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INTERACTION BETWEEN RAPESEED OIL FUEL AND MOTOR OIL

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ABSTRACT: Motor oil thickening can be a major problem when operating vegetable oil engines in aggregates or vehicles. As a pre-condition, often a big amount of vegetable oil fuel gets into the motor oil, due to bad combustion quality (e.g. insufficient engine adaptation) or malfunction of engine components (e.g. injection nozzles, fuel-pumps). Research works indicate that oil thickening is caused by polymerisation or ionian linkage of oxidised vegetable oil. When being aged in the laboratory, the viscosity of motor oil increases more, the more the added rapeseed oil was pre-aged. Different motor oil types show inconsistent results when being aged under the same conditions.
Keywords: rapeseedoil, diesel engines

1 INTRODUCTION

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 (Figure 1). 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 mainly unknown. Moreover, probable influences on the process, like temperature, composition of the blowby exhaust gas or catalytic active metals in the engine (surfaces, abrasion) are not identified, yet.

Figure 1: Motor oil thickening of a tractor

2 OBJECTIVE

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 laboratory and in practice to find out more about different factors that cause motor oil thickening [3]. Additionally, possibilities are to be shown, how to reduce the risk of oil thickening, when operating vegetable oil engines.

3 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/injection pumps, lubricated by motor oil
- insufficient engine adaptation
- 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 (blowby 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 block, 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 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 bondings of fatty acids (high iodine numbers) are susceptible to oxidation and hydration. This starts further polymerisation reactions and the formation of residues.

4 METHODOLOGY

To simplify the complex influences in practice, 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 (Figures 2 and 3) in the laboratory. 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.

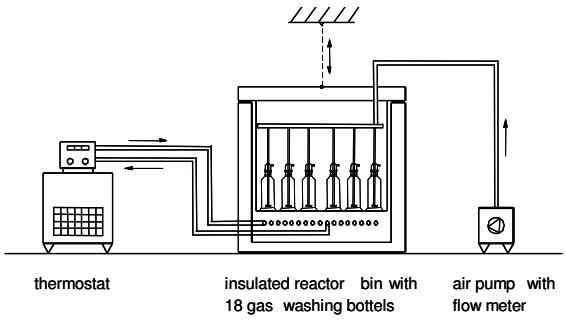

Figure 2: Test apparatus for oil sample ageing

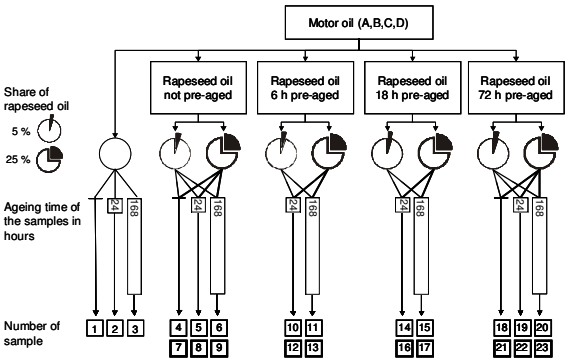

Figure 3: Testing program – variants of oil ageing (selection)

5 RESULTS

As expected, analysis of the samples show, that within an ageing duration of 168 h, viscosity of the motor oil/rapeseed oil mixtures increases. The increase is higher for the mixtures, than for pure motor oil. Viscosity increase is also higher, the more rapeseed oil is added to the motor oil and the more the added rapeseed oil was pre-aged (low oxidation stability).

The increase of the viscosity at 40 °C is always higher than 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 (Fi gure 4). However, the general conclusion, that the use of motor oils with high quality additives 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.

Analysis of other oil quality parameters, like acid value, total base number (TBN) content of additives did not show any consistent results.

When ageing pure rapeseed oil, a decrease of linoleic and linolenic acid is significant, whereas rapeseed oil/ motor oil mixtures do not show any changes in the fatty acid composition. The reason therefore is the anti-oxidative effect of the motor oil additives.

Despite the long ageing time of one week (168 hours) none of the samples became 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.

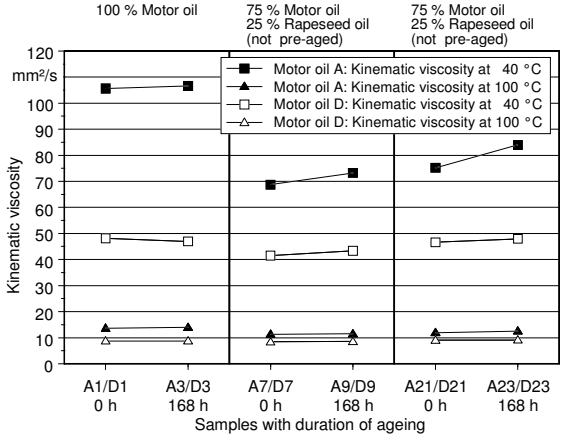

Figure 4: Viscosity of rapeseed oil/motor oil mixtures (Motor oil "A": mineral oil basis, conventional additives; motor oil "D": ester basis , high quality additives)

6 CONCLUSIONS

Following recommendations can be given to minder the risk of motor oil thickening:

Design features

- professional engine adaption for rapeseed oil use
- securing cleanliness and functionality of injection nozzles
- low blowby rates by proper sealing piston rings
- increase of motor oil amount by additional oil reservoir or bigger oilpan
- continuous motor oil refreshment, e.g. Plantotronic® lubrication system [2]
- avoiding low corrosion resistant and highly catalytic surfaces in the engine

Operation conditions

- avoiding low load operation and frequent cold operation
- avoiding engine overheating

Rapeseed oil fuel

- there are only few experiences with other vegetable oils than rapeseed oil, but it can be assumed, that with increasing number of double bondings (high iodine number), tendency to polymerisation is stronger
- rapeseed oil fuel with low acid value conserves motor oil additives and minders corrosion on engine surfaces
- rapeseed oil fuel with high oxidation stability decelerates oxidation processes of the motor oil

Motor oil

- specific motor oil properties (basis oil, additives) have effects on motor oil ageing, but motor oil recommendations for the use in vegetable oil engines can not be given
- motor oils with highly active antioxidants, detergents, and dispergents may also enhance oxidation stability of the vegetable oil share in the motor oil

Maintenance

- frequent oil exchange
- oil quality control
- oil level control

Further activities

- development and testing of motor oil quality control systems for continuous operation
- development and testing of motor oil level control for continuous operation

Further investigations are necessary to reproduce oil thickening in the laboratory in order to verify and complete present results, especially to concretise evident motor oil influence on motor oil thickening.

6 REFERENCES

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