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Interaction between Rapeseed Oil Fuel and Motor Oil

Motor oil thickening is a major problem when operating vegetable oil engines in aggregates and vehicles. Often this is caused by adding large amounts of vegetable oil fuel to the motor oil, due to bad combustion quality or defective engine components. Oil thickening appears to be caused by either polymerisation or by ionic linkage of oxidatively modified vegetable oil. Ageing in the lab shows higher motor oil viscosity the more the rapeseed oil added is pre-aged. Various motor oils from one producer can show different increases in viscosity under constant ageing conditions.

Vegetable oil, used as a fuel in suitable engines, has major advantages. However, malfunctions occur, that are typical when operating vegetable oil engines. Special attention has to be paid to motor oil thickening. Thickened motor oil usually affects engine lubrication, which can cause severe engine damage e.g. on pistons. Experiences indicate that oil thickening occurs, whenever a big amount of vegetable oil fuel gets into the motor oil. Besides the amount, also the quality of the vegetable oil as well as the type of motor oil has influences on the thickening process. The mechanisms of formation are largely unknown. Moreover, probable influences on the process, like temperature, composition of the blow-by exhaust gas or catalytic active metals in the engine (surfaces, abrasion) have not been identified, yet.

Objective

The objective of the study, supported by the Bavarian Ministry for Agriculture and Forestry, is to investigate the interaction between rapeseed oil and selected motor oils in the lab and in practise to find out more about different factors that cause motor oil thickening. Additionally, possibilities are to be shown, how to reduce the risk of oil thickening, when operating engines with vegetable oil .

State of Knowledge

Rapeseed oil fuel, getting into the motor oil, when operating vegetable oil engines is usually accumulated there. This is different to Diesel fuel operated engines, because rapeseed oil does not evaporate at the prevailing temperatures. Reasons for the entry of a high amount of rapeseed oil can be:

- faulty injection nozzles
- faulty fuel or injection pumps, that are lubricated by the motor oil
- insufficient adaptation of engines (poor combustion quality)
- frequent cold starts
- too long intervals for motor oil change

Due to the accumulation of vegetable oil fuels in the motor oil, additives are both diluted and used up, leading to increased motor oil ageing. Additionally, metals (surfaces and abrasion) and chemical substances (blow-by exhaust gas) can have catalytic effects on the process. In an advanced stadium of the oil ageing a partly or even total thickening of the motor oil can occur. Oil pump or oil pipes can be blocked by residues, resulting in an insufficient lubrication and cooling of the engine. Damages of bearings and pistons can be the consequence.

Gaupp (1937) [1] discovered in engine tests that fuels with low iodine numbers (palm oil: 56) also have the lowest potential to build up residues in the motor oil, whereas

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Keywords
Rapeseed oil fuel, motor oil, motor oil ageing

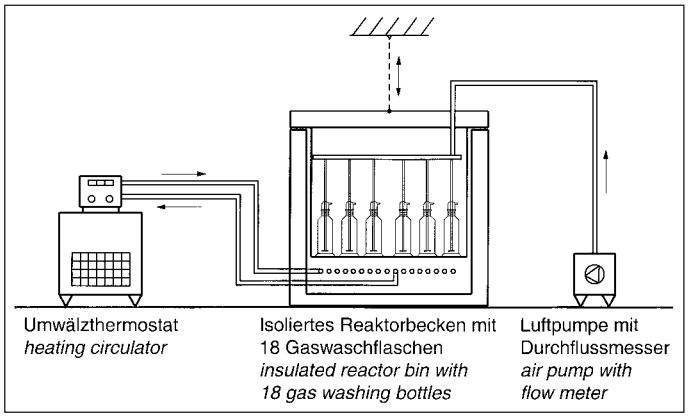

Fig. 1: Experimental design for sample ageing

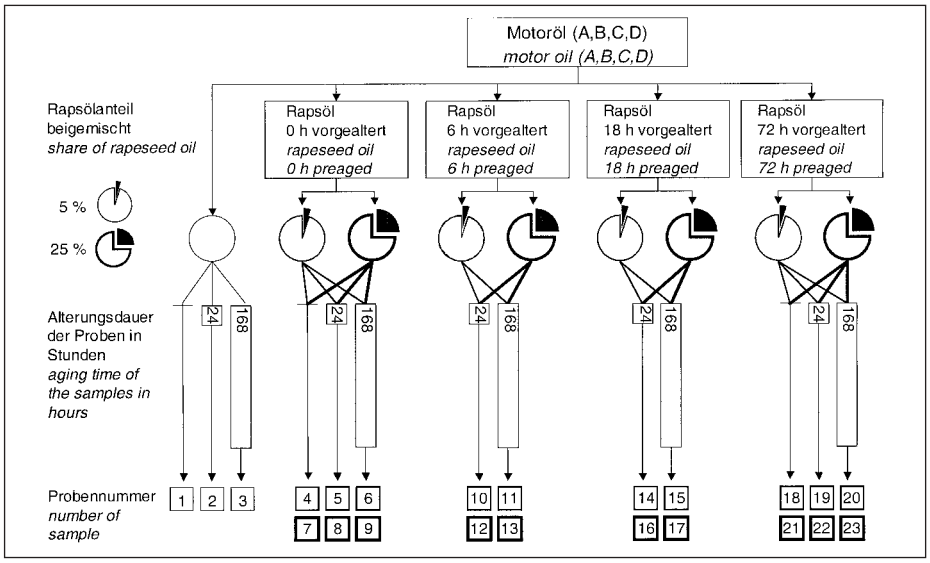

Fig. 2: Experimental design - variants of sample ageing (selection)

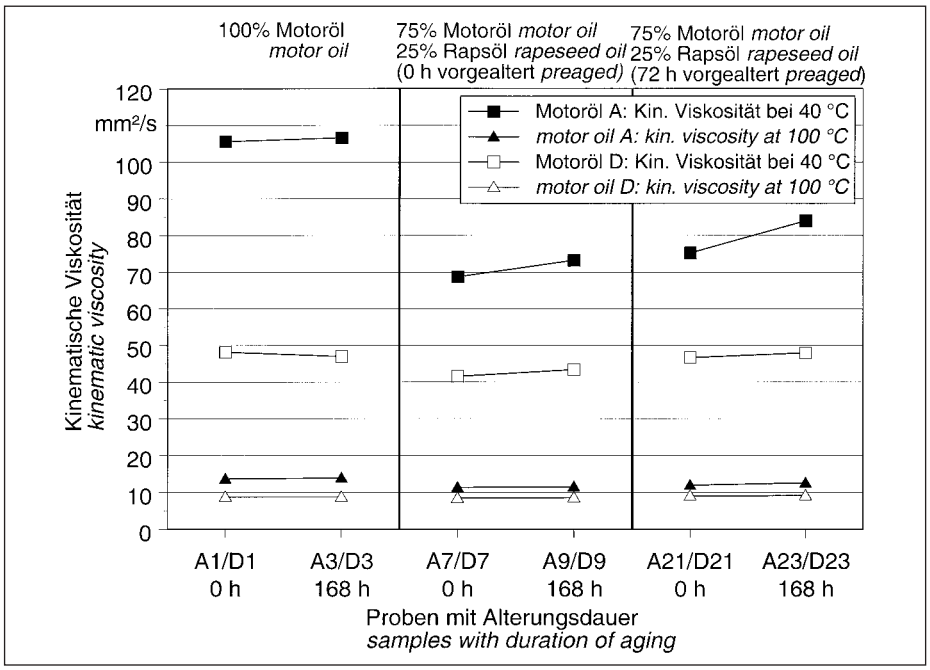

Fig. 3: Viscosities of different rapeseed engine oil mixtures (engine oil A,mineral oil alkaline, conventionally added; engine oil D,mineral oil ester-alkaline, high grade-added)

fuels with high iodine numbers (soy: 130) show the highest increase of viscosity and tend to build up more residues. An indication, that especially the double bonds of fatty acids (high iodine numbers) are susceptible to oxidation and hydration. This starts further polymerisation reactions and the formation of residues.

Wilharm analysed practise samples of black coloured, solid (gel) thickened motor oil. The residues are soluble in hexane (apart from 3,5 % residues) and not soluble in polar solvents. The residues have a remarkable high content of calcium, presumably originating from the motor oil additives and linking the fatty acids of the residues.

Methodology

To simplify the complex influences in practise, that affect the motor oil during operation, 18 samples (100 ml) of motor oil-/rapeseed oil mixtures were aged in gas washing bottles at a temperature of 100 °C and an air flow of around 28 l/min per sample in the lab (*fig. 1 and 2*). Motor oil type A is a conventionally additivated product on mineral oil basis and is classified in viscosity class 15-W40. From the same producer motor oil type D is high quality additivated, based on esters and has a viscosity class of 0-W20.

Results

As expected, analysis of the samples show, that within a ageing duration of 168 h, viscosity of the motor oil/rapeseed oil mixtures increases. The increase is larger, the more rapeseed oil is added to the motor oil and also the more the added rapeseed oil was preaged (low oxidation stability). The increase of the viscosity at 40 °C is always higher than the viscosity at 100 °C. The samples with the high quality motor oil type D show a lower increase in viscosity than those with the conventional motor oil A do (*fig. 3*). However, the generalising conclusion, that the use of motor oils that are high quality additivated or motor oils that are on ester basis reduce the risk of oil thickening compared to conventional motor oils can not be drawn at this stage. Despite the long ageing time of 1 week (168 h) none of the samples got solid. This is also the case, when for accelerating the ageing, copper or iron powder as well as nitric acid or hydrochloric acid is added. Thus, further investigations are necessary to reproduce oil thickening in the lab in order to verify and to complete present results.

Literature

[1] *Gaupp, K.*: Pflanzenöle als Dieselkraftstoffe. ATZ Automobiltechnische Zeitschrift, (1937), Nr. 8, S. 203-207