EI Research Report

Investigation of microbiological susceptibility of biodiesel and biodiesel blends

energy institute

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INVESTIGATION OF MICROBIOLOGICAL SUSCEPTIBILITY OF BIODIESEL AND BIODIESEL BLENDS

March 2014

Published by
ENERGY INSTITUTE, LONDON
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Registered charity number 1097899

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The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies

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Total UK Limited
Tullow
Valero
Vattenfall
Vitol
World Fuel Services

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ISBN 978 0 85293 658 0

Published by the Energy Institute

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FOREWORD

The petroleum industry has raised concerns that the increasingly widespread use of Fatty Acid Methyl Esters (FAME) in road transport and other diesel fuels will make fuels more susceptible to microbial spoilage and associated operational problems during their distribution and use. FAME is more readily biodegraded than mineral fuels, and anecdotal evidence from the field suggests a significant increase in operational problems as a result of microbial growth and contamination of diesel fuel systems. These problems include increased plugging of fuel filters at diesel retail sites and in large diesel vehicles, and also microbially-influenced corrosion of fuel tanks. There has been consequent speculation that if FAME inadvertently contaminates aviation fuels during transport, for example, in non-dedicated pipelines or ship tankers, there may also be increased microbial growth in aviation fuel tanks and systems, with potentially dramatic impact on aircraft operational safety.

The Energy Institute (EI) commissioned a review paper, *Implications of biofuels on microbial spoilage and corrosion within the fuel distribution chain and end use*, published in May 2008, which identified that very little research had been conducted to establish the extent to which FAME content influenced the susceptibility of fuels to microbial spoilage.

At the request of the EI's Microbiology Committee, a laboratory study was undertaken to investigate the influence of FAME concentration on the susceptibility of fuels to microbiological spoilage. The study consisted of two parts: one investigated the influence of various FAME blend concentrations (2 % (B2) to 100 % (B100)) in diesel fuel; and the second investigated the influence of trace concentrations (100 ppm and 400 ppm) of FAME in aviation fuel. Microcosms of zero-sulphur diesel (ZSD) and high sulphur diesel (HSD) fuel blended with FAME were inoculated with a mixture of fuel spoilage micro-organisms in a small amount of aqueous phase and were assessed for the extent of subsequent microbial growth by a number of techniques. A similar study was conducted for both mercaptan oxidation (MEROX)-treated and hydro-treated aviation kerosene without FAME and with FAME at 100 ppm and 400 ppm. In both studies the rate and extent of microbial growth was compared to the base fuels without FAME. The opportunity was also used to compare a number of different methods for assessing microbial contamination in fuels, including commercially available test kits which have been adopted, or are under consideration, as industry standard methods.

This research report presents the results of the laboratory study. It concludes that FAME does increase the susceptibility of fuels to microbial growth, most notably fungal growth. Under the test conditions, the increase in susceptibility of the fuels to microbial growth increased with increasing FAME concentration.

For diesel fuels it is concluded that when FAME is blended above 2 %, the influence on the rate and extent of microbial growth warrants additional consideration in the maintenance and monitoring of fuel handling facilities.

For aviation fuels it is concluded that, although FAME did marginally increase susceptibility to microbial growth, the influence was modest compared to the influence of other factors associated with MEROX treatment as opposed to hydro-treatment. At the concentrations proposed as *de minimus* limit values in aviation kerosene (provisionally 100 ppm), any increased susceptibility to microbial growth due to the presence of FAME is unlikely to have significant operational impact.

ACKNOWLEDGEMENTS

This project was commissioned by the Energy Institute's Microbiology Committee.

The work was carried out by Graham Hill, ECHA Microbiology Limited, United Kingdom and steered by members of the Microbiology Committee, who during the project included:

Simon Ashton	ExxonMobil
Simon Christopher	BP
Brian Crook	HSL
Carol Devine	North East Corrosion Engineers (NECE)
Bob Eden	RawWater Engineering Company
Beate Hildenbrand	Energy Institute
Graham Hill	ECHA Microbiology
Joan Kelley	CABI UK
Jan Kuever	Bremen Institute for Materials Testing
Jan Larsen	Maersk Oil & Gas
Bart Lomans	Shell
Torben Lund Skovhus	Det Norske Veritas (DNV)
Elaine McFarlane	Shell Global Solutions
Andrew Price	Oil Plus
Tony Rizk	Saudi Aramco
Kerry Sinclair	Energy Institute
Jim Stott	Intertek - Capcis
Ian Vance	Centromere
Neil Whitehead	Minton Treharne & Davies Ltd

The EI wishes to record its appreciation of the work carried out by the author and also its gratitude for the valuable contributions made by the Microbiology Committee during the course of the project.

1 INTRODUCTION

1.1 TECHNICAL BACKGROUND

1.1.1 FAME in automotive diesel

The European Union Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport, mandates that all fuel sold for use in road vehicles should contain a minimum 5,75 % (calculated on the basis of energy content) of components derived from renewable sources. For automotive diesels the requirement is implemented in practice by blending conventional fossil diesel with Fatty Acid Methyl Esters (FAME) derived from a variety of plant sources; including rape seed oil, soy bean oil, palm oil and also from animal fats (tallow). Member states have shown varying degrees of progress towards meeting the Directives' requirements, but in much of Europe automotive diesel has for the past few years contained in the order of 2 - 5 % FAME. These concentrations are likely to increase in the foreseeable future and in some countries diesel containing 7 or 10 % FAME is already widely used. Automotive diesel specification EN590 currently allows up to 7 % FAME.

Industry experience suggests that diesel fuels containing FAME can have an increased susceptibility to microbial growth (Hill and Hill, 2009). The Energy Institute (EI) published a review paper (Price, 2008) which highlighted the need for further research. The EI has also issued a Technical Bulletin which discusses the implications of FAME on microbial growth and provides provisional recommendations for the maintenance of fuel handling facilities. The Technical Bulletin expands on previously issued technical guidance already published by the EI for all fuel types (Hill, 2008).

Microbial growth by bacteria and fungi in diesel storage tanks, distribution facilities and end-user tanks can lead to contamination of the diesel with microbial particulates (biomass) which can cause severe filter blocking problems and blocking of fuel lines. Significant operational issues have already been experienced by some fuel retailers, where rapid onset of pump filter blocking has been encountered. Fuel filter blocking and fuel starvation problems have also been experienced by some truck and bus fleets; although, to date, operational problems attributed to microbial contamination of diesel in private cars have been extremely rare.

Field evidence suggests that the most extensive problems associated with microbial growth occur in diesel where FAME is blended at less than 20 % but greater than 2 %. There is some evidence that when FAME blend concentration exceeds approx. 20 % in diesel, providing excessive amounts of visible water, then microbial growth may actually be reduced or inhibited. This is because FAME has a water scavenging effect. Microbes can only grow when free water is present; when high concentrations of FAME are present, water is dissolved in the fuel and is no longer available for microbial growth.

This document reports research on the influence of FAME concentration on susceptibility of diesel to microbial growth. On-going research will address in more detail the influence of water content.