U.S. is involved in similar work.

The latest proposed draft German specification from DIN for FAME (E-DIN51606) contains most of the items proposed by the FIE manufacturers for inclusion in an acceptable standard. Uppermost in these requirements are the following:-

- **Oxidation Stability** - **Thermal Stability** - **Total Acid Number** - **Iodine Number**
- **Water Content** - **Content of methanol, free glycerine & glycerides** **Flash Point**
- **Low Temperature Operability parameters such as viscosity, CFPP & pour point.**

It is anticipated that, to reach acceptable levels for these parameters the development and inclusion of suitable fuel additives and appropriate test methods will be required.

For determination of oxidation stability, it is being proposed to use a modified IP306 procedure. Current experience suggests that the best of the FAME fuels tested cannot better an "induction period" of four hours. Fuels without additives to improve this characteristic are of concern to the FIE manufacturers

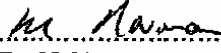
Attachment

Fuel injection equipment - potential problems with FAME
(non exhaustive list)

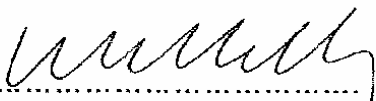
Fuel Characteristic	Effect	Failure Mode
Fatty acid methyl esters (general)	-Causes some elastomers including Nitrile rubbers to soften, swell, or harden and crack	Fuel Leakage
Free methanol in FAME	-Corrodes aluminium & zinc -Low flash point	Corrosion of FIE
FAME process chemicals	Potassium and sodium compounds Solid particles	Blocked Nozzles
Dissolved water in FAME	Reversion of FAME to fatty acid	Filter Plugging
Free water in mixtures	Corrosion Sustains bacteria Increases the electrical conductivity of fuel	Corrosion of FIE Sludging
Free glycerine	Corrodes non ferrous metals Soaks cellulose filters Sediments on moving parts and Lacquering	Filter clogging Injector Coking
Mono- & di-glyceride	Similar to glycerine	
Free fatty acid	Provides an electrolyte and hastens the corrosion of zinc Salts of organic acids Organic compounds formed	Corrosion of FIE Filter plugging Sediments on parts
Higher modulus of elasticity	Increases injection pressure	Potential of reduced service life
High viscosity at low temperature	Generates excessive heat locally in rotary distributor pumps Higher stressed components	Pump seizures Early life failures Poor nozzle spray atomisation
Solid impurities	Potential lubricity problems	Reduced service life
Ageing products		
Corrosive acids (formic & acetic)	Corrodes all metallic parts may form simple cell	Corrosion of FIE
Higher molecular organic acids	Similar to fatty acid	
Polymerisation products	Deposits especially from <u>fuel mixes</u>	Filter plugging Lacquering formation in hot areas

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

Signed on behalf of
Delphi Diesel Systems


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Dr M Norman
Technical Director
Delphi Diesel Systems

Signed on behalf of
Stanadyne Automotive Corp.


.....
Mr William Kelly
Vice President & General Manager
Fuel Injection Pumps
Diesel Systems Group

Signed on behalf of
DENSO CORPORATION


.....
Mr Masami Manabe
Director
Diesel Injection Product Division

Signed on behalf of
Robert Bosch GmbH


.....
Mr K Krieger
Senior Vice President Engineering
Automotive Equipment Group Systems
Diesel FIE Division.K5