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MEASUREMENT OF THE CETANE NUMBER OF RAPESEED OIL FUEL USING THE "FUEL IGNITION ANALYSER"

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ABSTRACT: Rapeseed oil can be used as a renewable fuel for adapted diesel engines. The cetane number describes the ignition characteristics of a fuel for diesel engines and is an important quality criteria. The cetane number is ordinary measured with the CFR-test-engine, according to ISO 5165. However, the CFR-engine is not a suitable engine for the combustion of rapeseed oil fuel. Therefore it is not possible, to measure the cetane number of rapeseed oil fuel, which is comparable to the cetane number of diesel fuel with this testing-engine. A new testing equipment for the determination of the cetane number of rapeseed oil fuel, the "Fuel Ignition Analyser" (Fueltech AS, Trondheim), was checked for suitability. First results of the repeatability and reproducibility of the new cetane number testing instrument are presented.
Keywords: biofuels standardization, rapeseed oil, diesel engines

1 BACKGROUND AND PROBLEM

Rapeseed oil can be used as a renewable liquid fuel for adapted diesel engines. The minimum requirements for rapeseed oil fuel are laid down in the "Quality Standard for Rapeseed Oil as a Fuel (RK-Qualitätsstandard) 05/2000" [1, 2]. 15 properties of rapeseed oil fuel, with their limiting values and testing methods determine the quality requirements. One of these characteristics is the cetane number, which describes the ignition properties of a fuel for diesel engines. The "Quality Standard for Rapeseed Oil as a Fuel" is shown in Figure 1.

The determination of the cetane number of diesel fuel take place in a single cylinder, four stroke, indirect injection test engine (CFR-engine), according to ISO 5165. However, the CFR-engine is not a suitable engine for using rapeseed oil as fuel. So during the measurement e.g. the injection nozzle can coke and the spraying of the fuel is not sufficient. Therefore it is not possible to measure the cetane number of rapeseed oil fuel, which is comparable to the cetane number of diesel fuel with this CFR-test-engine.

LTV-Work-Session on Decentral Vegetable Oil Production, Weihenstephan
Quality Standard for Rapeseed Oil as a Fuel (RK-Qualitätsstandard) 05/2000
in Cooperation with:

Properties / Contents	Unit	Limiting Value min.	Limiting Value max.	Testing Method
charcteristic properties for Rapeseed Oil				
Density (15 °C)	kg/m³	900	930	DIN EN ISO 3675 DIN EN ISO 12185
Flash Point by P.-M.	°C	220		DIN EN 22719
Calorific Value	kJ/kg	35000		DIN 51900-3
Kinematic Viscosity (40 °C)	mm²/s		38	DIN EN ISO 3104
Low Temperature Behaviour				Rotational Viscometer (testing conditions will be developed)
Cetane Number				Testing method will be reviewed
Carbon Residue	Mass-%		0.40	DIN EN ISO 10370
Iodine Number	g/100 g	100	120	DIN 53241-1
Sulphur Content	mg/kg		20	ASTM D5453-93
variable properties				
Contamination	mg/kg		25	DIN EN 12662
Acid Value	mg KOH/g		2.0	DIN EN ISO 660
Oxidation Stability (110 °C)	h	5.0		ISO 6886
Phosphorus Content	mg/kg		15	ASTM D3231-99
Ash Content	Mass-%		0.01	DIN EN ISO 6245
Water Content	Mass-%		0.075	pr EN ISO 12937

Figure 1: Quality Standard for Rapeseed Oil as a Fuel (RK-Qualitätsstandard) 05/2000 [1, 2]

2 PURPOSE

The purpose of the research project “Measurement of the cetane number of rapeseed oil fuel using the Fuel Ignition Analyser” (financial support: Bavarian State Ministry of Agriculture and Forestry) is, to investigate a method of analysing the cetane number of rapeseed oil fuel by measuring the ignition delay with a new testing equipment, the Fuel Ignition Analyser (FIA).

3 APPROACH

First, the suitability of this new type of measurement instrument “Fuel Ignition Analyser” FIA (by Fueltech, AS Trondheim, Norway) will be tested. Thereby important parameters of the ignition and combustion process of different fuels for diesel engines with the FIA will be monitored. Afterwards first investigations concerning the repeatability and the reproducibility with diesel fuel will be conducted.

Then, the cetane number testing method of rapeseed oil fuel with the Fuel Ignition Analyser will be developed and laid down. Finally, the repeatability and the reproducibility for this test method will be determined.

4 DESCRIPTION OF THE “FUEL IGNITION ANALYSER” FIA AND THE MEASUREMENT PRINCIPLE

The Fuel Ignition Analyser basically consists of a fuel pump, fuel reservoir, fuel injection unit, combustion chamber and the temperature and pressure measurement equipment as well as a control and analysis software. The components of the Fuel Ignition Analyser are shown in Figure 2.

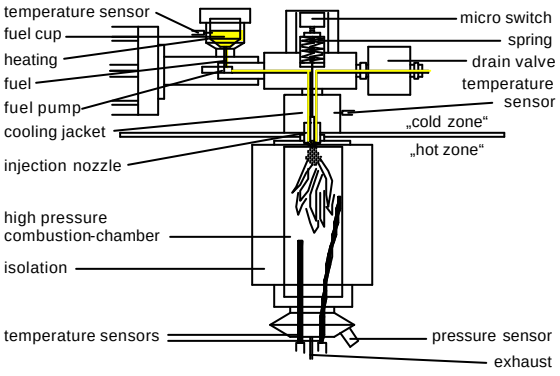

Figure 2: Components of the Fuel Ignition Analyser FIA (by Fueltech AS, Trondheim Norway)

The ignition of the fuel in the FIA-instrument is similar to the ignition process in diesel engines. The fuel is injected in a combustion chamber with constant volume. The temperature of the combustion air in this high pressure chamber is about 500 °C and the pressure is about 2 MPa. For each injection the temperature and the pressure in the combustion chamber is measured. From a free chosen number of single injections (normally 10 –20 injections), the ignition delay is calculated by statistical analysis of the single measurements. The FIA-cetane-number (FIA-CN) of the tested fuel is deducted by comparison with a calibration curve. The calibration curve is compiled from measurement results with ASTM-diesel fuels with known cetane numbers (CFR-engine).

5 FIRST RESULTS

The ignition and combustion of both, diesel fuel as well as rapeseed fuel with the Fuel Ignition Analyser is practicable.

The measurements of eight diesel fuel samples (for each measurement about 15 single injections were evaluated) with a known cetane number of CN = 50,0 (CFR-engine), result in an average FIA-cetane-number of FIA-CN = 49,7. The standard deviation is 1,2. The results and for better interpretation of the results, the requirements for repeatability and reproducibility, according to ISO 5165, are shown in Figure 3.

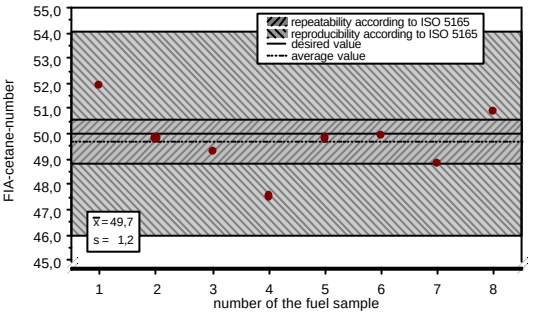

Figure 3: FIA-CN of eight diesel fuel samples with a CN = 50,0 (CFR-engine)

In this case, the requirements for reproducibility according to ISO 5165 (comparison of Fuel Ignition Analyser with CFR-engine) are met. The repeatability of the Fuel Ignition Analyser does not quite fulfill the requirements of the method ISO 5165. But it has to be taken into account, that the test method is not optimized yet.

The first results of attempts to measure the FIA-cetane-number of rapeseed oil fuel are shown in Figure 4.

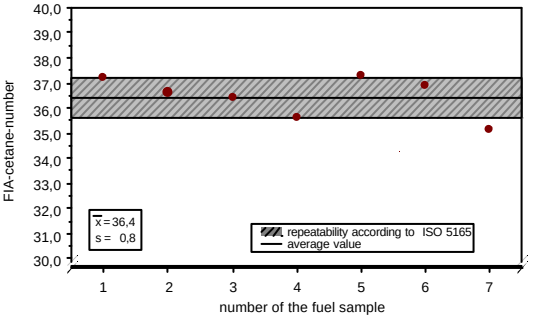

Figure 4: Deviation of FIA-CN of seven rapeseed oil fuel samples

Not the average value of FIA-CN = 36,4 of this measured rapeseed oil fuel samples is of special interest, but the positive results concerning the deviation. The repeatability of the measurements of rapeseed oil fuel is quite as good as the repeatability of the measurements of diesel fuel. The method for measuring the cetane number of rapeseed oil fuel with the Fuel Ignition Analyzer is not optimized yet.

6 CONCLUSIONS AND OUTLOOK

It is the first time, that the cetane number of rapeseed oil fuel can be measured properly.

Next, the repeatability and reproducibility of the Fuel Ignition analyzer will be improved by using a statistical method for the handling of runaways.

After that, the exact cetane number testing method for rapeseed oil fuel with the Fuel Ignition Analyser will be developed and the repeatability and reproducibility of this method will be monitored.

The knowledge of the cetane number of rapeseed oil fuel will promote the acceptance of this renewable fuel.

7 REFERENCES

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