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EFFECT OF THE VEGETABLE OIL FUELS ON MAIN PARAMETERS OF THE ENGINE OIL

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ABSTRACT: *It is necessary to investigate usability of different fuels and their impact on operation of the engine. During research work we examined the effect of vegetable oil fuels on the engine oil. 50 working-hour tests were made with three types of fuel (RME, rapeseed oil with additive and diesel oil) and then we evaluated engine oil samples (S40, RME, TESSOL, GAZO) at the end of the cycles. During the analyzes we determined conclusions on the main lubrication characteristics of engine oil (viscosity, viscosity index, total acid number, total basic number, flash-point, deposit content etc.) and we defined changes in quality of engine oils.*
KEYWORDS: *Vegetable oil fuels, engine oil, lubrication parameters lubrication characteristic, oil analyzes tests, oil condition*

INTRODUCTION

Synergistic effect of the climate change as well as continuous and permanent increasing of fossil fuel price, furthermore in order to increase the security of energy supply and create a modern transport the alternative fuels come to the fore. To this end European Union has adopted some directives and a number of research groups are investigating different kinds of vegetable oils as fuel and their limitations, difficulties and economic benefits as well.

In Diesel engines primarily crude vegetable oils, esterified vegetable oils and put an additive into vegetable oils can be utilized. [4, 6, 9] In this short study I would like to illustrate the effect of vegetable oil-based fuels to engine oils by identifying changes in the quality of engine oils.

METHODOLOGY

During the research work we performed long term operating tests on D-240 type Diesel engine with Junkers-brake. We examined whether different kinds of fuels have any effect on engine oils by the same engine parameters or whether there are significant differences between the engine oils for lubrication purposes.

Three types of fuels (diesel oil, raps-methyl-ester – RME, rapeseed oil with additive) were used during 50 working-hour tests. The engine lubricating oil type was MOL Standard S40 (manufactured by Hungarian Oil and Gas Company) monograde diesel engine oil for each fuel. And then engine oil samples were evaluated in order to achieve the objective.

Crude and refined rapeseed oil can be use as fuel but it causes deposits in the internal combustion engine. [1-3] For this reason it is need to put an additive into rapeseed oil. The TESSOL additive (developed in Germany) takes the light diesel oil fraction. This additive has low boiling point (200 °C), and rapeseed oil has high boiling point (320-350 °C). Additive is necessary because it must be reduced high molecular weight of the rapeseed oil so that it can be the missing light diesel oil fraction which is required to start the combustion.

The raps-methyl-ester is prepared by transesterification of rapeseed oil with methanol. Dilution of the lubricating oil can be observed negative during application as a fuel. [7]

At the end of 50 working-hour tests the engine oil samples were analyzed in the accredited testing laboratory at Metric Ltd. and in the Wearcheck Laboratory at Hungarian Oil and Gas Company (MOL Corporation).

Below are listed the main parameters for lubrication, but not limited to, describe the engine oil, these typical properties were evaluated and analyzed in the experiments.

The kinematic viscosity is a measure of oil's resistance to flow and its theoretical unit is mm^2/s. The appropriate viscosity of oil is basic requirement for optimum lubrication. Viscosity changes (oil oxidation) when using the engine oil. VI (Viscosity Index) is a number describing how the viscosity of a fluid changes with temperature. [8, 10, 15]

The TAN (Total Acid Number) shows the acidity of the oil as a function of time. These acids are produced by combustion and oxidation of the oil and oil additives. The TBN (Total Base Number) volume of the oil allows the determination to be made of whether the used oil is still capable of neutralizing acid residues. When the oil is in service too long, the TBN will drop significantly. Too low TBN volume can be due to heavy oxidation of the oil. Based on the above, an oil can be considered generally accepted waste oil if the fresh oil TBN value is reduced 40% or lower, or TBN and TAN values are equal. [10, 15]

The flash point is the lowest temperature at which it can vaporize to form an ignitable mixture in air but does not burn continuously. The flash point is indirectly used for lubricating evaluation. It should be considered together, the kinematic viscosity and flash point for lubrication purposes.

Coking residues of waste oils contains on the one hand coke from decomposition of the hydrocarbons and the other hand ashes of the additives and also wear particles.

Dispersant testing is required for analysis of engine oils, the easiest way is oil spot test: oil dripping onto special paper, which migrates through the paper and it gives a very good idea of how good level of the engine oil. Shape of the spot indicates the saturation with soot is suspended in the oil. [2, 10]

ENGINE OIL TESTS

Objective reason is that function of engine oil – like liquid machine elements – is as important as any other structural elements of the engine. Purpose of its use in the engine – as in a complex tribological system – is to reduce the friction, so to minimize the surface wear, neutralize acidic products, dissipate heat from the friction system and fulfil lubrication and other tasks (e.g. environmental requirements). It must implement these tasks under changing circumstances, and therefore engine oil is a complex "machine element" of the engine. [5, 10]

Waste oil samples are called (depending on fuels):

- *GAZO (diesel oil fuelled engine)*
- *RME (raps-methyl-ester fuelled engine)*
- *TESSOL (fuel is rapeseed oil with TESSOL additive)*

The fresh engine oil sample is called:

- *S40 (MOL Standard S40 (SAE 40 API CC))*

Table 1 contains the most important properties of MOL Standard S40 monograde oil which will be required in the lubrication analysis.

Table 1. Properties and typical values of S40

Density at 15 °C [g/cm^3]	0.901
Viscosity at 40 °C [mm^2/s], max.	177
Viscosity at 100 °C [mm^2/s]	9.3-15.4
Viscosity Index, min.	86
Flash point [°C], min.	210
TBN [mgKOH/g], min.	3.5

The examination of fresh engine oil was needed to get answers to the following question: what are the measured results compared to the catalogue values, whether there are differences? The answer is: condition of the fresh oil is good. Thus, in the future the analyses will be referred to both the measured results and the catalogue value. Analyzes determine impact of the fuels on the waste oil. In each case the reference oil is the original engine oil (MOL Standard S40).

Metric Ltd. makes analytical analyzes, this means that several oil parameters can be determined within a certain limits. While Wearcheck-tests have an advantage such as trend analysis: determine change from the samples taken at certain intervals.

In the lubrication analysis we looked for correlation between the lubrication properties (characteristics), we examined typical parameters how change in the function of the other one(s). So the research objective was to determine the changes in quality of oil samples.

In general we can say that short-term engine tests did not use the engine oils, general conditions of samples of waste oils are good so that is more difficult to detect the differences.

At the end of the 50 working-hour tests it can be described the following conclusion based on test results, the parameters of samples of waste oil. The evaluation of three different types of fuels was made according to original MOL Standard S40 engine oil. In a relatively short test period it could be characteristically determined the impact of three different fuels on waste engine oil. It is important to note that the oil analysis results give reliable information for the oil and the lubricated equipment already after 20 working hours.

It can be concluded based on the tests that the rape oil fuel with additive TESSOL increased kinematic viscosity of engine oil at 40 °C. The same trend can be estimated for kinematic viscosity at 100 °C, the viscosity is increased by 38%. This may be due to the additive TESSOL. Large increase in viscosity of TESSOL oil sample is not hazardous if the additive is itself dense. If, however, the additive induces viscosity increasing processes (polymerization, resin formation), it can be very hazardous.

Adverse impacts can be the slow start oiling, deposits, piston-ring sticking, engine oil consumption increased etc. It can be concluded, however, that the significant viscosity did not cause dysfunction for engine. Viscosity of RME and GAZO samples did not change neither at 40 °C and nor at 100 °C.

The kinematic viscosity and flash point correlation (based on the RME sample) clearly shows that dilution of waste engine oil (with fuel) did not occur. This trend is illustrated in figure 1. The theory prevailed that higher viscosity oil has a higher flash point.

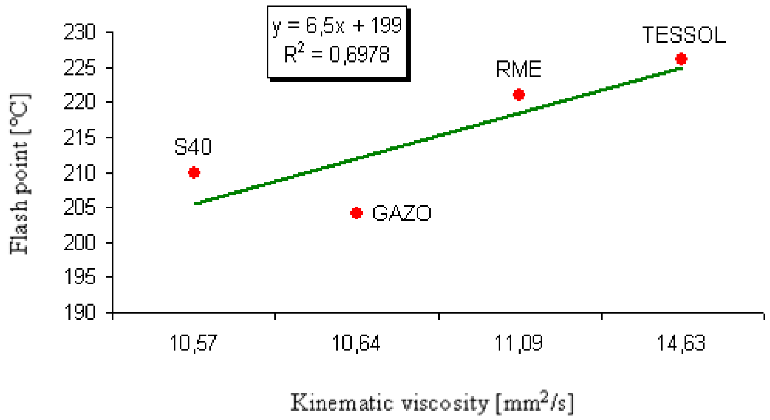


Figure 1. Relationship between kinematic viscosity and flash point

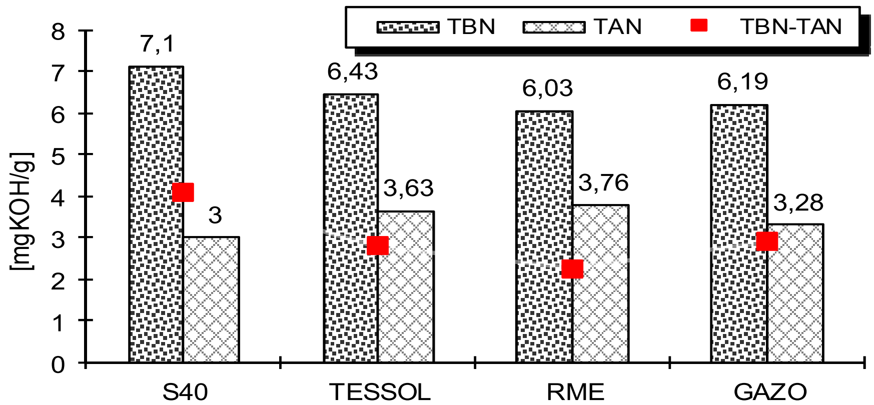


Figure 2. TAN és TBN values at mgKOH/g

Figure 2 illustrates the TBN–TAN values, like acid neutralizing capacity for each sample.

The requirement of difference between decreasing TBN and increasing TAN (TBN–TAN) must be positive. Differences are 4.1 mgKOH/g for S40 sample, 2.8 mgKOH/g for TESSOL, 2.27 mgKOH/g for RME and 2.91 mgKOH/g for GAZO. So RME sample has the lowest acid neutralizing capacity as a result of acidic effect. Figure 3 clearly shows that the acid neutralizing capacity of raps-methyl-ester fuelled is the lowest.

CONCLUSIONS

During engine oil tests, three waste engine oils were analyzed and it could be concluded impact of the fuel on the engine oils or whether there are significant differences between waste oils for lubrication. Based on analyzes of lubrication properties (find correlation between parameters) so it can be determined that one of the parameter how changes in the function of the other, that is, primary objective is to defined the change in quality of the engine oil.

In summary, we can say that:

- *Type of the applied fuels have impact the condition of the engine oil.*
- *The engine, operated on raps-methyl-ester is able to produce test results similar to diesel fuel operation.*
- *RME sample did not have insoluble residues, but in the course of rapeseed oil fuel operation (TESSOL sample) it could be observed residue content which is probably due to the additive.*
- *The engine oil analysis helps in making decision.*
- *Experimental results based on one waste oil sample refer to the current condition of the lubricant and machinery.*

It should be emphasized, however, the relatively short time (50 working-hour) engine tests are not enough to define general professional conclusions. But the oil analysis results are reliable after 20 working-hour tests and describe condition of the oil.

REFERENCES

[1] Carranca, José N. (2005) Green power from diesel engines burning biological oils and recycled fat. RIO5 - World Climate & Energy Event, Rio de Janeiro (Brazil), p 283-296

[2] Chevron, O. (2000) Classification and Specifications Automative. Lubricants, Houston, Texas-USA

[3] C. Gergel, W. (1995) Diesel engine oil drain intervals. The Lubrizol Corporation, Wickliffe, Ohio, USA

[4] Eder, B., Eder, F. (2005) Pflanzenöl als Kraftstoff. Autos und Verbrennungsmotoren mit Bioenergie antreiben

[5] Gregász, T., Korondi, E. (2008) Influence of maintenance strategies on environmental load, Acta Polytechnica Vol 5, No 3, pp. 29-37

[6] Hancsók, J., Lakatos, I., Valasek, I. (1998) Üzemanyagok és felhasználásuk (Fuels and their use). Tribotechnik, Budapest

[7] Kacz, K., Neményi, M. (1998) Megújuló energiaforrások (Renewable energies), Mezőgazdasági Szaktudás Kiadó, Budapest

[8] Kántor, I. (1996) Kenéstechnikai ABC (Lubrication Alphabet), MOL Rt. Kenőanyag Üzletág, Komárom

[9] Laczó, F. (2008) Bioüzemanyagok előállításának lehetőségei Magyarországon (Biofuel production possibilities in Hungary), Környezettudományi Központ, Budapest

[10] N. Kapilan, Ashok Babu T. P., Reddy, R. P. (2010) Performance and emissions of a dual fuel operated agricultural diesel engine, Annals of Faculty Engineering Hunedoara Tome VIII, Fascicule 1, pp. 159-162

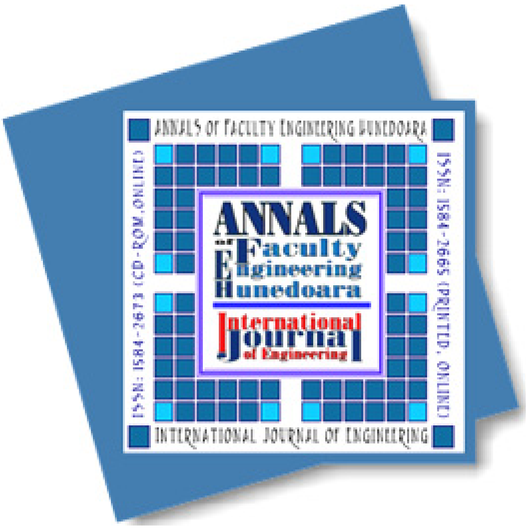
[11] Pordán, M. (2001) Biodízel a kutaknál (Biodiesel at filling station), Autószaki (Hungary) 11, pp. 16-17

[12] R. J., Crookes (20096) Comparative bio-fuel performance in internal combustion engines, Biomass and Bioenergy, Volume 30/5, pp. 461-468

[13] Shakinaz A. El Sherbiny, Ahmed A. Refaat, Shakinaz T. El Sheltawy (2010) Production of biodiesel using microwave technique, Journal of Advanced Research Vol 1, pp. 309-314

[14] Surapol, R., Anant, M. (2003) Effects of RPO fuel on wear of diesel engine components, Wear Volume 254, Issue 12, pp. 1281-1288

[15] http://www.wearcheck.ca/about-oil-analysis/



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