11TH INTERNATIONAL CONFERENCE ON STABILITY, HANDLING AND USE OF LIQUID FUELS
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Abstract Summaries

SESSION 1: AVIATION FUELS

Keynote Address:

ALTERNATE FUELS – STRATEGY AND RESULTS
William E. Harrison, III

The US Air Force began evaluating alternative fuels for aviation for a second time in 2004. The first look at alternative fuels was in the late 1970's and 1980's and focused on fuels produced from oil shale and coal. Many things have changed since the 1980's such that today's alternative fuels for aviation must balance national energy security issues, the impact on climate change, and yet offer robust economic sustainability to insure long-term sustainable supplies. The Air Force is working in partnership with the US commercial airlines through the Commercial Aviation Alternative Fuels Initiative to evaluate fuels produced from a variety of resources including biomass, coal, coal and biomass, and natural gas. Alternative fuels derived from these resources must meet aircraft performance, operation and durability requirements such that they are drop-in replacements for petroleum derived fuels. Recent work by the Air Force and the commercial sector has shown that 50/50 blends of Fischer Tropsch (FT) fuels with petroleum are drop-in alternative fuel blends and the Air Force is nearly finished the certification of these fuels. In addition, the commercial sector approved a new specification for a 50/50 blend for use in all US commercial aircraft. Based on the success of the FT fuel program the Air Force and commercial sector are now looking at hydrotreated renewable jet fuels produced from fats and oils including those produced by algae. These biomass derived feedstock are chemically similar to FT and petroleum derived fuels and can be produced from a wide range of oil seeds as well as animal tallow. Laboratory analysis has started on fuels produced from cellulosic feedstocks, which offer the promise of a widely abundant feedstock for sustainable supply. Although biomass derived fuels offer advantages by recycling the carbon produced when they are burned, determining the life-cycle greenhouse gas footprint has proven challenging and some biomass fuels may be carbon friendly when direct and indirect land use change is considered in the evaluation. The challenge is to find biomass feedstocks that not only provide the ability to be converted into drop-in fuels but also offer reductions in the greenhouse gas footprint. To help better characterize alternative fuels, new metrics are being developed to compare complex parameters such as technology readiness, manufacturing readiness, life-cycle greenhouse gas footprint, sustainability, and the energy return on investment such that informed choices can be made for the use of these alternative fuels.

REDUCTION OF TRACE BIO-COMPONENTS IN JET

Alisdair Q Clark

Specifications for jet fuel state that product must be derived from crude oil, or a limited number of other controlled sources, to ensure manufacturing and operational consistency. However, with the introduction of the Renewable Transport Fuels Obligation in Europe, which mandates the use of bio-components in ground fuels, there is now a risk that unspecified components may enter the aviation pool in trace amounts. The most notable of these are Fatty Acid Methyl Esters (FAME), as used for bio-diesel production. Jet and diesel often share ship / pipe-line systems which potentially may result in contact through adherence of material to walls, manifold dead-space and liquid interfaces. It is at these points that trace amounts of bio-component may be adsorbed/mingle with jet. At present a specification of less than 5 parts per million of FAME in jet is set as a control measure. This paper seeks to examine potential points within the distribution network where bio-components might enter jet and discuss methods to mitigate such risks.

USING THE CETANE ID 510 FOR THE PREDICTION OF DERIVED CETANE NUMBERS OF AVIATION TURBINE FUELS

Scott K Berkhous, PhD

In recent years, the use of diesel powered aircraft has gained popularity amongst the general aviation community. The increase in popularity has generated demand for suitable diesel engine fuels. Of the currently available fuels offered at fixed based operator sites, aviation turbine fuel has the greatest potential for use in diesel powered aircraft. However, the current aviation turbine fuel specifications do not regulate the cetane number of turbine fuels. Cetane number is a critical property to diesel powered aircraft to ensure adequate combustion characteristics. In this paper, the combustion characteristics of aviation turbine fuels were explored using a CVCC analyzer. Based upon the ignition delay and combustion delay values for each fuel, a derived cetane number was calculated. This paper also explored the use of cetane improving additives on the combustion characteristics and derived cetane number of turbine fuels.

THE USE OF JET FUEL IN DIESEL POWERED AIRCRAFT

Roger G. Gaughan

The practice of fitting diesel (compression ignition) engines to general aviation aircraft is becoming more prevalent with a number of aviation authorities around the world certificating aircraft with diesel engines to run on jet fuel. It appears, however, that not all relevant jet fuel properties were fully considered during the engine certification process. As a result, the aviation industry is in the process of addressing key jet fuel properties as they apply to diesel engines in order to mitigate any potential fuel property issues. Properties currently being evaluated include ignition quality, low temperature and lubricity. The appropriateness of using Jet engine tested and approved additives in diesel engines will also be discussed.

FUEL EFFECTS ON RANGE VERSUS PAYLOAD FOR MODERN JET AIRCRAFT

S. Blakey, C. W. Wilson, M. Farmery, R. Midgley

With changes in the availability and quality of existing aviation fuels anticipated in the next 30 years, it is timely to assess how changes in fuel properties would affect the range payload performance of aircraft. The effects on range and payload of a wide range of candidate fuels for aviation are investigated, including changes to the existing hydrocarbon blend used. Light fuels tend to be more desirable for commercial flights, where the flight is as close to the maximum payload as possible. Flights favouring range over payload are better suited by a more dense fuel. The hydrocarbon blends suggest for each aircraft, an optimum fuel may exist for the maximum payload and allowing the maximum range.

SESSION 2: BIOFUELS

THE IMPACT OF FAME ON THE DISTRIBUTION AND HANDLING OF AVIATION FUELS

Dr. Anthony Kitson-Smith

Many countries are looking at renewable fuel sources to supply part of their energy requirements. This has resulted in the widespread introduction of biodiesel fuels containing fatty acid methyl esters (FAME) in Europe during 2008. Despite warnings that there may be cross- contamination issues associated with the co-transport of these FAME containing diesel fuels with Jet fuel in the pipelines, ships, and other non-dedicated carriage systems, the directives mandating minimum percentage use of FAME has forced the issue. As a result, there have been instances of Jet fuel contaminated with FAME at airports leading to supply disruption. This paper will survey the history of work on FAME in co-transport systems, briefly review the generic issues associated with FAME in these co-transport systems and how this can easily lead to contamination incidents and finally look at the measures that have been put in place to prevent this. In conclusion, the outlook for the near term is the possible approval of 100 ppm FAME in Jet fuel and whilst the implications of this are a reduction of the risk of supply related disruption, the industry will still have to carefully manage the distribution logistics. As the mandate for biofuels spreads to other geographic areas the industry may need to contemplate further measures.

UNDERSTANDING THE LOW TEMPERATURE PROPERTIES OF BIODIESEL

Mark L Brewer, Rick E Malpas

The addition of FAME to diesel fuel can have a considerable impact on the low temperature properties (cloud point and CFPP) of the fuel. Understanding this impact is one of the key aspects of ensuring fuel fitness for purpose. This paper aims to describe the various ways in which FAME can affect fuel cold properties, discuss the reason why these occur and present advice for minimizing the effects. Issues seen with a common impurity “mono-glycerides” will be considered in this context. The low temperature properties of diesel fuel can be influenced through two distinct mechanisms: though the fatty acid methyl ester composition of the FAME

and through the presence of impurities in the FAME. Methyl esters are the main components of FAME and the low temperature properties are mainly influenced by the saturated methyl ester content of the FAME. This influences basic cold flow properties such as the Cloud Point and CFPP. The presence of impurities in FAME can also influence the cold properties. These impurities can precipitate from the fuel mixture at temperatures above the cloud point, which can lead to blockage of fuel filters. This paper discusses the two impurities that have been identified in relation to field problems of this kind, saturated mono-glycerides and sterol glucosides. Saturated mono-glycerides have been identified as one of the main problem species related to field problems observed in Sweden. They have poor solubility in diesel fuel. FAME specifications only contain limits on total mono-glycerides and the proportion of these in a particular FAME that are saturated will depend on the FAME type.

EFFECT OF FAME ON DIESEL FUEL COLD FLOW PROPERTIES
Vincent J. Denecker and Dave Coultas

The introduction of FAME both as a B100 fuel and as diesel fuel component has resulted in a number of fuel quality concerns due to the high ester-wax content and the presence of chemical impurities in FAME that were previously unknown in fossil fuels. These new chemical species can affect familiar fuel properties such as filterability, cold flow performance and operability. New additives have been developed to deal with these issues. The treat rate of cold flow improver additives can be an order of magnitude higher for FAME (B100) than for a corresponding fossil diesel to achieve a similar CFPP depression. In addition, additives which are required to improve the handling, filterability and storage characteristics of the B100 often end up in BX blends. It is therefore imperative to understand their effect on cold vehicle operability and whether there are any harms associated with their use. This paper presents new data from an investigation of the effect of B100 both with and without additives on the cold flow performance of BX. Performance has been evaluated using CCCD (cold chamber chassis dynamometer) on a variety of vehicles with critical cold weather performance. The no-harms profile of high treat rates of a typical biodiesel flow improver (BDFI) have also been demonstrated in engine and passenger car field trials.

REFINERY HYDROTREATED DIESEL PRODUCTION BY ORGANIC OILS HYDROCONVERSION
Nelmo F. Fernandes

This paper present the H-BIO process was developed to introduce a renewable oil source in the diesel fuel production scheme taking advantage of existing diesel hydrotreating plants. The vegetable/animal oil stream blended with mineral diesel fractions is hydroconverted in Hydrotreating Units (HDT), which are mainly used for diesel sulphur content reduction and quality improvement in petroleum refineries. This process involves a catalytic hydroconversion of the mixture of diesel fractions and vegetable/animal oil in an HDT reactor under controlled conditions of high temperature and hydrogen pressure. The triglycerides from the vegetable or animal oil are transformed into linear hydrocarbon chains, similar that already existing in the diesel coming from petroleum. The most important aspect of H-BIO process is its very high

conversion yield, at least 95% v/v to diesel, without residue generation and a small propane production as a by-product. The converted product contributes to improve the diesel pool quality in the refinery, mainly increasing the cetane number, reducing the sulphur content and density. The diesel pool quality upgrade will be a consequence of the vegetable oil percentage used in H- BIO process. A large range of operational conditions and several vegetable oils, like soybean and castor oils, were tested in pilot plants. Afterwards, industrial tests have been carried out in refinery HDT Units for technical evaluation, demonstrating the technology flexibility. The Petrobras H-BIO technology introduces a new way to include renewable feedstock for bio-fuels production in addition to the Brazilian Biodiesel Program, which is getting ahead following a fast-track development. This will enhance the biomass role in Brazilian transportation fuel supply, generating environmental benefits and improving social inclusion. The main reactions and the results of castor oil and soybean oil processing will be presented as well as a corrosion study at an industrial unit.

EFFECT OF FAME ON SUSCEPTIBILITY OF MEROX-TREATED AND HYDRO-TREATED JET A-1 TO MICROBIOLOGICAL GROWTH

Graham C. Hill

Many countries now mandate that certain percentages of fuels for road transport use must be derived from renewable sources. This has resulted in widespread presence of Fatty Acid Methyl Esters (FAME) in fuel distribution systems with consequent logistical problems in ensuring aviation fuels in distribution remain FAME-free. There are opportunities for cross contamination of aviation fuel by diesel, particularly in pipeline distribution or transport by sea in non-dedicated tankers. Consequently, small amounts of FAME can be expected to be occasionally recovered in jet fuels. Aircraft engine OEM's have been canvassed to approve the use of jet fuels containing small quantities of FAME and a proposal to allow 100 ppm is currently tabled. Although a considerable amount of work has investigated the impact of FAME on the physical and chemical properties of aviation fuel, there is no available data on the influence on the fuel's susceptibility to microbiological growth. Field experience and laboratory investigation shows that automotive diesels with a FAME content of a few percent are significantly more prone to rapid microbial growth and there may be consequent quality and operational problems. This paper reports work sponsored by the Energy Institute to investigate the influence of FAME on microbiological growth in MEROX treated and hydrotreated aviation fuel. Microcosms of each fuel type without FAME and with FAME at 100 ppm and 400 ppm were inoculated with a synthetic aqueous phase, containing a wide variety of fuel degrading micro-organisms, at a fuel water ratio of 1000:1. Microbiological growth was assessed over time by viable counts, ATP measurement and visible and microscope examination. The pH of aqueous phase was also monitored. At the end of the investigation the filterability of the fuel and the total dry weight of particulates present were also assessed. The types of microorganisms which developed in each microcosm were investigated by DNA profiling. It was found that FAME did influence the susceptibility of the fuel to growth by some microbial species; hydro treated Jet fuel was more susceptible to fungal growth when FAME was present. However, MEROX treated fuel was found to be equally susceptible to microbial growth even in the absence of FAME.

HYDROTREATED RENEWABLE JET FUELS
Robert J. Allen

This paper is a summary of our experience with testing and analysis of Hydrotreated Renewal Jet (HRJ) fuels and includes an overview of the certification process for alternative fuels. The HRJ fuels were compared to JP-8 and analyzed in accordance with the Small Sample Protocol which was developed for the evaluation of alternative fuels. The fuels discussed in this paper were all derived from biological sources and could be produced on a renewable basis. The JP-8 to which the HRJ's were compared was selected from the Petroleum Quality Information System as being representative of an average JP-8.

APPLICABILITY OF TEST METHODS FOR FILTER PLUGGING TENDENCY (PUMPABILITY) FOR EVALUATION OF THE FOSSIL DIESEL AND BIODIESEL FUELS BLENDS
Ph D. M. Svoljšak Jerman, M. Moder , A. Gregorc

This work will demonstrate the performance of the selected test method, used for the evaluation of aged fossil diesel fuel/biodiesel blends. The work assessed the applicability of the Pumpability method for quality control of fossil diesel fuel/biodiesel blends, as well as predict the applicability of biodiesel blends after longer storage. The performance of the test methods is investigated on the following blends: B5 (5%V/V biodiesel in fossil diesel fuel) and B10 (10% V/V biodiesel in fossil diesel fuel). Ageing processes is observed during the period of eight months at normal laboratory conditions. Diesel fuel engines are getting more and more demanding the higher fuel quality requirements. Market is strongly resisting and fear for the increasing of the biodiesel content (above 5%V/V) in the fossil diesel fuel blends. Study includes additional research on blends which contain a special additive package to improve detergency, corrosive resistance, deemulsity and decrease foaming of the fuel.

SESSION 3: ADDITIVES & ADDITIVE RELATED PROPERTIES

KEYNOTE: AUTOMOTIVE FUELS IN THE CZECH REPUBLIC – PRODUCTION, DISTRIBUTION, QUALITY AND QUALITY ASSESSMENT SYSTEMS
Vladimir Matejovsky

This paper affords a brief information on the production, distribution and market of automotive fuels in the hostesy country of the 11th International Conference and describes the systems used for quality monitoring in the way from refinery to service stations and vehicles tanks. Modern technology of Czech refineries ensures a high level of fuels quality but this is not the end of needfull care about it. Addition of bio components to petrol and diesel fuel can deteriorate fuel stability and this fact presents some limitation for fuel transport and storage and brings new requirements for care about quality. Transport and storage present enormous numbers of manipulations during which the quality is in danger

of damage, if the care is not sufficient. From this reason, the only quality control of fuels before their dispatching from the refinery is insufficient and it is necessary to repeat it after following manipulations. In 2001, a new integrated quality control system was introduced. It is derived from monitoring according to EN 142 74, obligatory used in EU, and from the former fuel quality inspection according to the law for customer protection. About 2500 samples a year are taken by random sampling at service stations from the dispenser nozzles and their quality is verified by state inspection body. The results of state monitoring are presented in this paper. If any fuel quality non-conformity is identified, the service station is penalized but it is inadmissible to publish the names of petrol stations where non-conformities were found. From this reason it was necessary to introduce another monitoring system, performed by an independent inspection body as a contracted service for petrol stations. If the monitoring results can acknowledge quality correctness in the long term, the service station is awarded by a special sticker SEAL OF FUELS QUALITY, which is stuck by dispensers as a guarantee for customers that the quality of fuels dispensed by this service station is good and reliable.

DETERMINATION OF MINIMUM REQUIRED FSII USE AND PROCUREMENT LIMITS FOR USAF AIRCRAFT

Matthew J. DeWitt, Steven Zabarnick, Steven Shaeffer, Theodore Williams, Zachary West, Linda Shafer, Richard Striebich, Scott Breitfield, Ryan Adams, Rhonda Cook, Charles L. Delaney and Donald Phelps

Fuel System Icing Inhibitor (FSII) is one of the required additives in U.S. military aviation fuels JP-5 and JP-8. The primary function of the FSII is to prevent solidification of free water within the fuel, which can adversely affect fuel system operation. Di-Ethylene Glycol Monomethyl Ether (DiEGME) is the currently approved FSII, with a required procurement dosage of 0.10- 0.15% by volume for both fuels. The use limits are currently 0.03% (JP-5) and 0.07% (JP-8), respectively. Many motivating factors, ranging from logistical/economic issues to application- based concerns, exist for determining if the required procurement and use limits can be reduced. Lower FSII requirements could significantly reduce associated logistical footprint and procurement issues and would render a considerable cost savings. In addition, environmental and material compatibility concerns related to DiEGME could be significantly alleviated. Extensive laboratory and large-scale studies have been performed to provide improved insight into the manner by which FSII interacts with free and dissolved water and prevents ice formation in fuel systems. These efforts have provided valuable information which assists in determination of a minimum required FSII dosage while allowing for safe operability of varying aircraft platforms and mission profiles. Several of these efforts were presented and discussed at the 10th International IASH Conference; additional results and progress will be presented herein. These include: supplementary laboratory evaluations, large-scale component icing studies, the potential effect of a reduced DiEGME concentration on Fuel Tank Topcoat Peeling, and a supply-chain study to investigate potential expected FSII losses during transport and storage. An overview of these various efforts will be provided and implications will be discussed.

HYDROCARBON LIQUID FUELS THERMAL STABILITY, ANTIOXYDANT INFLUENCE AND BEHAVIOUR

Sterenn Gernigon, Mickaël Sicard, Frédéric Ser, François Bozon-Verduraz

Jet fuel undergoes an oxidative chemistry upon being heated in fuel system of advanced civil aircraft. The degradation process may lead to the formation of bulk and surface solids. For engines featuring a low-NOx combustion chamber based on multipoint injection, these deposits could plug the injection system. Deposits formation has different origins; one of them is dissolved oxygen. The aim of this study is to strongly decrease or inhibit the autoxidation reactions present during the fuel degradation. This is why the use of antioxidant additives is considered. So, autoxidation reactions are exacerbated by the use of a static device developed at ONERA. Liquid fuel is stressed to a bulk temperature of 185°C with an air flow of 100 ml/min during 72 hours. Kerosene Jet A-1 is composed of hundreds of hydrocarbons, so we used different molecules representative of the main families present in the jet fuel. We tested a linear alkane (n-dodecane, C12H26), a ramified alkane (2,2,4,4,6,8,8-heptamethylnonane, C16H34), and two cyclic compounds (1,3-diisopropylbenzene, C12H18 and cyclohexylbenzene, C12H16). The characterization of the various products formed during degradation (gas, liquid, and solid) allows knowing the role played by the selected molecules in the degradation of kerosene. GC, GC/MS, and IR are the characterization techniques used for the analytic part of this study. The live consumption of each initial compound is observed during the entire test. In parallel of this consumption, different gases like CO, H2, and light saturated and unsaturated hydrocarbons are formed. The liquid analysis shows the formation of oxidized products like ketones, carboxylic acids, and alcohols. Moreover, only cyclohexylbenzene formed solids. The degradation of a mixture of hydrocarbons involves the formation of alcohols, ketones, and carboxylic acids. Three antioxidants have been tested on each hydrocarbons: the phenol, 2,6-bis (1,1- dimethylethyl)-4-methyl- (BHT), the phenol, 2- (1,1-dimethylethyl)-4-methyl- (TBMP) and the phenol, 2,4-bis (1,1-dimethylethyl) (2,4-DTBP). The quantity added to each hydrocarbon is about 1 wt %. TBMP and 2,4-DTBP are not very efficient for the selected hydrocarbons.

STUDIES OF THE COMPATIBILITY OF DIEGME AND TRIEGME ICING INHIBITOR ADDITIVES WITH AIRCRAFT TANK TOPCOAT MATERIAL

Steven Zabarnick, Ryan Adams, Zachary West, Matthew J. DeWitt, Linda Shafer, Richard Striebich, Charles L. Delaney, and Donald K. Phelps

In the 2007 IASH conference, we reported on initial studies of the development of alternative fuel system icing inhibitor candidates for replacement of diethylene glycol monomethyl ether (DiEGME). DiEGME was implicated in an increasing incidence of reports of the peeling of topcoat material in the ullage space of integral wing tanks in the B52 and other military aircraft. Work has indicated that for the combination of DiEGME in JP-8 fuel, the icing inhibitor additive can concentrate in the tank ullage and condense at elevated concentrations on the upper tank walls. These high concentrations of DiEGME cause swelling and subsequent peeling of the epoxy-based topcoat. In the current work we report on detailed studies of the compatibility of DiEGME and icing inhibitor replacement

candidate triethylene glycol monomethyl ether (TriEGME) with fuel tank topcoat material. Tests were designed to simulate fuel tank wall exposures with subsequent topcoat degradation measured by icing inhibitor uptake analyses, pencil hardness evaluations, and attenuated total reflectance IR spectroscopy. The lower volatility of TriEGME relative to the JP-8 fuel components results in it being less able to concentrate in the tank ullage and promote topcoat failure. This was confirmed with lower additive levels measured in the ullage, condensed vapors, and the exposed topcoat material. The pencil hardness of topcoat material exposed to fuel vapors was significantly improved upon changing from DiEGME to TriEGME exposure. Plans for future evaluations will be described.

SHELF LIFE IMPROVEMENT OF C 18:2 RICH BIODIESEL WITH BAYNOX ANTIOXIDANTS - AN EVALUATION OF EQUIVALENT EFFICACY ACCORDING TO THE EU DRAFT DIREC. 2008/0016

Dr. Axel Ingendoh

The draft of the EU specification for Biodiesel blends B7 with fossil diesel requires the addition of 1.000 ppm of BHT to the biodiesel or any other antioxidant equivalent to 1.000 ppm BHT. Information, tests procedures or limits on which effects and test results equivalency should be based on are lacking. We have designed an equivalency test program for the laboratory to fill the lack. It lead to a rational conclusion on which parameters the equivalency should be based upon. The first is the achievable starting stability of 1.000 ppm BHT the second the resulting shelf life of the blend treated with 1.000 ppm BHT. The extensive laboratory tests revealed the following parameters: 1) Rancimat value of 1.000 ppm BHT = min 12 h, and 2) Shelf life of Biodiesel with 1.000 ppm = min 150 days. The tests revealed that rape seed oil biodiesel differs from soybean oil biodiesel in the response to the 1.000 ppm dosage of BHT. SME is far more oxidation sensitive and the parameters developed from RME biodiesel value can be only fulfilled with a double increase in dosage, that is 2.000 ppm BHT instead of 1.000 ppm. These specification now serve as new parameters to evaluate the equivalency of the new highly efficient antioxidant Baynox® plus to the new EU specification. The test results are documented in the report and they show, that in pure RME 400 ppm Baynox® plus are equivalent to 1.000 ppm of BHT. In pure SME the same results as with 1.000 ppm BHT in RME can only achieved with 2.000 ppm BHT or 800 ppm Baynox® plus as equivalent. We recommend Biodiesel from rape seed oil – RME – to be stabilized with 400 ppm of Baynox® plus minimum and from soy bean oil – SME- with 800 ppm Baynox® plus minimum. This relates to a relative efficiency of Baynox BHT vs Baynox plus of 1: 0.4. The dosage of any blends of RME and SME should be evaluated by linear correlation of SME content in RME. Biodiesel from different producers might response differently on the antioxidants and the above recommendations should be corrected accordingly.

HIGH-TEMPERATURE STABILIZERS FOR CHINESE RP-3 JET FUELS AT 700K

Guozhu Liu, Yingjie Wang, Xiangwen Zhang, Guoqiang Xu, Zhentao Mi

In the modern aircraft, jet fuel generally not only provides the propulsive energy for flight, but also plays a crucial role in the thermal management system as a primary coolant to absorb a large quantity of excess heat of fuel system and engine subsystems. Unfortunately, exposed to significant higher temperature than 150 oC, jet fuel inevitably degrades in present of the dissolved oxygen (ca. 70 ppm) and leaves behind solid deposits on the wetted passages surfaces. In this paper, a series of electrically heated tube experiments is conducted to study the performance of several thermal-stable stabilizers of Chinese RP-3 jet fuel under a similar conditions expected in the thermal management system of advanced engines. Solid depositions of the thermal stressed Chinese RP-3 jet fuels from 400 K to 700 K are tested in 321 SS tubes (2000×2.2×0.2 mm) at a mass flow rate of 120 g/min under 5 MPa. It is found that the deposition peak at 350 oC is completely eliminated, and that the total carbon deposition rates of Chinese RP-3 jet fuel saturated with oxygen is reduced above 60% with an optimal concentration of developed additive packages consisting of antioxidant, metal deactivator, detergent/dispersant, and oxygen scavenger. Therefore, the developed antifouling additive for Chinese RP-3 jet fuels is effective to prevent the deposit formation when the fuel is used as coolant.

SESSION 4: FUEL FILTRATION & CLEANLINESS

FILTRATION – AN ATTRACTIVE ROUTE FOR DIRT REMOVAL

Alisdair Q Clark

Cleanliness has been a primary quality requirement for aviation fuels from the dawn of flight to the present day. During this time procedures have been developed to remove dirt and water from fuel throughout the manufacturing and distribution chain, ensuring product delivered to aircraft is of the highest quality. Test methods and specifications have evolved to monitor quality, sometimes simple visual checks and, more recently, sophisticated particle analysis. Within this paper some of the sources of dirt in fuel are examined, including test methods for detection/quantification and remediation technology. Particular focus is placed on the presence of rust and the use magnetic filtration. Contamination sources, particle size distribution and performance are discussed, including operational procedures and environmental impact of magnetic versus conventional filters.

NEW TECHNIQUES IN PARTICLE COUNTING HELP ANALYZING HIGH PERFORMANCE LIQUID FILTERS

Michael Schumacher

The filter industry is always trying to improve the performance of filters. New media move the separation limits to sizes well below 4µm(c). The automotive and other industries request media with better ß200 to improve the reliability of injection systems. PAMAS

GmbH developed a new particle counting sensor to move the limits for test stands to smaller particle sizes below the limits of extinctions sensors. A new scattering sensor was designed to specifically fulfill the requirements of the fuel and oil filter industry. The new sensor can be calibrated according to ISO11171. It has the ability to see particles as small as 1µm(c) with very high concentrations. This paper describes the performance of this system and shows how it was integrated into the ISO11171 framework. The paper will also show gaps in the calibration definitions that will need a closer look in the future.

CONDITION MONITORING SENSOR EVALUATION AND TEST PROTOCOL DEVELOPMENT

Kathleen M. Kennedy; Paul P. Wells

Over the past several decades, highly specified filtration systems have been used to provide clean jet fuel through the delivery process. Filters, when paired with conventional spot checks, have proved effective in providing fuel with acceptable dirt and water content. However, recent concerns with filter monitor media migration and reviews of aircraft refueling practices coupled with advances in sensor technology have highlighted the value of actively monitoring fuel cleanliness using real-time electronic sensors. This paper reports efforts to test several candidate sensors and develop testing protocols to understand the performance of condition monitoring systems to support implementation of the sensors in aircraft refueling. Some of the issues that must be addressed in implementation strategies will be discussed with some analysis of advantages and disadvantages of differing approaches.

MEDIA MIGRATION FROM AVIATION FUEL FILTER MONITORS

Paul P. Wells

A laboratory-scale test apparatus, the Aviation Fuel Filtration Rig (AFFR), has been constructed and a test procedure developed to better understand media migration from aviation fuel filter monitor elements. Research with 2” filter monitors presented at the 2007 IASH meeting supported the hypothesis that super absorbent polymer (SAP) contamination originates primarily from manufacturing debris. In this next phase of research, 6”, in-to-out configuration filter monitors from three different manufacturers are evaluated. The effect of revised manufacturing techniques on the propensity of these filter monitors to release SAP into jet fuel is explored. In order to establish future industry limits, it has become apparent that a more quantitative method of assessing SAP contamination is required. The original method employed a visual count of SAP particles stained blue via ion exchange with copper sulfate solution. The new method developed by ExxonMobil removes the copper from the SAP with a dilute mineral acid wash and quantifies the resulting concentration using a commercial induction-coupled plasma (ICP) device. (SAP types vary in their ion exchange capacity so standard curves are used to convert the copper concentration to the mass of a given SAP.) This methodology has been successfully demonstrated in the AFFR.

SESSION 5: CHALLENGES IN FUEL DISTRIBUTION & STORAGE

LOGISTICAL CHALLENGES ASSOCIATED WITH THE IMPLEMENTATION OF ALTERNATIVE FUELS

Pamela Serino

As we move toward the use of a variety of alternative fuels, we need to look at the impact on our fuel handling, storage and distribution systems. We have already experienced the cross- contamination of Fatty Acid Methyl Ester (FAME) into our jet fuel by assorted modes of transportation. What is ahead as we increase the use of FAME in diesel fuels? Will there be unforeseen consequences as we implement the use of Fischer-Tropschs, Hydrotreated Renewable Jet and other drop in fuel blends? Will additional policies and laws pertaining fuel cleanliness, emissions and greenhouse gases increase the complexities to fuel distribution? These questions and more will be addressed and discussed through the experiences of the Defense Energy Support Center.

UTILIZING COLORIMETER/HAZE ANALYZERS FOR ONLINE QUALITY CONTROL AND INTERFACE DETECTION WITH SPECIALTY FUELS

Kam Mohajer

This paper will analyze the role of Colorimeter/Haze Analyzers in the unique quality control, interface detection, and/or security challenges created by today's specialty, dyed, and aviation fuels. Historically, interface or batch detection was done by first batching fuels of greatly disparate densities against each other in the pipeline, then using densitometers to monitor density changes. Specialty and/or dyed fuels have minute or no density variation and thus render density measurement for interface detection nearly obsolete. Because Colorimeter/Haze Analyzers utilize the principles of light refraction rather than density to measure fluid properties, they are uniquely qualified for interface detection and quality control issues in specialty fuels. Colorimeter/Haze Analyzers use fiber optics to pass colored light through fluids, and then measure the return absorption. Results are represented by colors corresponding to numerous industry scales, but cover the full spectrum of visible color. Additionally, Colorimeter/Haze Analyzers detect haze or trace dissolved water, which often contaminates fluids in transit. This is a particularly important quality control issue as haze may be detectable to the end user's eye. Finally, with the rapid of escalation of security concerns around fuel transport and contamination, in particular aviation fuels, Colorimeter/Haze Analyzers offer the most specific and accurate quality assurance available.

FIT FOR PURPOSE IMPLICATIONS FOR FUEL SUPPLIERS, HANDLERS AND USERS

George R. Wilson, III and Steven R. Westbrook

In the process of developing specifications for alternative fuel sources many 'non-spec' requirements have become significant issues. Additionally, users often underestimate their

need to ensure their equipment is fit for purpose by mistaking statistical means for quality limits. This paper explores the evaluation of candidate fuels and fuel using hardware to determine how well suited they are for the purpose.

FUEL QUALITY IMPACTS ON TIER 2-4 OFF ROAD DIESEL ENGINES HAVING COMMON RAIL FUEL SYSTEMS

Norman C. Blizard

Modern diesel engines are designed to meet US EPA Tier 2-4 and EU stringent exhaust emission requirements through exhaust aftertreatment, in-cylinder and air handling improvements but also through fuel system improvements. Modern high pressure common rail (HPCR) fuel systems are being applied by Cummins to large engines having 19 through 60 liter displacements and beyond. The high injection pressure at all speeds, multiple injection events and fuel injection timing and rate shaping flexibility of these systems are key enablers to achieving low emissions and fuel consumption. However, these systems are challenged by widely varying worldwide commodity diesel fuels, even with some conforming to ASTM, ISO and other fuel specifications. Operational problems encountered with these fuels and HPCR fuel systems will be described in the presentation, along with known countermeasures. Improvements in fuel cleanliness, water content, stability, storage and handling are essential parts of the effort to achieve high reliability and durability in these modern fuel systems. Filtration and water separation (on engine and off engine) must also be improved to maintain the fuel clean and dry. Deposit formation due to thermal stressing of the fuel must be avoided through selective additization or refinery improvements.

SESSION 6: SYNTHETIC & ALTERNATIVE FUELS I

SUPERIOR STABILITY PERFORMANCE OF FISCHER-TROPSCH (FT) KEROSENE

Mariam Ajam, Carl L Viljoen

In the application of kerosene as aviation turbine fuel in modern aircraft, the fuel is increasingly used as the primary coolant for various aircraft systems, thereby increasing the thermal stress that the jet fuel is exposed to. In the quest for increased efficiency of aircraft engines, the engines are operating at higher a temperature than before, which increases the importance of thermal stability of the fuel. The importance of good thermal stability of jet fuel has resulted in the establishment of a specific thermal stability specification and test method, the ASTM D3241 Jet Fuel Thermal Oxidation Tester (JFTOT) procedure conducted at 260 °C. The current Jet A-1 specification requires the fuel to pass the test at a test temperature of 260 °C, but work is in progress to change the specification to report break point temperatures in future. Storage stability is also important especially in military applications since these fuels may be stored for extended periods of time. Hydrotreated fuels and synthetic kerosenes, which generally lack natural antioxidants, require the addition of synthetic antioxidants such as hindered phenols to limit oxidation and hydroperoxide formation in the fuel during long-term storage. In recent years there has

been increasing interest in alternative sources of fuel to supplement crude oil-derived fuels. The development of Fischer-Tropsch (FT) jet fuel has progressed to the point where Sasol's fully synthetic jet fuel has been approved for commercial use as published in DEFSTAN 91-91, Issue 6 in April 2008. Since FT fuels are expected to have inherently good thermal and oxidative stability due to their negligible quantities of heteroatomic species, olefins and aromatics, a study was undertaken to evaluate the JFTOT break point temperatures and storage stability properties of various Sasol FT kerosene streams. It was found that these streams generally exhibit superior JFTOT break point temperatures. This paper summarises the results obtained during the evaluation of the JFTOT break point temperatures of FT kerosenes in comparison with crude oil-derived Jet A-1, including their respective storage stability results. The significant enhancement in thermal stability that was found due to clay treatment is also discussed, while possible reasons for the observed superior thermal stability of FT kerosene are postulated.

RECENT PROGRESS IN SYNTHETIC FUELS DEVELOPMENT FOR AVIATION
Joanna M. Bauldreay, Paul F. Bogers, Tim A. Snijders, Joris A. Melkert

The twin drivers of high oil prices and environmental concerns have accelerated recent developments in synthetic jet fuel since Bauldreay et al [IASH 2003] set out some of the key properties of paraffinic fuels derived via Fisher-Tropsch synthesis. Although the emphasis of research has been on fit-for-purpose properties and ensuring that these synthetic fuels can be operated safely in current and future air transport system, this paper sets out some recent findings that identify specific performance benefits and risks. Based on in-house research at Shell and collaborative work with TU Delft, it will cover a description of the key linkages between fuel composition and physical properties, and explores the effect these have on aircraft performance and gas turbine emissions. The paper identifies the key compositional constraints of Fisher-Tropsch fuels and how they influence the jet fuel properties critical for the safe and efficient operation of the aircraft/engine system. The results of several fit-for-purpose experiments will be presented. The effect of fuel properties, including gravimetric and energy density, have been modelled on the critical payload-range performance of existing aircraft configurations; a range of techniques have been used, including a basic aircraft performance model and a high-fidelity gas turbine cycle performance package. Results are presented for three aircraft/engine combinations ranging from a business jet to a long haul commercial airliner. The composition of synthetic fuels free of sulphur and aromatic compounds will affect its combustion properties. These will be quantified for a range of fuel blends from low percentages up to 95% synthetic fuels based on recent experiments.

EVALUATION OF SYNTHETIC DIESELS FOR US NAVY SHIPBOARD APPLICATIONS
Philip H. Chang and Richard Kamin

Recently there have been heavy activities in developing alternative fuels from renewable and non-petroleum-based feedstock. Progress has already been made in the conversion of

agricultural oil and fat to hydrocarbon fuels, and some initial progress has been reported for waste-to-fuel efforts. The US Navy evaluated several synthetic diesels for potential shipboard propulsion applications. The synthetic diesels have been tested against the requirements of the F-76 specifications (MIL-PRF-16884L), non-specification areas of concern such as storage stability, lubricity, etc. and Petroleum Quality Information System (PQIS) data from the Defense Energy Support Center (DESC). The synthetic diesels evaluated were all hydrocarbon fuels from the various sources such as coal, soy bean oil and agriculture waste. The major processes involved for the production of fuels are Fischer-Tropsch (FT) process, hydrogenation, and thermal conversion process, etc. This study will benefit the US Navy in preparation for approval processes for alternative fuels.

CHEMICAL, THERMAL STABILITY, SEAL SWELL AND EMISSIONS CHARACTERISTICS OF JET FUELS FROM ALTERNATIVE SOURCES

E. Corporan, L. Shafer, M.J. DeWitt, C. Klingshirn, S. Zabarnick, Z. West, R. Striebich, J. Klein

Instability in petroleum-rich countries and the potential impact on the cost of petroleum products and national security, have renewed interest in the research and development of fuels derived from alternative and domestic sources. In addition, concerns with greenhouse gas emissions and impacts on global warming has increased interest in the production of fuels from renewable (carbon neutral) feedstocks and processes. In recent years, the US Air Force has been very active in the evaluation, demonstration and certification of fuels derived from natural gas and coal via Fischer-Tropsch (FT) synthesis, specifically, Synthetic Paraffinic Kerosene (SPK). To date, the B-52, C-17 and B-1B have been certified for use of a 50/50 JP-8/FT blend. Other aircraft (i.e., F-22, KC-135, F-15, C-5, T-38) have already undergone flight tests and are scheduled to be certified on the FT blend in the near future. In order to certify fuels for use in aircraft, extensive laboratory and large-scale evaluations are performed to demonstrate aircraft system compatibility, proper engine performance and ensure no negative impacts on the aircraft mission and emissions. The present effort describes recent evaluations of jet fuel candidates derived from coal, natural gas, chicken fat and shale oil. Evaluations for specification tests per MIL-DTL-83133F, chemical composition and characteristics, thermal stability as assessed on several test rigs, and emissions characteristics using a T63 engine were completed. Comparisons between the performance of these alternative fuel candidates relative to specification JP-8 and currently approved SPKs will be presented. The potential of these fuels as drop-in replacements for conventional jet fuel and observed deficiencies will be discussed.

SESSION 7: SYNTHETIC & ALTERNATIVE FUELS II

THERMAL STABILITY OF ALTERNATIVE JET FUELS

Mickaël Sicard, Bruno Raepsaet, Frédéric Ser, Jacques Ancelle, Laurie Starck, Nicolas Jeuland

The recent increase of the crude oil price, the depletion of this fossil resource and the worrying environmental situation lead the Nations to rethink their energy policy and thus to turn to alternative fuels. For mainly safety reasons, the introduction of alternative fuels in civil aviation will be possible only after a long process of studies and certifications. Moreover, as aircraft brought into service today will fly for 30 years, the alternative fuels chosen must be compatible with current engines. Thus, all the physicochemical characteristics of the alternative fuels have to be evaluated in order to determine if they are compatible or not with the jet fuel specifications. The thermal stability of the fuel is a critical property. In modern aircraft, on board fuel is used not only for propulsion but also as primary coolant. Thus, in fuel system and injection devices, the fuel temperature can increase significantly. This thermal stress conjugated with the presence of dissolved oxygen can lead to the formation of gums and solids. These deposits can cause fouling of nozzles and heat exchangers. The goal of this work is to study the thermal stability of alternative fuels. Five fuels from several origins have been chosen. They are: synthetic fuel coming from Fischer-Tropsch process (representative of future BtL (Biomass to Liquid) fuels) and blends X/Jet A-1 where X could be vegetable oils (coprah, palm), heavy alcohol, and FAME. The results are compared with these of the Jet A-1 used as reference. The tests are carried out with a back surge device at 185°C. In order to exacerbate the oxidation reactions, a continuous air flow (100 mL/min) is added to the liquid. During a 72 hour test, regular samplings of the liquid and gaseous phases are carried out. They are characterized by GC, GC/MS, HPLC and IR spectroscopy. As expected, the stability towards oxidation is different from one fuel to another. For example, after 72 hours of test, solid particles are observed in the case of the blend palm oil/Jet A-1 but are not with the BTL. In some cases, gases like H2, CO2 and light hydrocarbons are detected. Nevertheless, oxidized products such as alcohols, ketones and carboxylic acids are formed in all the fuels.

POTENTIAL OF ALTERNATIVE FUELS FOR AIRCRAFT: FOCUS ON THERMAL AND OXIDATION STABILITY

Laurie Starck, Mickaël Sicard, Frédéric Ser and Nicolas Jeuland

Fuel availability at a reasonable cost seems more and more uncertain. While energy demand remains high, peak oil is expected to be seen in the coming years; as an aggravating factor, the production areas are concentrated within politically unstable countries. Moreover, climate change implies that greenhouse gases emissions should be reduced. In that context, the search for alternative fuels for aircraft seems to be a promising solution. Nevertheless, aeronautics represents a very specific and constraining transportation mode, due to its usage (short range, middle range, long range with the same fuel, worldwide distribution of the fuel...) and its compulsory security constraints. The properties of Jet fuel can be divided into three main families: properties linked to the

combustion, properties linked to the use at high altitude and the last group is about storage and safety. The stability specified in DEF STAN 91/91 is measured by JFTOT (Jet Fuel Thermal Oxidation Tester) and shows the tendency of the product to form deposits on a metallic surface at high temperature. The present work is dedicated to evaluate the thermal and oxidation stability of potential alternative fuels for aircraft. The alternative fuels tested in this work are blends of conventional Jet fuel with alcohol, or esters and also BtL product. Three different techniques are used: JFTOT, MicroCoking and PDS (Pressurized Differential Scanning). JFTOT is the conventional technique used in international specifications. The MicroCoking bench test is a method commonly used to qualify engine oils and allows to evaluate thermal stability. And the last test, PDS, covers the determination of the stability under accelerated oxidation conditions. This work shows that the combination of these different techniques allows to better understand the oxidative and thermal stability of alternative fuels.

EFFECT OF CHEMISTRY AND BOILING-POINT DISTRIBUTION ON THE PROPERTIES AND CHARACTERISTICS OF SYNTHETIC PARAFFINIC KEROSENE AND BLENDS WITH JET A

Clifford A. Moses, Petrus N.J. Roets, Carl L. Viljoen, and George R. Wilson, III

Two synthetic paraffinic kerosenes (SPK) have been produced from the same synthetic crude product derived from natural gas using a Fischer-Tropsch process. The two SPKs differed primarily in boiling-point distribution and in the normal/iso-paraffin ratio. The first SPK had a larger fraction of normal paraffins and, therefore, required a lighter boiling-point distribution in order to meet the requirement for freezing point. The second SPK was produced by hydro- isomerization of the syncrude, and it was able to meet freezing point with a significantly broader boiling-point distribution. Both SPKs met all of the requirements of Table 1 in the Jet A/Jet A- 1/JP-8/F-34 fuel specifications except for density. Blends were then made with a conventional Jet A in the ratio of 50/50. These blends met all of the Table 1 requirements including density. The properties of the blends were found to be very similar to each other and to the original Sasol semi-synthetic jet fuel, which used coal as the feed source for the SPK; the blends also had fit- for-purpose properties and characteristics that were very typical of conventional jet fuels.

SESSION 8: MIDDLE DISTILLATE FUELS AND HEAVY OILS

ANALYSIS OF ISSUES CONCERNING THE PRODUCTION AND DISTRIBUTION OF LOW SULPHUR DIESEL - ONE BRAZILIAN'S REFINERY EXPERIENCE

Nelmo F. Fernandes, Paulo Sergio de Souza Rego

Deposit formation in fuels is a continuing problem in the storage instability of middle-distillate diesel fuels. Instability is usually defined by the formation of insoluble sediments and gums. The oxidative degradation of petroleum products is a complex yet fascinating problem. It is becoming clear that the simple description of the oxidative degradation of

petroleum products involves many processes like storage conditions, distribution logistics and the refinery production as well. Severe conditions of hydrotreating, particularly high temperatures and low partial pressures of hydrogen can lead to problems of stability in the products of hydrotreating units. The stability issues are primarily related to storage due to the fact that hydrotreated fuels may lead to formation of gums, sediments and change of color after hydrotreating and over time. Many reports of mechanical problems in diesel engines in the metropolitan area of Belo Horizonte, Brazil, start the analysis of the events related to the distribution logistic, storage and check possible deviations in refinery diesel production. This paper aims to present the production schedule and optimization of production of diesel in the Gabriel Passos refinery and the studies developed to understand all the issues related to the storage conditions, distribution logistics and the diesel quality. This analysis must extend the scope to the chemical characterization of the feed pool to the hydrotreated unit and the final product from the unit.

PREDICTING THE IMPACT OF ULSD STABILITY ON MODERN ENGINES
Jack Burgazli

Recent developments in diesel engines and fuel injection equipment combined with the change to ULSD and bio-blends have resulted in increased reports regarding deposits within injectors and filters. The paper will discuss analytical studies to characterize deposits implicated in filter blocking, as well as studies examining the suitability of common fuel stability tests to possibly predict fuel propensity to produce filter blocking deposits.

THERMAL STRESSING OF ULTRA-LOW SULFUR DIESEL AND LOW SULFUR F-76 DIESEL FUELS
David J. Evans, Chris K. J. Hulston, Lance C. Kelly, Michael G. O'Connell, Paul Rawson and Christy-Anne Stansfield

In recent years there has been an increased employment of high pressure common rail (HPCR) fuel injection systems in high speed marine diesel engines. This is largely due to their increased efficiency and reduced fuel consumption. The HPCR systems stress the fuel to a higher degree than conventional fuel injection systems, with some systems operating up to 1800 Bar, with fuel reportedly being exposed to temperatures up to 200 □C, and return fuel temperatures commonly exceeding 100 □C. Some HPCR systems utilise the fuel for hydraulic actuation of the injectors as well as cooling and lubrication of the injectors resulting in a significant proportion of the fuel being return to the bulk storage tank or day tank. This exposure to high temperatures and pressures can accelerate the formation of hydroperoxides aiding the auto-oxidation processes with the hydrocarbons in the fuel. Additionally, chemical processes that occur in stressed fuel can lead to poor water separability, increased filter blocking tendency, and formation of acidic species that can promote wear and corrosion of fuel system components potentially leading to catastrophic failures. In order to investigate the effects of this thermal stressing on fuel properties, laboratory thermal stressing experiments have been carried out that involved exposing F-76

naval distillate and automotive diesel fuel (ADF) to temperatures of 165 °C and 186 Bar for short residence times (<10 Minutes). Initial investigations have demonstrated that peroxide values greater than 10 mg/kg can be achieved with short residence times. F-76 and ADF have both shown differing effects from the incorporation of fuel additives. ADF with biocide added obtained a peroxide value greater than 10 mg/kg with a residence time of 110 seconds compared to the equivalent F- 76 sample that took 275 seconds to achieve a similar peroxide value. F-76 containing phenolic oxidation inhibitors achieved identical residence times (385 seconds) to un-additised F-76 in comparison to the amine derived additives for F-76 where peroxide values greater than 10 mg/kg were observed with a residence time of 275 seconds. We are currently investigating the effect this increased peroxide content has on water separability, filterability and gum formation.

OXIDATIVE DESULPHURIZATON OF DIESEL FUEL
Michio Ikura

The effectiveness of a newly developed process for deep desulphurization was tested using conventional No. 2 diesel fuel. This process combines oxidation with solvent extraction. Oxidation converts weakly polar aromatic sulphur to polar sulphoxides and sulphones. Subsequent solvent extraction removes these polar compounds, thus producing clean diesel fuel. An oxidation catalyst used was of TiO2, V2O5, and Pt wash-coated on cordierite. Catalytic oxidation was carried out in a single step under atmospheric pressure, mild temperature and using ozone as the oxidizer. The feed No. 2 diesel fuel contained 360 ppm sulphur but it was reduced to as low as 32 ppm upon methanol extraction of the oxidized oil. Detailed analytical revealed that sulphur compounds boiling in 290oC-350oC were selectively removed by the present method. It was determined that the most critical operating parameter for obtaining a low sulphur product was the ratio of fresh ozone feed rate to fresh oil feed rate. The formation of tarry precipitates depends of the severity of oxidation conditions; It reached 12 wt% of the feed when sulphur was reduced from 360 ppm to 32 ppm. GC-MS of the tarry precipitates revealed that they were mostly aromatics and sulphur compounds were concentrated in this fraction.

ASPHALTENES STABILITY IN DILUTED BITUMEN AND HEAVY OILS
Parviz M. Rahimi, Teclemariam Alem, Zhiming Fan and Irwin Wiehe

It is projected that the production of bitumen from Oil Sands in Alberta will increase from the current 1.2 MMB/d to 3.0 MMB/d by the year 2014. At the present part of produced bitumen is upgraded to SCO (Synthetic Crude Oil) by the upgradres and refiners such as Syncrude, Suncor Energy (Fort McMurry), Husky Energy (Lloydminster), Shell (Fort Saskatchewan) and Petro- Canada (Edmonton) using coking and hydrocracking technologies. Although it is expected that the upgrading capacity to increase when the new upgrading facilities are built in Alberta, but at the same time major portion of bitumen will be transported via pipelines to the refineries in the US. To reduce the viscosity (350 cSt) and density (940 Kg/m3) of bitumen to meet pipeline specification, 30vol% diluent is added to produce Dilbit. Bitumen and heavy oil can also be diluted with synthetic crude oil

(gas oil range) and pipelined to different refineries. In this case 50vol% of the synthetic crude oil is needed to meet pipeline specification for viscosity and density (Synbit). Depending on the availability of diluents, bitumen producers may be forced to use other sources of diluent including hydrocarbons from different refinery streams (C5, C6, etc.). No matter which diluent is added to bitumen to reduce density and viscosity, one has to make sure that there is no chance of asphaltenes precipitation during transportation and storage. In this paper methods and techniques for measuring asphaltenes stability will be presented. The solvent strength of different diluents and refinery streams for blending with bitumen and heavy oils will be compared.

SESSION 9: MICROBIOLOGICAL CONTAMINATION & BIODEGRADATION

MICROBIAL CONTAMINATION IN DIESEL FUEL – ARE NEW PROBLEMS ARISING FROM BIODIESEL BLENDS?

Wolfgang Siegert

Standard diesel fuel contains only a maximum of 0.2 cm3 water per litre of fuel from which a third of this is dissolved. The rest of the water settles at the tank bottom and is sufficient to serve as a biosphere for the microorganisms. Microbial products of decomposition form an emulsion of water and fuel and make separation off the water more difficult. Microbes are the cause for operational problems like fouling of tanks, pipes, filters and tank corrosion. These microbial problems in mineral diesel have been known for over 70 years. But nowadays the mineral diesel fuel is blended with Biodiesel such as FAME. Since the widespread of biodiesel blends an increase of operational problems are observed. Does the addition of FAME increase the risk of microbial contamination? Is it enhancing microbial growth? The fatty acid esters, such as FAME, in mineral diesel produce an environment in which microbial growth is encouraged due to the ability of microorganisms to degrade natural fat and oil to yield energy for growth. The microbial growth can be enhanced at every stage in production, storage, distribution and in end users vehicles. Good housekeeping, monitoring and proper usage of an effective biocide are crucial measures to an anti-microbial strategy.

BIOCONTAMINATION DIVERSITY IN JP-8 AND JET-A

Marlin Vangsness, Susan Mueller, Loryn Bowen, Lisa Brown, Lori Balster, Capt. Jerrod McComb, and Ellen Strobel

Microbial contamination results in millions of dollars each year spent on corrosion remediation, premature filter replacement and physical tank cleaning. Additionally, equipment as well as aircraft down time may result in lost income while contaminated fuel tanks are cleaned and fuel stores are treated and filtered. Previous studies have focused on culturing microbes from polluted water, soil, or from fuel tank water bottoms to determine the identity of problem microbes and how to best control infestations. Unfortunately, this method is biased toward species that grow well in the laboratory. To eliminate the culture bias DNA was recovered directly from fuel

samples to provide a nearly unbiased estimate of microbial diversity within a single sample. DNA sequences were grouped into phyla and genera to calculate diversity indices across geographic areas, aircraft type, and fuel type. Data indicates the diversity of a microbial population varies between fuel types while geographic location and aircraft type have little to no effect on the microbial populations.

EFFECT OF FSII ON MICROBIAL CONTAMINATION: DIEGME AND TRIEGME

Lori Balster, Ellen Strobel, Marlin Vangsness, Loryn Bowen, Susan Mueller, Lisa Brown, Daniel Pike, and Diana Dalrymple

From 2003 to the present, the fuels laboratory at Wright Patterson AFB has investigated microbial contaminants in Air Force fuel systems. Some of the most common microbes identified were used to represent typical field consortia in the current study. Recently, there has been mounting pressure to reduce aviation fuel costs in the Air Force. Diethylene glycol monomethyl ether (DiEGME), the current Fuel System Icing Inhibitor (FSII) additive, is added to JP-8 at a maximum volume percentage of 0.15 and is an obvious candidate for cost reduction. In addition to its function as an anti-icing additive, it also is known to have some biocidal/biostatic activity. In this study, microbial consortia isolated from the field and those obtained from American Type Culture Collection (ATCC) lab cultures were tested at low levels of DiEGME, 0-30% in the aqueous phase of a liquid aviation fuel/simulated water bottom setup, to determine a minimum level at which DiEGME was still effective against microbial contamination. Both the field and lab consortia were shown to be significantly affected at levels above 10%. In addition to the goal of reducing FSII additive levels, another current goal is to replace DiEGME with Triethylene glycol monomethyl ether (TriEGME) to eliminate various issues ascribed to the use of DiEGME, such as tank topcoat peeling. Therefore, this study also included field and lab consortia tests at 0-30% TriEGME in the aqueous phase. Field and lab consortia were shown to be significantly affected at TriEGME levels of 15% and above in the aqueous phase.

EFFECT OF ETHANOL ON MICROBIAL PROLIFERATION IN UNLEADED GASOLINE MICROCOSMS

Frederick J. Passman, Russel P. Lewis, James L Palmer, Harlan Reid

Ethanol is a well-known disinfectant. Conventional wisdom holds that when phase-separation occurs in tanks containing ethanol-gasoline blended fuel, the ethanol that partitions into the aqueous-phase will act as a disinfectant. Reports based on culture data generally support this hypothesis. However, at ICSHLF 5, one of the authors reported evidence of microbial activity in the aqueous-phase of underground storage tanks containing 10% ethanol in regular unleaded (87 octane) gasoline. In the current study, culture and adenosine triphosphate data were compared in twelve types of microcosms, based on a combination of volume of added water (0, 0.2 and 1.2% v/v) and ethanol concentration in the fuel-blend (0, 10, 15 and 20 % v/v; E-0, E-10, E-15 & E-20). Triplicate microcosms were prepared for each water/ethanol-blend combination. Although the aqueous-phase ethanol concentrations under the E-10, E-15 and E-20 fuels were consistently

30±5%, the ATP biomass increased with initial ethanol concentration in the fuel- phase. Culture data were uniformly below detection limits for all microcosms.

STRATEGIES FOR RESOLVING PROBLEMS CAUSED BY MICROBIAL GROWTH IN TERMINALS AND RETAIL SITES HANDLING BIODIESELS

Edward C. Hill & Graham C. Hill

Adding fatty acid esters, such as FAME, to mineral diesel, has produced in Europe an environment in which microbial growth can be prolific, at every stage in production, storage and distribution, and particularly at retail premises and in end users' vehicles. The chemical and physical factors which are stimulating this prolific growth will be discussed with reference to our extensive experience in laboratory analysis of biodiesel samples and investigation of operational problems on site. The paper will consider the influence of water content and water activity and its behavior in biodiesels. We will discuss observations on the types and distribution of microbes found in biodiesel tanks. Many blenders and suppliers of B5 have adopted excellent preventive monitoring and control strategies, with proper regard to minimal impact on facilities downstream. These strategies are currently tailor-made but they are adaptable, and the tools for monitoring and treatment are widely available. There is still some way to go to develop safe and reliable strategies for vehicles and retail sites and possible options will be considered.

IMPORTANT TECHNICAL CONSIDERATIONS WHEN CONTEMPLATING BIOLUMINESCENCE AS AN ANALYTICAL TOOL FOR THE DETERMINATION OF MICROBIAL CONTAMINATION OF PETROLEUM FUELS AND OTHER MATRICES

Edward W. English, II and Charlotte Lindhardt

Bioluminescence has become a very versatile analytical tool used for the assay of microbial ATP. With the availability of high purity and commercially pure prepared reagents, highly sensitive photomultiplier tubes (PMT), software, miniaturization of portable power supply and equipment, this analytical technique has moved from the research laboratories and universities and into the field where technicians and laypersons with a minimum amount of training can quantify the microbial load of fuel samples from pipelines, storage tanks, vehicles and aircraft on a nearly real time basis. As such this technique has earned its rightful place as a valid analytical tool used to quantify the microbial load present in petroleum fuels, some biofuels and their respective fuel associated bottom water. Since 1947 when William D. McElroy isolated and purified the heat-stable luciferin and labile enzyme luciferase from the firefly, many analytical challenges have been identified and resolved in order that bioluminescence could become a reputable and reliable analytical tool. For example, in order to ensure optimal light emissions proportional to the ATP concentration the chemicals and solutions used to duplicate reactions found in nature has to be commercially available; in order to ensure the maximum optical output of photons from the cuvette to the detector, the cuvette material has to be of a certain minimum optically quality; temperature compensation and computer algorithms has to be available to ensure results are corrected to the optimal temperature; and the detector has to be of a specific design capable of sensing low light/photon output in the spectrum of 460nm to 580nm from the

bioluminescence reaction over an interval of several seconds as well as managing background noise levels. This paper will address the more technically important considerations when contemplating bioluminescence as a valid analytical test method for the determination of microbial contamination of petroleum fuels and other matrices.

IMPACT OF BIODETERIORATION ON DIESEL FUEL SYSTEMS

Nelly Klinkspon

The ongoing development of current injection systems for diesel fuel has increased the requirements for fuel preparation, among other things; for example, in the particle separation level and water separation. To protect the injection system against corrosion, cavitation, reduced lubricity, and the increasing influence of microbiological growth fuel filter modules contain a highly efficient particle and water separation. The introduction and distribution of biofuels, e.g. Biodiesel, intensifies the problem even more. The present paper summarizes the result of intensive work during the last two years starting with a survey in the automotive industry. Analyzing the feed back from engine supplier, petrol industry, car manufacturer and system supplier systematic lab trials were started to simulate the impact of biodeterioration on diesel fuel systems. In a first step diesel/water and biodiesel/water systems were set up to investigate the growth of microbes. After having these first results it has been decided to set up a system to simulate the affinity of microbes to fuel systems construction materials. The test system consists of a glass bin in which several fuel system materials can be introduced and exposed to the microbes. For these tests several materials like steel plate, Polypropylene (PP), Polyamide 12 (PA 12), Polyamide 6,6 (PA 6,6), Polyoxymethylene (POM) and filter-paper were used and studied. The microbes in this test were isolated and cultivated from truck pre-filters and P. putida und P. oleovorans were applied as control. The affinity of the different microbes to the surface the fuel system construction materials were investigated by using methods like ATP-measurement, PCR, protein concentration and vitality. To collaborate the laboratory results with field experience pre filters from diesel trucks were analyzed and methods for biodeterioration control applied.

SESSION 10: ANALYTICAL METHODOLOGY

A RAPID LABORATORY ANALYTICAL METHOD FOR DETECTING LOW LEVELS OF FAME IN JET FUEL: METHOD DEVELOPMENT AND PRELIMINARY INDUSTRY STUDY RESULTS

Scott J Hartman, Oliver Seiler, Laura Owen and Paul Spitteler

The European Union's directive that a minimum of 10% Biofuels should be used in road transport fuels by 2010 has some unintended consequences. The fatty acid methyl esters, (FAME) contained in biodiesel (currently at approximately 5% by volume) and carried within the multi-product supply chain throughout Europe, have the potential to come into contact with jet fuels carried in those systems. Recent studies and incidents have shown that FAME contamination of jet fuels can and has occurred, despite improved fuel handling procedures. This has raised concerns about the safe supply and use of jet fuel, and at the

2008 UK Aviation Fuel Committee meeting there was a call for studies to commence to resolve this issue. In response, the Energy Institute (EI) invited oil majors and interested parties to take part in an industry-wide study towards developing FAME detection methods. Shell Global Solutions, UK had already started work on potential detection methods during 2007 and continued this work in 2008 with Stanhope-Seta for the development of the 5ppm "Laboratory Analytical Method", resulting in the only 'rapid' screening test methodology, for detection of FAME as low-level contaminants in Aviation jet fuels, currently being considered by the EI group. This paper describes the development and trialling of the rapid laboratory analytical method. It involves a novel two-step approach using solid phase extraction chromatography (SPE) and Infra Red (IR) spectroscopy. It initially separates FAME compounds, by extraction and evaporation, from the fuels (both jet and diesel fuel), and then quantitatively analyses the FAME concentration down to 5ppm (by mass) levels. This paper compares data from the rapid laboratory analytical method with sensitive, laboratory methods such as 1-HNMR and GCxGC, proving that the concept is robust. It also details the results from studies, using a set of blind samples provided by the EI, aimed at determining the 'robustness' of the method. The EI samples contained 6 different FAMEs at levels of 0 to 150 ppm (by mass), in 2 different base fuels. An automated version of the method is currently being developed as an instrument for routine use in the industry and is the subject of a separate paper.

THE DEVELOPMENT AND USE OF FLOW ANALYSIS BY FTIR SPECTROSCOPY IN A RAPID SCREENING TEST METHOD FOR MEASURING TRACES OF FATTY ACID METHYL ESTERS IN AVIATION TURBINE FUELS

Paul Spitteler, Rob Shaw, Mike Sherratt and Scott Hartman

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 ppm) are acceptable. However the aviation industry, in conjunction with the Energy Institute, is moving towards acceptance of 30 to100 ppm 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 an extraction based Fourier Transform Infra Red (FTIR) analytical technique (Laboratory Analytical Method) that exhibits a proven ability to measure down to 5 ppm levels. However this analytical technique requires the use of solvents in a laboratory environment and is therefore unsuitable as a rapid screening test. Stanhope-Seta has now developed 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 30 ppm are possible and this technique is being standardised by a new EI Rapid Screening Test method. This paper

discusses the development and performance of the new Rapid Screening Test method for the measurement of 30 to over 100 ppm (mg/kg) of FAME in aviation turbine fuel and introduces the instrumentation required to carry out the rapid screening test.

ADVANCES IN FLUORESCENCE EVALUATION OF THERMAL STABILITY

Nigil Satish Jeyashekar and George R. Wilson, III

Thermal Stability is a characteristic that related to the fuel's ability to resist the formation of deposits when passed over a heated surface. The adverse effects of poor thermal stability are formation of deposits, which deteriorates fuel system hardware in an aircraft engine. This paper aims to address the capabilities of LASER-Induced Fluorescence (LIF) as a tool to access the thermal stability of Jet fuel. In the 1990s Southwest Research Institute (SwRI) developed LIF as a viable technique to measure the relative concentration and rate of formation of precursor molecules that lead to the formation of deposits in a fuel nozzle in a thermally stressed Jet fuel. Recently, SwRI demonstrated the potential relationship between JFTOT break-point temperature and relative precursor concentration measured by the LIF technique as a result of heating. The current work involves measurement of relative precursor concentration and rate of precursor production for nineteen different Jet fuels with break-point temperatures ranging from 225-315C. The work will investigate and present the dependence of fluorescence intensity, effect of work on the fuel on Breakpoint temperature. The ultimate objective of this research is to investigate the extent to which the LIF technique can assess the thermal stability of Jet fuels.

FURTHER DEVELOPMENTS IN THE MEASUREMENT OF LIQUID PHASE H2S IN MARINE FUELS

Wanda Fabriek , Chris Roach and Mike Sherratt

At the last 2007 IASH conference in Tuscon, a presentation titled "New developments in the measurement of liquid phase H2S in marine fuels" discussed the safety and practical issues associated with the presence and measurement of H2S. Since the last conference, there has been intense activity regarding the revision of the marine fuel specification ISO 8217, the development of an Energy Institute test method for H2S, a ruggedness trial, two round robins to determine precision, optimization of the procedure and changes to the apparatus, and results from field tests. This presentation will discuss the aims and potential future changes to the specification, identify the effects of key test apparatus parameters, and show how the development of the test method and apparatus has progressed.

SESSION 11: POSTER SESSION

THE DEVELOPMENT OF A PORTABLE INSTRUMENT AND AUTOMATED DATA PROCESSING SOFTWARE TO PREDICT/CONTROL HEAVY FUEL OILS STABILITY/COMPATIBILITY CHARACTERISTICS

Neil Ryding, Corina Sandu, Huzeifa Ismail, and Sebastian Csutak

Baker Petrolite has developed a portable instrument to predict the stability and/or compatibility of heavy fuel oils. This paper presents recent instrumental developments, progress on implementation of an automated data collection, and processing software that allows the user to obtain faster and reliable results. Heavy fuel oils, also known as # 6 oils or residual fuels and heavy opportunity crudes are lower grade fuels but very important resources for different industries such as: marine and power generation. Transformation of these resources into high economic values is typically done by either mixing them with high quality fuels or by blending lower quality fuels with higher quality ones. With new worldwide legislation changes, an increase in fuel quality specifications and requirements is predicted. One of the main quality characteristics of these fuels is to remain stable upon mixing with a high-grade fuel or compatible by blending different sources of low-to high-grade fuels. This paper presents recent developments on a new optical tool with improved features relative to common methods currently available on the market. This instrument uses the onset of flocculation of asphaltenes as the primary parameter in assessing the stability/compatibility of these fuels. The key development has enhanced the following features: portability and robustness, faster data acquisition, integrated and automated design and ease of data processing. Data obtained with this new instrument, as well as comparisons with existing methods such as Hot Filtration Test (HFT) and TURBISCAN® turbidity analysis, will be presented.

COORDINATING RESEARCH COUNCIL (CRC) OVERVIEW AND PROGRAM SUMMARY

Brent K. Bailey and Jan R. Tucker

FALEX 400, A NEW JET FUEL THERMAL OXIDATION TESTER, ASTM D 3241

Jim Hepp

This paper presents a new commercially available jet fuel thermal oxidation test instrument and test specimens, designed to run ASTM D 3241. The paper will show the improved functionality of the instrument over established instruments. It will also detail laboratory tests of the instrument and test specimens that show the new instrument produces equivalent results existing ASTM D3241 test instruments. ASTM D3241 requires a strict conformance to critical test requirements (table 2) for the jet fuel industry for this critical test. The Falex 400 matches results to existing test instruments because Falex has dutifully included the critical equipment specification that controls the heater test section and the test conditions. Designed for years of long operation, the reliable Falex 400 provides traceability, long maintenance intervals and pour-and-go technology, where simply pour

your sample into a beaker, push a button and D 3241 is run. From the world's oldest leading supplier of Standard Tribology Test Specimens comes the NEW Falex Heater Tube. These tubes are about to go through the extremely rigorous trials that ASTM Subcommittee D.02.J0 mandates before allowing equivalency and these trials will be discuss during the presentation. Each tube will meet the exacting requirements of ASTM D3241 giving you the maximum assurance and peace-of-mind that you need when dealing with aviation jet fuels.

AN EVALUATION OF BIOCIDES TO CONTROL MICROBIAL CONTAMINATION OF HYDROCARBON FUELS, INCLUDING BIOFUELS AND THEIR BLENDS

Phil Keene

Hydrocarbon fuels are known to be susceptible to microbial contamination during their storage due to the introduction of water into fuels (e.g. through condensation). At the water- hydrocarbon interface, conditions are favourable for the growth of micro-organisms which often contaminate fuels. Biofuels and commercial biofuel blends, such as B5 have a higher susceptibility to microbial contamination and a higher incidence of reported microbial contamination issues. Uncontrolled growth of microorganisms can on one hand damage the equipment through increased corrosion and on the other reduce the fuel quality. Reduced fuel quality can lead to clogged filters, poor engine performance and in heavily contaminated systems it may also develop a foul odour. Biocides can be used as part of a fuel management system to control microbial contamination, maximize long term fuel storage and to minimize fuel biodegradation. Four biocides, CMIT/MIT (a mixture of 5-chloro-2-methyl-4-isothiazoline-3-one and 2- methyl-4-isothiazolin-3-one), 4-(2-nitrobutyl)-morpholine, 4,4- dimethyloxazolidine and 2,2- dibromo-3-nitrilopropionamide were screened in six different hydrocarbon fuels; a diesel fuel, a B100 biodiesel, a B5 diesel, light heating oil, marine diesel and a heavy fuel. Testing used three test microorganisms; Pseudomonas aeruginosa, Hormoconis resinae, and Yarrowia tropicalis and was based on the methodology outlined in ASTM E1259-05 "Standard practice for evaluation of antimicrobials in liquid fuels". In addition, no harm data was generated according to EN 590 to confirm that the biocides have no detrimental effect on the fuels being treated with these biocides. With the wide variety of biofuels being used six different fuel types were used to profile biocide performance. CMIT/MIT, 4,4- dimethyloxazolidine and 2,2-dibromo-3- nitrilopropionamide were all very effective biocides in all the fuels tested. 4-(2-nitrobutyl)- morpholine gave mixed results suggesting it is effective in diesel fuels but not in the samples of biofuels or the B5 biofuel blend used in this test. When selecting a biocide to use in a hydrocarbon fuel it is advisable to assess the biocide performance using a suitable test method, such as ASTM E1259, as reported in this paper.

COULD JET FUEL THERMAL OXIDATIVE DEGRADATION BE AT LEAST PARTIALLY RESPONSIBLE FOR A RECENT CRASH? A PROPOSED HYPOTHESIS & EXPERIMENTAL PLAN TO TEST THIS HYPOTHESIS

Bruce Beaver and Chris Kabana

On 17 January 2008 a British Airways flight from Beijing crashed at London's Heathrow airport. The crash investigation by the Air Accidents Investigation Branch (AAIB) has focused upon ice buildup on the face of the fuel oil heat exchanger (FOHE) impeding fuel flow to both engines. We suggest that fuel oxidation in the FOHE may have also contributed to fuel flow restriction in the Rolls-Royce RB211 Trent 895-17 engines (i.e. Trent 200 series engines). Fuel oxidation, coupled with an increase in fuel pressure, as the engine demanded more thrust, may have increased fuel viscosity and contributed to the observed fuel restriction to both engines prior to the crash. We also suggest that low temperature oxidative reactivity of some jet fuels has increased, within the last ten years, because of an increase in the percentage of hydrotreated material blended into these fuels. This hypothesis is consistent with the increase in fuel filter blockage incidents during flight and a general decline in fuel filter life times observed in the commercial aviation sector. Finally, our hypothesis is also consistent with the relative lack of deposit mass, only 3-4 gms, found in a fuel filter that blocked during a commercial flight, which was examined by ExxonMobil investigators during the "media migration investigation."

TECHNICAL ISSUES TO CONSIDER WHEN EVALUATING BIOLUMINESCENCE AS AN ANALYTICAL TOOL

Edward English and Charlotte Lindhardt

Bioluminescence has become a very versatile analytical tool used for the assay of microbial ATP. With the availability of high purity and commercially pure prepared reagents, highly sensitive photomultiplier tubes (PMT), software, miniaturization of portable power supply and equipment, this analytical technique has moved from the research laboratories and universities and into the field where technicians and laypersons with a minimum amount of training can quantify the microbial load of fuel samples from pipelines, storage tanks, vehicles and aircraft on a nearly real time basis. As such this technique has earned its rightful place as a valid analytical tool used to quantify the microbial load present in petroleum fuels, some biofuels and their respective fuel associated bottom water. Since 1947 when William D. McElroy isolated and purified the heat-stable luciferin and labile enzyme luciferase from the firefly, many analytical challenges have been identified and resolved in order that bioluminescence could become a reputable and reliable analytical tool. For example, in order to ensure optimal light emissions proportional to the ATP concentration the chemicals and solutions used to duplicate reactions found in nature has to be commercially available; in order to ensure the maximum optical output of photons from the cuvette to the detector, the cuvette material has to be of a certain minimum optically quality; temperature compensation and computer algorithms has to be available to ensure results are corrected to the optimal temperature; and the detector has to be of a specific design capable of sensing low light/photon output in the spectrum of 460nm to 580nm from the bioluminescence reaction over an interval of

several seconds as well as managing background noise levels. This paper will address the more technically important considerations when contemplating bioluminescence as a valid analytical test method for the determination of microbial contamination of petroleum fuels and other matrices.

DIESEL FUEL CONTAMINATION – ANALYSIS OF SOME UNUSUAL NEW CONTAMINANTS
Steven R. Westbrook

Diesel fuel is susceptible to contamination throughout the delivery, storage, and use of the fuel. Typical contaminants include water, dirt, metals, microbiological growth, and the by-products of chemical degradation of the fuel. These contaminants can plug filters and screens, cause corrosion, and degrade fuel performance in the engine. Analysis and identification of these contaminants is routine and well understood. This paper describes the analysis and identification of recently encountered contaminants that do not fit into the categories listed above. The contaminants were found in diesel fuel from a vehicle storage tank and from underground storage tanks. Analyses used included electron microscopy, solubility, infrared spectroscopy, x- ray diffraction spectroscopy and energy-dispersive spectroscopy.

ENHANCED THERMAL STABILITY & STORAGE OF HIGH VISCOSITY FUELS AND OILS USING PHYRE'S OIL DE-OXYGENATION SYSTEM (PODS)
Steven Walker, Wesley Jung, Stuart Robertson and Santosh Limaye

MEASURED PHYSICAL CHEMICAL PROPERTIES OF MODEL COMPONENTS
Kavitha Moorthy, James E. Johnson, and George R. Wilson, III

MICROBIAL GROWTH ON SELECTED AIRCRAFT MATERIALS
Marlin Vangsness, Lisa Brown, Loryn Bowen, Susan Mueller, Lori Balster, and Ellen Strobel

VARIATION OF JP-8 PROPERTIES IN CONUS AND POTENTIAL IMPLICATIONS DURING BLENDING WITH SYNTHETIC PARAFFINIC KEROSENE (SPK)
Erin Shafer, Richard Striebich, Matthew J. DeWitt, Timothy Edwards and William Harrison

EMISSIONS EVALUATIONS OF DIESEL ENGINES OPERATED WITH JP-8 AND A 50/50 FISCHER-TROPSCH/JP-8 BLEND

Edwin Corporan, Matthew J. DeWitt and Christopher D. Klingshirn

The emissions of diesel engines operating on JP-8 and a 50/50 JP-8/Fischer-Tropsch (FT) blend were assessed. Particulate matter (PM) and gaseous emissions were measured from three diesel engines operating with the two alternative fuels and No. 2 diesel. The engines evaluated are used to power R-11 and R-12 military refueling trucks. The exhaust sample was extracted from the engine tail pipe to measure mostly non-volatile (i.e., soot) PM emissions. The particle number, PM size, mass and smoke numbers were characterized using primarily commercially available aerosol instrumentation. Gaseous species measured include CO, NOx and SOx. Engine performance with the alternative fuels was also assessed, and discussed briefly in this paper. In general, the diesel engines operated satisfactorily with the alternative fuels. Although the engine particle number emissions did not follow clear trends relative to fuel type or engine power, in general, lower PM emissions (mass and size) were observed for the three engines during operation with the alternative fuels compared to diesel. Statistically significant lower CO and NOx emissions were also observed with the alternative fuels. As anticipated, higher SOx emissions were observed with the alternative fuels as the result of their higher sulfur content compared to the near ultra-low sulfur diesel. Discussions on the emissions results, engine performance and the potential impact of fuel chemical and physical properties on the resulting emissions are presented.

NEXT-GENERATION FUEL QUALITY SURVEILLANCE: THE NAVY FUEL PROPERTY MONITOR

Mark H. Hammond, Robert E. Morris, Kevin Johnson, Jeffrey A. Cramer, Braden Giordano, Christopher Von Bargen, and Susan L. Rose-Pehrsson

The use of liquid fuels necessitates methods to assess the quality and suitability of these fuels for their intended use. Traditionally, this is performed through a series of chemical and physical tests. However in some operational situations, streamlined methods to reliably evaluate fuel quality, would offer distinct advantages. The Naval Research Laboratory has been engaged in a research program to explore and develop rapid automated fuel quality surveillance technologies. Chemometric modeling methodologies have been investigated as a means to derive mathematical relationships between spectroscopic measurements and measured fuel specification properties. While this is not a novel concept, the nature of production fuels imposes certain restrictions on the use of traditional chemometric modeling approaches that have limited previous success in this area. Many of these inherent limitations stem from the fact that today's mobility fuels are produced with very close controls on the properties of the resulting product. As a consequence, it is not possible to develop a training set that statistically defines all the desired properties over the entire specification ranges. Moreover, the development of robust fuel property models requires large diverse calibration, or training sets and since it is generally impractical to acquire all the property measurements in one laboratory, reference property value uncertainties can also contribute to the uncertainty of the predicted values.

The performance of these property models is demonstrated in an example of a hardware implementation, i.e., the Navy Fuel Property Monitor (NFPM). The NFPM will rapidly estimate a range of specification fuel properties of jet and Naval distillate fuels, from a single analysis by near-infrared (NIR) spectroscopy. This technology will form the basis for control, acquisition and data analysis instrumentation for shipboard and land-based use. A further implementation of this technology will be for in-line sensing applications to provide real-time fuel grade and specification property monitoring as the fuels are moved through supply pipelines.

ASSESSMENT OF METHODS FOR THE MINIMISATION OF INTERFERENCE FROM SUSPENDED WATER DROPLETS IN JET FUEL DURING PARTICLE COUNTING

Vic Hughes and Paula Zard

Particulate contamination in jet fuel is normally assessed by gravimetric Millipore testing (IP 423 / ASTM D 5452). This test method has a number of disadvantages, such as poor precision, large sample size and that it is not possible to gain results in real time. In recent years, the use of particle counting technologies has been investigated and two laboratory methods, based on laser obscuration technology, are available from the Energy Institute (IP 564 and IP 565). These test methods are required by Defence Standard 91-91 issue 6 and the Joint Check List. Laser obscuration technology has been used for other petroleum products for many years and has a number of advantages over the gravimetric methods such as: Smaller sample size; reduced analysis time; technology transferable through distribution chain (on-line, real-time analysis available); calibration to ISO standards.

These laser obscuration methods detect both solid particulate and water but cannot differentiate between the two. This poster/paper assesses methods for removing or reducing the affects of suspended water droplets on particle counting results. Two methods are assessed: 1) The addition of a co-solvent to solvate water droplets; 2) The addition of a proprietary additive that forms a micro-emulsion reducing water droplet size to less than 1 µm. This droplet size is below the size detected by the two particle counting methods. The additive thereby reduces the affect of water on particle counts. The first method has been found to give erratic results are reasons for this are suggested. The second method appears more robust and is offered in a commercially available package.