Determination of fatty acid methyl esters (FAME) content of aviation turbine fuel using flow analysis by Fourier transform infra red spectroscopy – Rapid screening method

Background to "Determination of fatty acid methyl esters (FAME) content of aviation turbine fuel"
The present and growing international governmental requirements to add Fatty Acid Methyl Esters (FAME) to diesel fuel has had the unintended side-effect of leading to potential FAME contamination of jet turbine fuel in multi-fuel transport facilities, and industry-wide concerns. The aircraft and engine manufacturers have conceded that unmeasurable levels of FAME (< 5 mg/kg) are acceptable. However, the aviation industry, in conjunction with the Energy Institute, is moving towards acceptance of 30 to 100 mg/kg limits. For the purpose of quality assurance, this has created the need for robust and fast instrumentation to detect these levels of contamination.

To meet this urgent demand for test methodology, the Energy Institute started two initiatives: to develop an analytical and a rapid screening test method.

Following an in-house development programme started in 2007, Shell Global Solutions started a collaborative effort with Stanhope-Seta in 2008 to develop a procedure and apparatus based on the use of Solid Phase Extraction (SPE) cartridge technology and IR spectroscopy. This resulted in a new technique using flow analysis by FTIR (FA-FTIR), that is automated and does not require solvents. Extensive testing indicates that measurements down to 10 mg/kg are possible and this technique is being standardised by a new EI Rapid Screening Test method.

The development of FIJI - FAME in Jet Instrument
The development of FIJI (FAME in Jet Instrument) and its associated Test Method, *IP PM-DT* (to become *IP 583*) *Determination of fatty acid methyl esters (FAME) content of aviation turbine fuel using flow analysis by Fourier transform infra red spectroscopy – Rapid screening method*, are a direct result of an urgent requirement set by the UK's Defence Fuels Group, and airframe and engine manufacturers.

The problem is that the bio-component in automotive diesel, FAME, is a surface-active material. This means that it can adhere to pipe and tank walls as the diesel passes through, and then be released from the walls into the following product, which may be jet fuel. Also, small amounts of diesel containing FAME remaining within distribution manifolds, tanks, vehicles and pipes can result in traces of FAME getting into jet fuel transported through the same media.

Initial requirements were to measure 5 mg/kg levels of FAME to use with the specification level incorporated into *Defence Standard 91-91*. However, it was recognized from the beginning that this was a temporary measure and realistically a higher specification level was needed. The Energy Institute was given the mandate to develop a referee method to cover the 5 mg/kg levels and a rapid screening method to cover higher levels, initially identified as 100 mg/kg. Joint Inspection Group (JIG) member companies are working actively with other industry stakeholders in response to this issue. In addition, the Energy Institute is managing a Joint Industrial Programme (JIP) involving JIG members seeking approval from the aero engine and airframe manufacturers for the use of up to 100 mg/kg of FAME in jet fuel. Based on existing test results, 100 mg/kg represents a realistic and achievable approval level. To support this 100 mg/kg level, tests are being conducted at the normal 4× level: 400 mg/kg.

As it is conceivable that test results with > 5 mg/kg FAME content will be measured when the fuel is at the airport, the aircraft engine and airframe manufacturers are working on an Emergency Protocol with an upper limit of 30 mg/kg. Until this is universally agreed, the 5 mg/kg limit is the current limit for airport operations.

Following a successful 2008 collaborative effort with Shell Global Solutions to develop an extraction-based Fourier Transform Infra Red (FTIR) analytical technique, Stanhope-Seta decided to focus on the requirement for a rapid screening method to measure 100 mg/kg levels.

Aims of FIJI - FAME in Jet Instrument development

During the co-operation with Shell in summer 2008, Stanhope-Seta reached the conclusion that the industry needed a simple to use test instrument with a small bench footprint that would give results on the spot quickly. A 100 mg/kg target rather than 5 mg/kg would be achievable for a quick test. Personnel would be able to operate the instrument with very little training and without the need for solvents. This would allow quick screening of fuels that then do not have to be sent to a test laboratory for verification and could be used immediately. The research effort led Stanhope-Seta to the invention of a new technique using flow analysis by FTIR.