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TRIBOLOGICAL PROPERTIES OF BIODIESEL FUEL AND ITS MIXTURES WITH DIESEL FUEL

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Abstract. Implementation of biodiesel fuel in bus fleet or other responsible transport requires research of biodiesel properties, influencing lifetime of machines and performance quality. One of important side of fuel properties is tribological properties of fuels and mixtures of them with diesel fuel. Due to different origin and chemical structure, real fuel can contain non-stable states of liquid with undesired behavior in real fuel system. Such situation can cause undesired wearing of sliding surfaces in case of low lubricating film, seizing of jets in case of undesired sticking to metal and create big general resistance of fuel system.
Aim of the paper is to reveal results and noticed properties of such mixtures using HVAC test and create some points in stable mixture behavior.
Paper includes description of experiment, experiment equipment, methodology of experiment. Further results and graphs of most remarkable tests are presented and conclusions are made.

Keywords: biodiesel, tribological properties, coeficient of friction, lubricant film propery.

1. Introduction

New politics of EU for renewable fuel and requirements to increase use of it naturally raises importance of bio fuel quality. Newest direction in renewable energy implementation is bio-diesel and its derivatives. Biological and low performed fuels are known [1–14], but actuality of nowadays pushes technology to intensify use of bio-diesel fuels in mixtures with common diesel fuel. Use of biodiesels in modern diesel engines requires new geometry of jet systems and friction surfaces [8].

Different way of producing – distillation and cold extracting for petro- and biological diesel fuels makes mixture of them possibly non-uniform consistent and can raise problems on fuel injection system.

Biodiesel is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats which conform to ASTM D6751 specifications for use in diesel engines. Biodiesel refers to the pure fuel before blending with diesel fuel. Biodiesel blends are denoted as, "BXX" with "XX" representing the percentage of biodiesel contained in the blend (ie: B20 is 20 % biodiesel, 80 % petroleum diesel).

Problematic can be lubricating properties of the mixture, which can cause seizing of contacting details in fuel jet system. This characteristic is sufficiently represented by coefficient of friction of fuel and fuel film properties. Research of tribological properties of composed biodiesel and diesel fuel mixtures is important to ensure long lifetime and high quality of engine systems [9].

2. Formulation of investigation

Main aim of experimental research is to detect main dependencies of tribological properties for pure petro diesel, pure bio diesel and mixtures.

Experimental research of tribological diesel fuel and its mixtures is performed using wear and friction test machine, according standard procedure [11]. During testing procedure test samples, consisting of selected by specific properties petro diesel and its mixtures was tested for coefficient of friction and physic wearing values.

Values of coefficient of friction in time makes a graph and these values are used to calculate mean value of it. This method allows minimize influence of temperature and layers of non mixed test specimen.

Additionally lubricant film property existence is evaluated during the same test. Value of lubricating film is measure in per cents for very time moment and also create graph, samples of which are represented in result section (fig. 3–4).

So, finally, task of experimental research retrieve mentioned above quality parameters for a different

types of biodiesel and mixtures with oil diesel.

Fuel film properties are important not only in tribological point of view, but also in the case of atomization of fuel into droplets during jetting process. Fundamental and experimental research [10], [11] in this field shows dependency of droplet size and fuel film property.

General task of all research can be expressed as finding optimal ratio range of biodiesel and diesel fuel mixture from tribological point of view and this research is starting point in it.

3. Experimental technique

As equipment for a experimental research was used HFFR [9] test machine (fig. 1) with 4 rolling balls on control plane. Methodology of procedure is described in ASTM D6079-99 Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR) and in analog ISO standart.

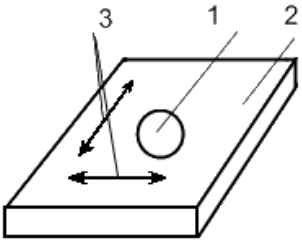

Fig. 1. HFFR test friction pair:
1 – ball; 2 – plane; 3 – direction of movement

Specimens for the test were selected from available source of Polish and Lithuanian origins. There were used two samples from different producers in Lithuania and some producers in Poland. In the testing research program was included two pure Lithuanian biodiesel samples, Lithuanian petroleum diesel with biodiesel, the same with Polish made specimens.

According description test was continued permanently 75 minutes of pure testing time. Used type of specimen was used ball and plate, load to specimen pair – 0,2 kg. Amplitude of recoprocating was taken as 1 mm. Test was performed in conditions of permanent humidity and permanent temperature 60° C.

Fig. 2. Universal machine for HFFR test

As output of experimental research are these parameters – instant coefficient of friction, instant lubricating fuel film quality (in percents), longitudinal and transverse wear of specimen ball, overall wear (both in micrometers), stability of lubricating film over the cycle of testing. All output characteristics are prescribed by HFFR standard [11]. In this case wear of surfaces in tested fuel represent integral output of efficient tribological properties.

4. Equipment

Testing machine performs standard test procedure on diesel fuel, which is standard for defining lubricating properties of sample fuel. During test lubricity characteristics are taken as indicative parameters, described above, and as real wear sizes, measured after test procedure.

5. Results

Given results represent tendencies in existing biodiesel products and grades them tribological properties. Of course, tribological properties not represent overall quality, but lack of lubricating facilities prevents use of such fuel.

Results of lubricating film value distribution of tested samples are presented in fig. 3.

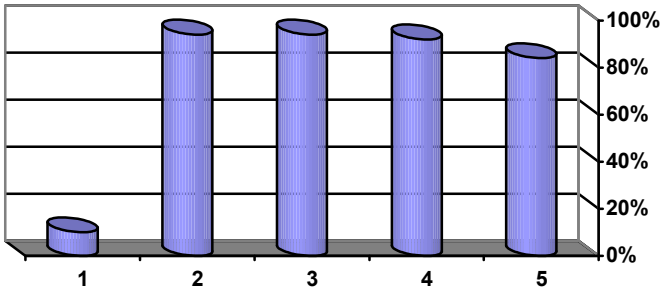

Fig. 3. Distribution of lubrication film values in most characteristic samples:
1 – diesel fuel basis (no additives, pol.); 2 – diesel fuel (lit.); 3 – agricultural diesel fuel (lit.); 4 – 100 % biodiesel (pol.); 5 – 100 % biodiesel old (lit.)

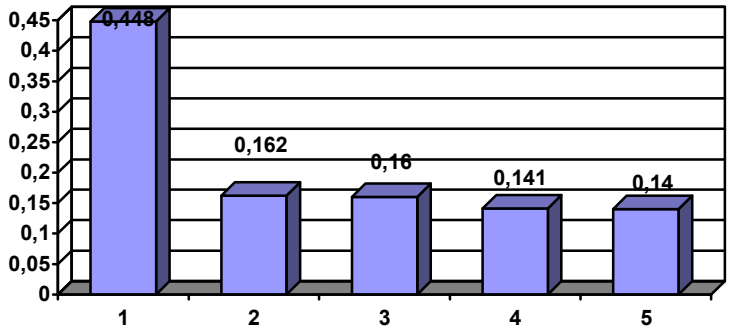

Fig. 4. Distribution of coefficient of friction values in most characteristic samples:
1 – diesel fuel basis (no additives, pol.); 2 – diesel fuel (lit.); 3 – agricultural diesel fuel (lit.); 4 – 100 % biodiesel (pol.); 5 – 100 % biodiesel old (lit.)

Distribution of coefficient of friction in test samples is presented below and shows wide range of it. This experimental research evidently requires increase numbers of test samples, because values are much dispersed.

During experimental research not samples with certain properties can be selected as good (fig. 5) or poor (fig. 6). Good results of regular diesel can be used as standard of tribological quality of diesel fuel.

Graph in fig.6 contains results of test of pure distillate of diesel fuel, which evidently shows that pure lubricating properties of such sample and definitely not applicable. High coefficient of friction and bad lubricant film quality point this test sample as unacceptable quality.

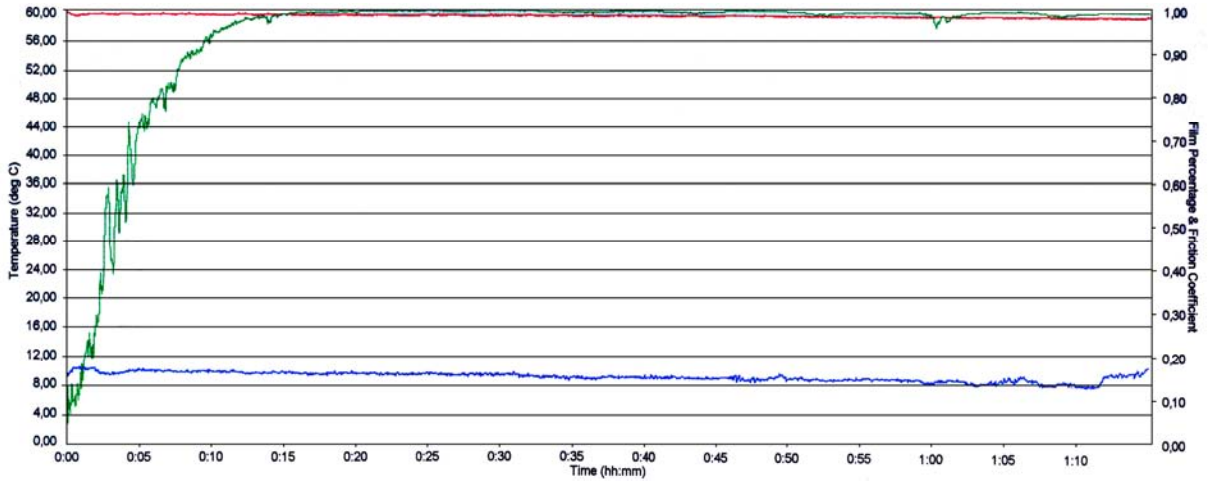

Fig. 5. Perfect tribological characteristics (Polish origin regular diesel fuel)

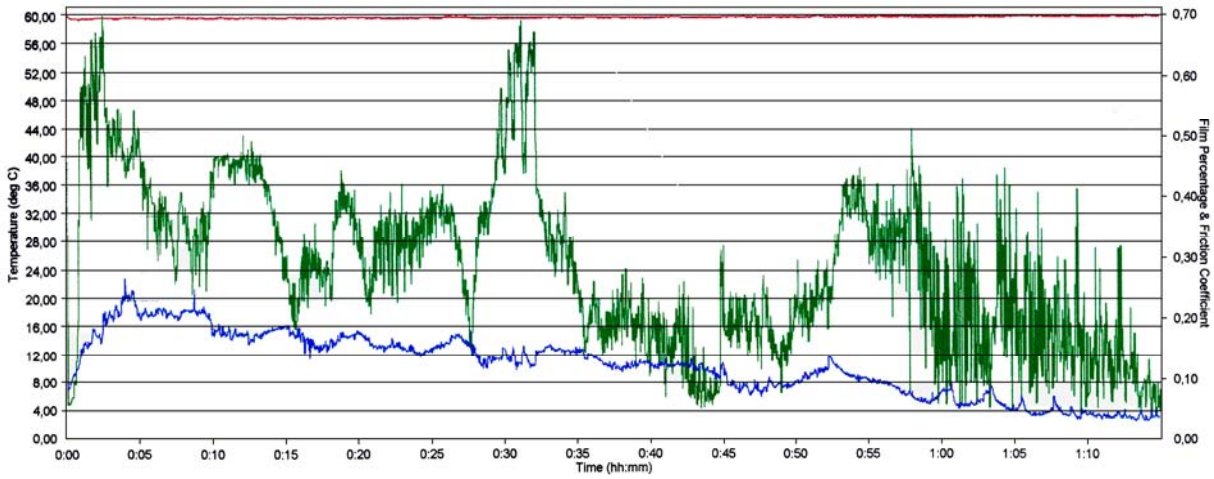

Fig. 6. Bad sample of diesel distillate basis (Polish origin, without additives)

6. Conclusions

Tribological properties of biodiesel and diesel mix can be very different and increase of bio fuel origins requires wider research. Initial research revealed some interesting dependencies and further analysis and research required. To get more detailed results, it is necessary perform more experimental tests with bigger variety of materials. Also percentage of bio diesel in mixture is not clear yet; nevertheless a standard for this is presented.

Research, presented in paper letting us to make these conclusions:

1. Tribological properties of pure biodiesel samples from different origin have better values, than pure oil distillates.

2. Pure biodiesel testing specimen shows lower tribological properties then the mixtures with diesel fuel.

3. Regular diesel fuels have more stable properties, than pure biodiesels, which is caused by difference in production process – biodiesels are not distilled, their raw material also differs.

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