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Development of a test method for a Cetane number determination of rapeseed oil fuel

A suitable test method for an important fuel property of the Diesel engine combustion process, the ignition quality, expressed through the Cetane number, is not available for rapeseed oil fuel, yet. The intention of this research project was the development of a reliable test method for a Cetane number determination of rapeseed oil fuel with a novel measuring device, the „Fuel Ignition Tester (FIT)". The test method was checked on the basis of several rapeseed oil samples from decentralized oil mills.

A general suitability of the FIT for Cetane number determination of Diesel fuel was asserted, whereas during the measuring of rapeseed oil fuel similar problems as known from test engines occurred.

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Keywords

Cetane number, rapeseed oil fuel, ignition delay, ignition quality, Diesel fuel

Due to the increase in price of crude oil products and a rising dependency from the petroleum exporting states, the farmers attention is turned to alternative, renewable energy resources. Further more there is a general cost pressure in agriculture as well as a discussion about a new arrangement concerning the subsidized diesel fuel for farmers. Thus farmers are forced to look for alternative fuels e.g. rapeseed oil fuel for adapted diesel engines.

In the „quality standard for rapeseed oil used as a fuel" (Qualitätsstandard für Rapsöl als Kraftstoff (RK-Qualitätsstandard) 05/2000), minimum requirements for the quality of rapeseed oil used in vegetable oil suitable engines are defined. [3].

A suitable testing method for an important fuel property of the Diesel engine combustion process, the ignition quality, expressed through the Cetane number, is not available for rapeseed oil fuel, yet. Thus, a limiting value could not be included in the quality standard [3].

For the Cetane number determination of Diesel fuel the BASF test engine (DIN 51773) [1], or the CFR test engine (DIN EN ISO 5165) [2] is used. Due to the higher viscosity of rapeseed oil fuel, a deficient fuel injection in test engines optimised for Diesel fuel occurs, which leads to an incomplete combustion and a quick coking of the injection nozzles [3]. An adaptation of the test engines for operating with vegetable oil is too intricate and expensive. Thus, an alternative test method for the Cetane number determination is required.

Objective

In the research project „development of a test method for Cetane number determination of rapeseed oil fuel" supported by the Bavarian Ministry for Agriculture and Forestry (BayStMLF) the suitability for a Cetane number determination of rapeseed oil with the Fuel Ignition Tester from FuelTech AS is to be tested as well as a test method is to be developed and described.

Material and methodology

The Cetane number determination with the FIT is similar to the combustion process in a Diesel engine. The test fuel is injected in a heated and pressurized combustion cham-

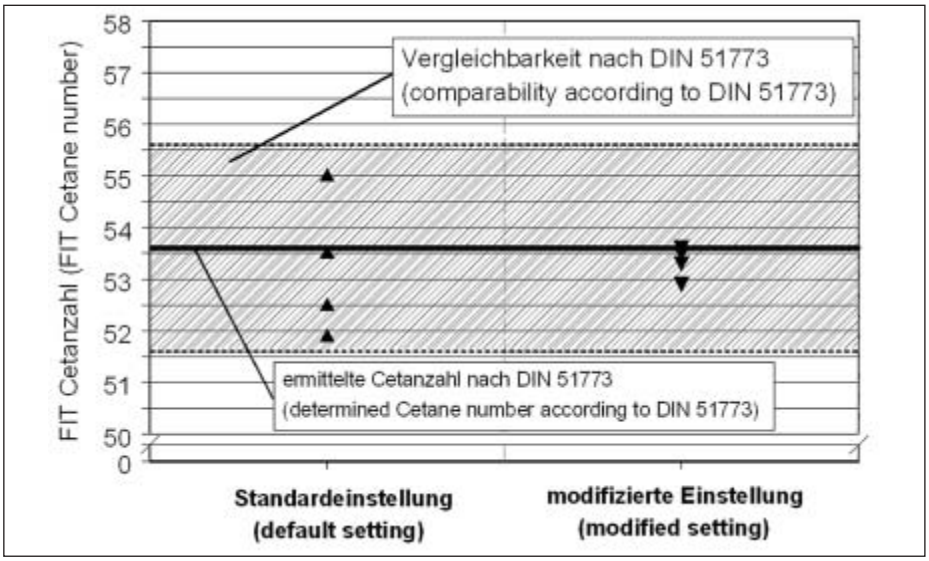

Fig. 1: Comparing the default setting of the Fuel Ignition Tester with modified setting with four cetane number measurements of a diesel fuel with known cetane number (cetane number measured acc. to DIN 51773:53,6)

ber, where self ignition and combustion takes place. The ignition delay is determined by the pressure increase. By comparing the average ignition delay of several single fuel injections with the ignition delays of reference fuels of known Cetane number compiled in a reference curve, the Cetane number can be determined.

First the Cetane number determination of Diesel fuel with the FIT was optimised regarding the comparability with the test results of a conventional test engine. As basis of evaluation the guidelines for the Cetane number determination according to DIN 51773 were used.

For this purpose the number of single injections as well as the accuracy in regulating the test conditions were analysed regarding the quality of the Cetane number determination. In addition the application of a program for a statistic outlier detection of the ignition delays of the single injections was tested. In the following the parameters combustion chamber temperature and combustion chamber pressure were adjusted to the optimal test conditions as well as the application possibility of an injection nozzle with larger injection hole diameter was checked.

The resulting setting for a Cetane number determination with the Fuel Ignition Tester was tested on the basis of several rapeseed oil fuels. The possible influence of other rapeseed oil characteristics (peroxide number, oxidation stability and total acid number) on the Cetane number was analysed.

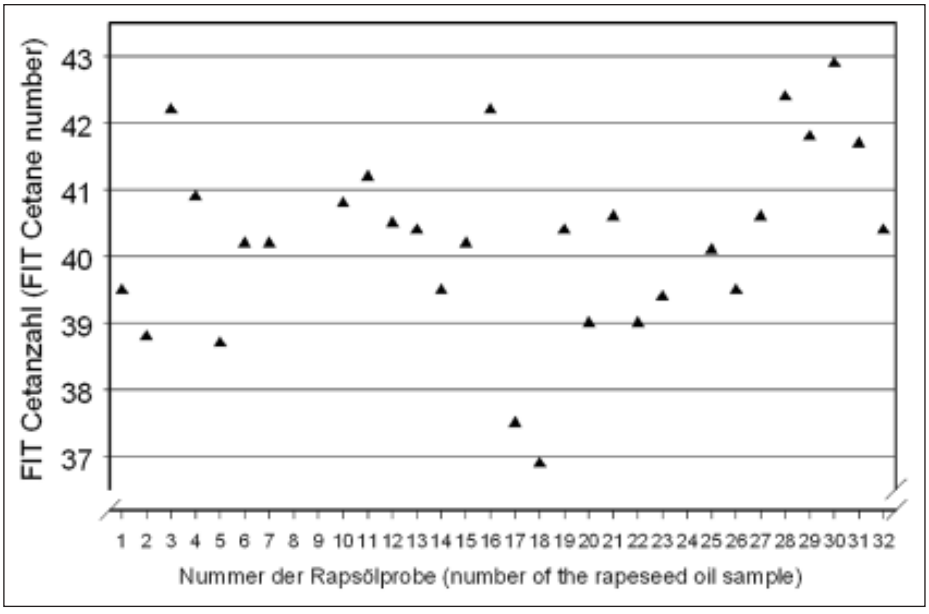

Fig. 2: Cetane numbers of various rapeseed oil samples from decentralised oil processing plants

Results

The results of a Cetane number determination of Diesel fuel with the revised instrument settings are within the range of the guidelines for the comparability and the repeatability according to DIN 51773 (*fig. 1*).

The tested statistic program offers a good and reliable basis for identifying possible outliers and leads to an additional improvement for the quality of the Cetane number determination with the FIT.

A Cetane number determination of rapeseed oil fuel results in similar problems as known from test engines. The injected fuel resinifies on the injection nozzle. This leads to a patchy injection and deficient operation of the instrument.

Thus, the guidelines for the repeatability according to DIN 51773 can not be reliably fulfilled at each Cetane number determination of rapeseed oil. Even the application of an injection nozzle with larger injection hole diameter does not lead to an appreciable improvement.

The precision of measurments of the FIT should be checked after each Cetane number determination of rapeseed oil using a reference fuel with known Cetane number. If the result is not within the guidelines for the repeatability according to DIN 51773 the injection nozzle must be exchanged or cleaned. The research showed, that two up to five measurements with rapeseed oil are possible with the FIT without overhauling the injection nozzle.

As a result, the Cetane number determination of rapeseed oil fuel with the Fuel Ignition is assessed to be too intricate. For a general suitability the measuring device should be modified for measuring rapeseed oil in the way, that no fuel residues remain on the injection nozzle. A simple dissambling of the injection unit for an overhaul of the injection nozzle would improve the suitability in practice.

The determined Cetane numbers of rapeseed oil samples from decentralised oil mills predominantly ranged from 38 to 42 (*fig. 2*). A correlation of possible influences of other rapeseed oil characteristics (peroxide number, oxidation stability and total acid number) on the Cetane number can not be asserted.

Literature

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