INFORMATION

Deutsche Wissenschaftliche Gesellschaft
für Erdöl, Erdgas und Kohle e.V.

Hamburg, January 2008 01/08

PROJECTS

DGMK-COMMITTEE
FUELS

2001 – 2008

Überseering 40 · D-22297 Hamburg · Amtsgericht Hamburg, 69VR6898 · USt-IdNr. DE 118712841
Telefon 040 639004 0 · Telefax 040 639004 50 · www.dgmk.de · email: downstream@dgmk.de

Contents

DGMK-Project 685 FAME in Light Heating Oil

Diesel fuel and light heating oil are chemically and physically closely related products, for which, however, different standards apply due to the different fields of application. Since January 2007 the admixture of fatty acid methyl esters (FAME) to diesel fuel is mandatory. Whereas the standard for diesel fuel since long allows the addition of FAME, so far this is not permitted for heating oil.
Because of their similarity diesel fuel and light heating oil are logistically not always strictly separated. There may be a common use of tanks, pipelines or means of transportation. Thus a minor intermixing cannot always be excluded. With the mandatory admixture of FAME to diesel fuel the amount of blended fatty acid methyl ether has increased and with it the risk of small amounts of FAME getting into heating oil.
The subcommittee Heating Fuels of the German Society for Petroleum and Coal Science and Technology (DGMK) therefore has initiated a study to find out which amounts of FAME are present in the distribution chain refineries, tank farms and dealers. Besides that the concentration of FAME was determined in samples from complaints in order to detect any possible interrelationship between malfunctions and the presence of fatty acid methyl esters.
A total of 169 samples was tested, with 29 from refineries, 62 from tank farms, 38 from dealers and 40 from complaints. The concentration of fatty acid methyl esters was determined by gas chromatography. Contents over 40 ppm could be quantified, below this value it only was possible to distinguish whether traces of fatty acid methyl esters were present or not. At concentrations above 2000 ppm the content of FAME was determined by an infrared method instead of gas chromatography.
With the number of possible contacts between light heating oil and potential remainders of diesel fuel the percentage of samples containing FAME as well as the average content of FAME rose. For the sectors refineries, tank farms and dealers 34, 87 and 89 % of the samples contained fatty acid methyl esters, the average concentration of FAME increased from 21 to 130 and 808 ppm. Thus the maximum increase occurs from tank farms to dealers.
The samples from complaints show lower FAME concentrations than those from dealers. From the data of this report it can not be concluded that the presence of low concentrations of FAME results in problems at the consumer. Whether this is true also for higher concentrations cannot be judged due to the small number of samples.

Source:

DGMK-Forschungsbericht 685
FAME in Heizöl EL
(FAME in light heating oil)
Author: Dr. Hans-Peter Schmiedel, 2007
Price: EUR 150,00 plus VAT (DGMK-Members 50 %)
30 pages, 10 tables, 4 figures
ISBN 978-3-936418-72-9

Further Information:

Jan Ludzay, DGMK ludzay@dgmk.de

DGMK-Project 661 Deposit formation by 5% FAME (fatty acid methyl ester) blends in premix burner systems

Reason and Objective

Since 2003, biofuels are granted tax concessions according to the Executive Order for Mineral Oil Taxes. In the area of diesel fuel, the addition of FAME is common practice. Currently, the national standard for light heating oil, DIN 51603-1, does not permit any addition of FAME. In other EU countries, an addition of FAME to heating oil is already allowed. Within the scope of EU harmonisation and the attempts, to significantly increase the share of biogenous fuels in total consumption, one has to anticipate that the addition of biofuels to heating oil will be promoted also in Germany in the foreseeable future. In this project, the implications of FAME additions on the reliability of heating systems as well as on the fuel storage shall be investigated.

Brief Description

The aim of this project is to investigate the effects of 5% fatty-acid-methyl-ester (FAME) containing fuel in comparison to FAME free fuels on modern oil burning installations. This comprised on the one hand the storage under practical conditions, storage time and product stability, on the other hand the evaporation and combustion properties. In particular the stability of the fuels shall be varied systematically using FAME from different raw material like rape-oil, soya-oil or palm-oil. The blends are partially mixed with 10% of aged fuel in order to reflect as accurately as possible the realistic conditions.
The evaporation is investigated separately under idealised conditions in a pan-vaporizer to expose temperature levels for deposit formation depending on different fuel composition and their deterioration over time. Moreover the combustion properties are examined in respect of emissions and deposit formation in three different burner systems, which reflect the actual commercial stock.
As a result of these investigations, limit values of the temperatures and retention times of the fuel in oil-bearing components shall be defined and in addition constitute basic principles for the design of new burner and burner components.

Duration 2006 - 2008

Research Institute OWI Oel-Wärme-Institut gGmbH
O. van Rheinberg, A. Fischoeder, Dr. K. Lucka,
Prof. Dr. H. Köhne

AiF
Ideen eine Zukunft geben

This research project is sponsored through the Consortium of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsver-einigungen e.V., AiF) by funds of the Federal Ministry of Economics and Technology (14784 N).

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

DGMK-Project 646 A List of Criteria for Light Heating Oil Additives

The use of additives for quality improvement of light heating oil is approved according to DIN 51603 -1. These additives may be applied in suitable concentrations, provided they are not known to exhibit any harmful side-effects.

For this report, recommendations were elaborated and test methods established, which should help to select suited additives.

The objective of this report was the establishment of minimum requirements, which have to be met, in order to preclude undesirable side-effects or interactions of additives in light heating oil.

For these minimum requirements, test methods were selected and investigated by laboratories with regard to their ability to differentiate and their handling capacity.

In total, six minimum requirements were defined, which should be part of the requirements on additives.

Source: DGMK-Forschungsbericht 646
Kriterienkatalog für Heizöl EL Additive
(A List of Criteria for Light Heating Oil Additives)
Authors: Iris Böhm et al., 2005
14 pages
Price: EUR 40,00 plus VAT (DGMK-Members 50 %)
ISBN 3-936418-45-4

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

DGMK-Project 641 Development of a procedure for the decentralized desulphurisation of liquid fuels for processes in fuel cells

Reason and Objective

Within the scope of the project, a significant contribution to the development of a process should be made, which makes the use of liquid fuels in fuel cells possible. Neither a process nor the equipment for a decentralised desulphurisation of liquid fuels is currently available in the range of performance of a few kW. Therefore, in the submitted research project, such a desulphurisation process shall be developed and investigated. It will be realised with light heating oil (low sulphur, < 50 ppm) as an example within a reforming process.

Brief Description

Within the scope of the project, test equipment is adapted to the fundamental investigation of the mixture preparation, using cool flames and desulphurisation of the product. At OWI, a reactor for the investigation of mixture preparation under the conditions of desulphurisation is assembled, and possible operational circumstances are determined. At EBI, preexaminations of a suitable catalyst selection and of the influence of the composition of cool flames on desulphurisation are carried out initially on available equipment. On the basis of these results, test equipment for desulphurisation is designed, which is combined with the premixing unit. The results of this combined operation are used for an optimisation of mixture preparation, and the new design is combined with optimised operational parameters for desulphurisation. With this system, long term investigations of the stability of the components are carried out. At the same time, an almost commercial functional pattern is developed, which is optimised with respect to volume and weight.

Duration 2006 - 2008

Research Institute Oel-Wärme-Institut gGmbH, Aachen
Engler-Bunte-Institut, Universität Karlsruhe

AiF
Ideen eine Zukunft geben

This research project is sponsored through the Consortium of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsver-einigungen e.V., AiF) by funds of the Federal Ministry of Economics and Technology (14783 N).

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

DGMK-Project 637 Influence of Tank Inspections on the Quality of Heating Oil

In the past, a break down of heating systems was sporadically observed after tank cleaning. It was quite often impossible to find out the cause for such a break down. Sometimes, this led to irritations and arguments among the participating businesses (mineral oil traders, builders of heating systems, tank cleaning companies) and the customer.

A joint project was initiated in the fall of 2003 with partners from the mineral oil trade, tank protection companies and tank builders, in order to better understand the causes and interrelationships and to clarify the influence of tank cleaning on the quality of heating oil in the tanks of the customer. The objective of this project was to systematically document tank cleaning procedures, including an analysis of heating oils before and after tank cleaning. These investigations were coordinated by the *Institut für wirtschaftliche Oelheizung e.V.*

Samples were taken during tank cleaning operations from a total of 30 heating systems in 2004 – 2005. All prevalent types of tanks were included, such as battery of plastic tanks, underground storage tanks and tailor-made tanks, assembled on-site. 25 customer tanks were prophylactically cleaned. The investigation included samples of five customer tanks, where complaints had occurred in connection with tank cleaning.

Samples were taken from the middle of the fill level and 5 cm above tank bottom, before and after tank cleaning. In 2005, samples from the tank bottom were also included in the investigations.

All samples were analysed for total contamination, water content, copper content, particle number and particle size distribution. The results for total contamination and water content were compared to the limit values for light heating oil as defined by DIN standard 51603, part 1.

Special attention was given to total contamination and water content of heating oil after tank cleaning with sampling 5 cm above tank bottom. These results are documented for every facility on a separate sheet in the appendix to this report.

This report describes the sampling and tank cleaning procedures, contains the analytical results and the conclusions and provides a perspective for still unresolved problems.

Source:

DGMK-Forschungsbericht 637
Einfluss von Tankrevisionen auf die Heizölqualität
*(*Influence of Tank Inspections on the Quality of Heating Oil)
Author: Susanne Seehack, 2006
87 pages, 12 tables, 4 figures, 9 annexes
Price: EUR 50,00 plus VAT (DGMK-Members 50 %)
ISBN 3-936418-58-6

Further Information:

Jan Ludzay, DGMK ludzay@dgmk.de

DGMK-Project 635 Composition of light heating oil fuel - Grade 2004 -

Already in 2002, DGMK investigated the composition of diesel fuels within the scope of an extensive programme on the composition of diesel fuels (refer to Research Project 583). Similar data for light fuel oil were not available so far. In the course of the growing importance of diesel fuels and more stringent requirements with respect to their quality and ecological compatibility, blending components suitable for the production of light heating oil are mainly produced in cracking processes. These can only be desulphurized in part due to the lack of sufficient production capacities.

For this reason, data should be made available, to yield information on the composition of standardized light heating oil.

Due to the high boiling range, it is impossible to identify single components with a justifiable effort, as was possible in the case of carburettor fuel. Therefore, in accordance with DGMK Project 583, a list of the most important parameters was established, which are of special interest for characterizing the composition of light heating oil and which can be determined according to the current state of technology.

Chemical composition and relevant physical and technical characteristics of heating oils were investigated.

In total, 14 heating oil samples were provided by refineries and importers in May and June 2004. One sample came from the so-called ARA area, one from Russia, one from Austria and 11 from German refineries. All samples have been taken from current production or imports. In all cases, the products were undyed.

As the detailed analysis has proven, the characteristics of all samples were within quality standard. The deviations from specification, as shown in the tables, are due to different handling by the refineries with regard to the time of additive dosage and the location of sampling.

In addition to the parameters required by the standard DIN 51603-1 (Fluid Fuels – heating oils – part 1: light heating oil; minimum requirements), unspecified characteristics were also determined. The investigation included parameters, which are of interest with regard to applicability or ecological criteria.

The analyses were mainly carried out by the laboratories of ARAL, SHELL, OMV and TOTAL. Standardized test methods were applied as far as possible.

The analytical results show, that composition and properties of the investigated heating oils stayed within a certain range. The quality of all samples was within specification. In total, 28 parameters were checked.

Source: DGMK-Forschungsbericht 635
Zusammensetzung von Heizöl EL, Standard - Produktqualität 2004 -
(Composition of light heating oil fuel - Grade 2004 -)
Author: Wolfgang Gorek, 2005
Price: EUR 150,00 plus VAT (DGMK-Members 50 %)
61 pages, 31 figures, 10 tables
ISBN 3-936418-42-X

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

DGMK-Project 626 Development of a Burning Concept to Improve the Quantitative Determination of the Fuel Bonded Nitrogen in Middle Distillates

The starting point of this project was the implementation of lower obligatory limit values of nitrogen oxide emissions as state of the art in the revised version of the Ordinance on Large Combustion Plants and Gas Turbine Plants from May 2003 together with the Technical Instructions on Air Quality Control (TA Luft). The sales volume of fuel oil (heating oil) was around 2.9 million t, which represents 10 % of the entire fuel oil volume in Germany. The efforts over the last years to reduce nitrogen oxide emissions aimed essentially at the reduction of thermal nitrogen oxides (NO_X) by means of primary measures. The achieved low levels of thermal NO_X shifted a great relevance to the fuel nitrogen oxides. Therefore an exact knowledge of the content of nitrogen in the Fuel is required.
The method regulated in the 13. BImSchV to determine the content of Nitrogen in fuel oil is according to DIN 51444. The results of a round robin test performed according to the standard DIN EN ISO 4259 showed insufficient reproducibility. For these appointed reasons the development of a suitable analysis method was required. Conditions leaner than Stoichiometrie are required for a complete conversion of the fuel bond nitrogen in nitrogen oxide. For fuel rich conditions, the formation of fuel nitrogen oxides will be suppressed and the NO reduction to N_2 is favoured. The solution is a complete premixed surface burner with low heat input (P = 0.5 kW bis P = 3.0 kW). For a profound knowledge of the conversion of fuel bonded nitrogen to nitrogen oxides the test of several parameters that affect the mechanism of fuel nitrogen is required. The tested parameters are the oxygen partial pressure, the energy density, the form of the chemical compounds and their content. The oxygen partial pressure has a substantial influence on the fuel nitrogen mechanism. With rising availability of O_2 the conversion rate increases. The same behaviour exhibits the energy density. During the analysis of a sample, the oxygen partial pressure and the fuel mass flow (energy density) are kept constant.
No overall dependence between the conversion rate and form of the nitrogen compounds was ascertained. This means that the nitrogen compounds contained in the fuel oil have a minor influence on the results of the analysis. A similar dependence was obtained between the conversion rate and the fuel nitrogen content for all samples. The conversion rate decreases with increasing nitrogen content. The relative standard deviation of this method amounts to $\sigma_n < 9\%$, presuming a constant conversion rate r_N (average value of the conversion rates without considering the influence of the content of nitrogen). Considering the dependence of the conversion rate on the content of nitrogen using a fit-function $r_N(\xi_N)$ the standard deviation is reduced to $\sigma_n < 5$ %. The test results of the developed method are reproducible and according to the Norm DIN EN ISO 4259, for samples with a nitrogen content of $\xi_N > 3$ mg_N/kg_{Fuel}. The developed system combined with the described Chemilumineszenz analyzer, is suitable to determine nitrogen contents $\xi_N > 3$ mg_N/kg_{Fuel}.
A complete conversion of the nitrogen bounded in the fuel to nitrogen oxides was not achieved, despite of the premixing of the fuel with the oxygen. However the dependencies are well known and considered during the evaluation of the analysis.

Source:
DGMK-Forschungsbericht 626
Entwicklung eines Verbrennungskonzepts zur Verbesserung
der quantitativen Bestimmung des Brennstoffstickstoffs in Mitteldestillaten
(Development of a Burning Concept to Improve the Quantitative Determination
of the Fuel Bonded Nitrogen in Middle Distillates)
Authoren: António Medeiros et al., , 2007
Price: EUR 100,00 plus VAT (DGMK-Members 50 %)
54 pages, 51 figures, 7 tables, 16 references
ISBN 978-3-936418-76-7

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

AiF
Ideen eine Zukunft geben

This research project was sponsored through the Consortium of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsver-einigungen e.V., AiF) by funds of the Federal Ministry of Economics and Technology (14405 N).

DGMK-Project 624 Correlations between the Composition of Light Fuel Oil and the Corrosion of Flame Tubes by Metal Dusting

In order to investigate fuel-related influence factors on the occurrence of the high temperature corrosion phenomenon known as metal dusting, numerous test series are conducted at close-to-reality and idealised test rigs.

Out of a multitude of fuel-related parameters the sulphur content provides as a good indicator for a increased probability of the occurrence of Metal Dusting at critical burners. Sulphur contents in the interval 20 ppm < *S* < 300 ppm are identified as potentially critical. A maximum of the carburization is found in the interval 100 ppm < *S* < 200 ppm.

Concerning further fuel-related parameters examined in the tests (nitrogen content, content of mono-, di- and polyaromatic compounds, boiling range, final boiling point (simulated distillation), thermal stability, content on of bio components (FAME), etc.) no distinct correlation to the probability of the occurrence of Metal Dusting can be determined.

With an idealised test rig it can be shown that the high carburizing rates, which are observed at systems critical to the occurrence of Metal Dusting, are not caused by carbon separation from the gaseous phase.

An impairment of the system can only occur, when additionally to the usage of a potentially critical fuel, the combustion system and the material of the flame tube are susceptible to metal dusting.

Source: DGMK-Forschungsbericht 624
Einfluss der Zusammensetzung von Heizöl EL auf die Korrosion von Flammenrohren durch Metal Dusting
(Correlations between the Compositon of Light Fuel Oil and the Corrosion of Flame Tubes by Metal Dusting)
Authors: Ralph Edenhofer et al., 2007
102 pages, 48 references.
Price: EUR 50,00 plus VAT (DGMK-Members 50 %)
ISBN 978-3-936418-67-5

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

AiF
Ideen eine Zukunft geben

This research project was sponsored through the Consortium of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsver-einigungen e.V., AiF) by funds of the Federal Ministry of Economics and Technology (14170 N).

DGMK-Project 619 Deposit formation in oil burners

Modern and low-emission liquid fuel burners make use of partial premix or premix fuel-mixture generation. This is a vital criterion in order to achieve low-emission combustion. Transition to gaseous phase must take place prior premixed combustion of liquid fuels. Heat is transferred to the fuel during this process, starting to the auto oxidation reaction inside the fuel that may lead to the formation of carbon deposits. Polymers with a high boiling point are the products of this radical induced reaction and they remain as deposits upon the surface of the evaporator.

Investigations about the formation of these deposits were conducted in a partial-premixing combustion system as well as in a premixing combustion system. The impacts of the parameters temperature, air/fuel ratio, mode of operation, and different fuel properties were investigated during this process. Dependencies on single parameters were determined by the use of idealised test rigs. Dependency on the temperature was proven by the vaporization of single fuel drops and correlated to results from premix combustors.

Source: DGMK-Forschungsbericht 619
Deposit formation in oil burners
(Untersuchungen zur Ablagerungsbildung in Brennersystemen)
Authors: A. Fischoeder et al., 2006
61 pages, 54 figures, 3 references, 1 annex
Price: EUR 50,00 plus VAT (DGMK-Members 50 %)
ISBN 3-936418-46-2

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

Ideen eine Zukunft geben

This research project was sponsored through the Consortium of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsver-einigungen e.V., AiF) by funds of the Federal Ministry of Economics and Technology (13848 N).

DGMK-Project 601 Determination of relevant sulphur limit of domestic heating oil for the promotion of oil condensing boilers

Different oil condensing boilers, which were available on the German market, have been investigated in order to determine the relevant sulphur-limit for low-sulphur heating oil. The experiments have been carried out by burning different heating oils (sulphur content 10, 50, 100, 150, 200 mg/kg) in 19 different condensing boilers (6 condensing boilers under field conditions, 13 in bench tests).

Theoretically, burning 1 litre of domestic heating oil produces 1 litre of condensate or 0.1 l condensate per kWh. In practical operation, the condensation rate is depending on the condensing boiler and the installation conditions. The water return temperature is an important parameter for most condensing boilers. The total amount of acid or metal-ions in the condensate, cannot be calculated from the concentrations only. Therefore, in this study the measured concentrations (in mg/l) were evaluated by multiplication with the relevant condensation rate (in l/kWh) of the condensing boiler.

At present, according to instructions in ATV-A 251, which is in many cases a basis for local legislation, neutralization of condensate of oil condensing boilers is required. The composition of the condensates from oil boilers came out to be similar to the condensate from gas condensing boilers, as long as the sulphur content of heating oil is below 100 mg/kg. As the neutralization of condensate from gas condensing boilers is usually not required up to 200 kW-boilers, there should be no technical reason for neutralization, as long as the sulphur content is below 100 mg/kg.

The condensing boilers, which are on the market today, are fit for purpose with heating oil according to DIN-specification 51603-1 (Sulphur < 2000 mg/kg). However, boiler manufactures are convinced, that only if the sulphur content is as low as 50 mg/kg, it will be possible to develop reliable oil condensing boilers for a reasonable price. Calculations of the total energy consumption came to the result, that primary energy can be saved. The increase of efficiency on the boiler side has more influence than the energy needed for desulphurization.

Source:

DGMK-Forschungsbericht 601
Ermittlung eines technisch begründeten Grenzwertes für Schwefelgehalte im Heizöl EL zur Förderung des Einsatzes von Brennwerttechnologie in Ölheizungsanlagen
(Determination of relevant sulphur limit of domestic heating oil for the promotion of oil condensing boilers)
Authors Dr. Ernst-Moritz Bellingen et al., 2002
85 pages, 66 figures, 9 references
Price: EUR 50,00 plus VAT (DGMK-Members 50 %)
ISBN 3-931850-96-X

Further Information:

Jan Ludzay, DGMK ludzay@dgmk.de

DGMK-Project 590 FAME in mineral oil products particularly heating fuel

Politicians want to support the use of renewable raw materials for heating of buildings as a means to improve the environment, assist farmers and to secure jobs. Because of their similarity with mineral oil products preference is given to the use of fatty acid methyl esters (FAME). The European Commission has mandated the European Commission for Standardisation CEN to define a specification for FAME as a heating fuel.

If a standard is to be developed, test methods and critical values have to be determined, that allow a good prediction of the field performance of the products under consideration. For this a determination of the relationship between field performance and laboratory test results is required. So far only a limited amount of data for the use of FAME as a heating fuel is available, because in the past fatty acid methyl esters have mostly been marketed as diesel fuel. As some requirements for heating fuels are similar to those of diesel fuel, the experiences obtained with this are useful.

This literature survey summarises the currently available results. It can be seen that so far especially for oxidative and thermal stability no satisfactory test methods exist. FAME preferably should be stored in the dark excluding air. Presence of water can result in hydrolysis and microbes could cause problems. Manufacturers of heating equipment have found malfunction by corrosion. Two research projects that have been approved by the European Commission will help to gain further knowledge.

Source: DGMK-Research Report 590
FAME in mineral oil products particularly heating fuel (FAME in Mineralölprodukten insbesondere HEL)
Author: Dr. Hans-Peter Schmiedel, 2001
30 pages, 13 tables, 62 references
Price: EUR 40,00 plus VAT (DGMK-Members 50 %)
ISBN 3-931850-86-2 (english)
ISBN 3-931850-80-3 (german)

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

DGMK-Project 578 Mixture preparation of industrial gas oil and air using pre-reactions beyond the conditions of auto-ignition

The use of cool flames for mixture preparation of heating oil and air was systematically investigated in flow reactors of both laboratory and semi-technical scale for gaining fundamental knowledge of the process. The experiments were carried out using light heating oil and model hydrocarbons such as n-heptane, dodecane, hexadecane and 1-methylnaphtalin. Cool flames are typically formed at temperatures of 300 °C up to about 500 °C producing an homogenous mixture of oil-vapour and air, that can be ignited and used in further energetic processes such as combustion systems. In the cool flames, only a small part of the oxygen (< 20 %) is consumed. The consumption of hydrocarbons can reach up to 75 % in the case of n-heptane. Cool flames are accompanied with a temperature raise of 10 K up to 150 K and stabilised due to the reaction kinetics on this higher level.

The experiments using n-heptane in a laboratory scale reactor show that a number of organic compounds are formed, e.g. aldehydes, olefins and furans. Additionally small amounts of CO and CO_2 are detected. The experiments using higher hydrocarbons reveal that linear long-chain hydrocarbons tend to ignite at lower temperatures due to their higher reactivity. Aromatic hydrocarbons do not show any conversion as they do not establish cool flame reactions until thermal ignition conditions are reached. Experiments with mixtures of dodecane and 1-methylnaphtalin show, that in this case a conversion of the aromatic hydrocarbon occurs even at lower temperatures.

The system pressure has a strong effect on the reaction as the reaction rate increases with rising pressure so that the cool flame range diminishes. The same applies for low air ratios. These correlations were found both in the lab-scale reactor using n-heptane and in the semi-technical scale system for light heating oil.

The experiment here shows that the main conversion of the fuel injected into a preheated air flow in a plug flow reactor is competed after characteristic reaction times, e.g. 0,25 s with an air preheating of 350 °C. Internal recirculation of reaction products causes a locally fixed reaction zone. In this case the stabilisation of the reaction is determined by the geometric boundary conditions rather than by characteristic reaction times. Photo-optical exposures show a pale blue light in the reaction zone that originates from stimulated aldehydes. Varying the thermal boundary conditions reveals that the energy balance of a vaporiser determines the initiation of the cool flame reaction.

Within the research activities process engineering and chemical technical bases have been developed that can help designing mixture preparation units for combustion processes. Thus it is possible to convert heating oil into a homogeneous mixture with air that can be used in energetic processes. The aim of the research project is achieved.

Source: DGMK-Forschungsbericht 578
Umwandlung von Heizöl in ein homogenes Brenngas-Luftgemisch durch oxidative Vorbehandlung jenseits der Bedingungen der Selbstzündung
(Mixture preparation of industrial gas oil and air using pre-reactions beyond the conditions of auto-ignition)
Authors: Christian Mengel et al., 2003
70 S., 65 Abb., 7 Lit.
Price: EUR 40,00 plus VAT (DGMK-Members 50 %)
ISBN 3-936418-06-3

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de

Ideen eine Zukunft geben

This research project was sponsored through the Consortium of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsver-einigungen e.V., AiF) by funds of the Federal Ministry of Economics and Technology (12760 N).

DGMK-Project 570-1 Investigations on Thermal Stability of Light Heating Oil and DGMK-Project 570-2 Investigations on Storage Stability of Light Heating Oil

Product stability of light heating oil gained increasing importance by various factors during the ninety-nineties. These factors include:

- Higher thermal loads of the fuel in increasingly more compact oil systems
- Sensitive constructional elements (nozzles of oil burners) for burners of low power
- Longer storage periods of the fuel as a result of improved efficiency of the oil burners with unaltered storage volumes.

Product stability was already taken into consideration as an additional quality feature, when the specification for light heating oil (DIN 51603-1) was revised in March 1998. The two criteria: thermal and storage stability were included into the list of requirements; however, no suitable test procedure was specified.

Since 1999, the DGMK Project Group 570 has been working on the development of two test procedures. This work differentiates between two project parts:

- 570-1 “Investigations on thermal stability of light heating oil”,
- 570-2 “Investigations on storage stability of light heating oil”.

Brief description of the method for the determination of thermal stability:

After filtration through a membrane filter, an oil sample is thermally treated at 105 °C for 16 h in the presence of a copper wire, and subsequently, after cooling down to room temperature, again filtered through a membrane filter. The filter residue is washed, dried, and weighed in mg/kg as “filtratable ageing residue”. The residue, which remained in the ageing vessel and on the copper wire, is dissolved in a solvent and transferred into a vessel for evaporation. After evaporation of the solvent and drying, this residue is weighed in mg/kg and reported as “not filtratable ageing residue”. The sum of filtratable and not filtratable ageing residues is reported in mg/kg as “thermal sediment”.

Brief description of the method for the determination of storage stability:

After filtration through a membrane filter, an oil sample is exposed to five artificial light sources (light box) for 24 h in the presence of a copper wire, and subsequently again filtered through a membrane filter. The filter residue is washed, dried, and weighed in mg/kg as “filtratable ageing residue”. The residue, which remained in the ageing vessel and on the copper wire, is dissolved in a solvent (4.5) and transferred into a vessel for evaporation. After evaporation of the solvent and drying, this residue is weighed in mg/kg and reported as “not filtratable ageing residue”. The sum of filtratable and not filtratable ageing residues is reported in mg/kg as “storage sediment”.

Status:

Both DGMK projects are completed. The results were submitted to FAM. DIN 51371 Fluid Fuels - determination of the thermal stability of light heating oil is available as a draft. A draft standard for storage stability is currently under development.

Further Information: Jan Ludzay, DGMK ludzay@dgmk.de