QUALITY ASSURANCE FOR RAPESEED OIL FUEL

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ABSTRACT: The number of decentral oil mills in Germany is increasing rapidly. Today in decentral oil mills some 500.000 t of rapeseed oil are produced, which is mainly used as a fuel. For a reliable operation of adapted diesel engines, the rapeseed oil fuel has to fulfill special quality requirements, which are defined in the pre-standard DIN V 51605. It was the purpose of this work to investigate influences of the whole production process on rapeseed oil fuel properties. To survey the rapeseed oil quality, available on the market, oil samples were periodically taken from several oil mills and analyzed. Further more, experiments on a small scale pilot oil mill were accomplished to investigate the effect of seed variety and quality on rapeseed oil fuel properties. Additionally, the influences of different storage conditions on the fuel quality were investigated. Finally the performance of safety filters was tested. Results are, that initially the rapeseed oil quality varied a lot, whereas with ongoing product control, fuel quality improved significantly. There is no obvious influence of the seed variety on oil quality, however seed ripeness appears as an important factor. Storage is best at a temperature of 5 °C, to prevent quick oil ageing. The testing of safety filters showed that the best efficiency was achieved with multi-layer filters.

Keywords: rapeseed oil, liquid biofuels, quality

1 INTRODUCTION AND PURPOSE

Since 1999 the number of decentral oil mills in Germany has increased from 79 up to nearly 600 plants (status April 2007). Today some 1.500.000 t of rapeseed are processed per year, corresponding to approximately 500.000 t of rapeseed oil, which is mainly used as a fuel. The processing steps in a decentral oil mill are shown in figure 1. The oil is extracted only mechanically (pressing) from the oilseed. Prior to pressing in few cases the seed is crushed or peeled. The extracted uncleaned oil is purified in at least two purification steps. Due to the lack of refining, as it is done within industrial oil production, oil seed quality and processing parameters have big influences on the characteristics of rapeseed oil fuel. For a reliable operation of adapted diesel engines with rapeseed oil fuel and to assure the compliance with present and future emission standards the fuel has to fulfill special quality requirements, which are defined in the pre-standard DIN V 51605.

It was the purpose of this work to help to improve rapeseed oil fuel quality in practice. Therefore it was necessary, on the one hand to investigate the current quality on the market and on the other hand to determine the influences of seed quality and seed variety, processing parameters, oil purification and oil storage on rapeseed oil fuel properties.

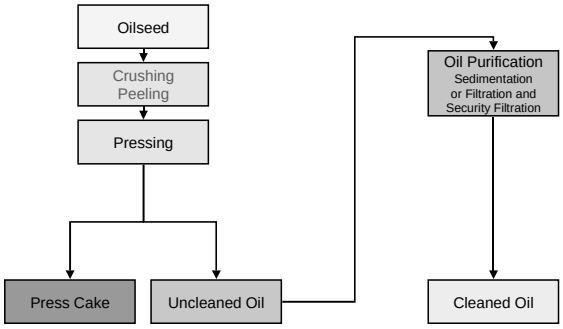

Figure 1: Processing steps in a decentral oil mill for the production of rapeseed oil

2 APPROACH

To survey the rapeseed oil quality, which was actually available at the market, oil samples of 22 selected oil mills were periodically taken over one and a half year. They were analyzed immediately after taking in experienced laboratories. The quality was assessed according to the pre-standard DIN V 51605 “fuels for vegetable oil compatible combustion engines - fuel from rapeseed oil - requirements and test methods”. Additionally to the rapeseed oil fuel, also the input product rapeseed and the by-product press cake were analyzed. Based on this, the influence of the oilseed quality on the oil properties and the effectiveness of newly introduced measures for quality assurance could be examined.

Besides that, 39 decentral oil mills took part at a voluntary quality check programme with unannounced sampling for six times over the investigation period of 18 months. Those oil mills, that produced rapeseed oil fuel according to DIN V 51605 constantly, were published in the internet.

Experiments on a small scale pilot oil mill were accomplished to investigate the effect of seed variety (seven winter rapeseed and two summer rapeseed samples, including one high-oleic breed) and seed quality (contamination, germination, degree of ripeness, peeling of the seed and seed drying temperature) on rapeseed oil fuel properties. Additionally the effects of press screw rotation speed on oil quality were carried out at two oil mills in practice.

Security filters of different designs and producers were tested at a trial filtration stand in the laboratory of the Technology and Support Center in Straubing. Thereby, the particular matter and the particle size distribution in the oil were examined, to determine the performance of the different filters.

The influences of storage conditions and storage duration on the fuel quality were investigated. Therefore four different fuel varieties (winter rapeseed oil, summer rapeseed oil, a mixture of 25 % summer rapeseed oil and 75 % winter rapeseed oil and with 2,9 % RME denaturated winter rapeseed oil) were stored under three

different conditions: Dark at 5° C, dark at 20° C and under outdoor weathering. The oil was stored in small tanks of steel, stainless steel and High-Density-Polyethylene (HDPE) under following conditions: Airtight, contact to the ambient air and contact with dried ambient air. Important fuel characteristics of these altogether 108 different varieties were monitored over a period of one and a half year.

3 RESULTS

The samples from the oil mills showed, that, depending on the plant, fairly different oil yields were achieved. According to this, the oil content of the press cake alternated. Also the acid number of the oilseed varied considerably and a difference between two crop years could be observed. The water content in the seed was almost constant and not dependent on the season. The requested water content of 7 to 8 mass-% was normally met. Oil analysis showed that the mostly failed limiting value was contamination. The fulfillment of the demands for the acid number, oxidation stability and water content was no problem for most oil mills. However, the limiting value of the phosphorus content was failed by three, the sum content of calcium and magnesium was failed by eight oil mills. In the majority of cases the content of sulphur is under the detection limit. Two plants were not able to produce fuel conforming to the standard over the whole sampling period.

The voluntary quality check of 39 oil mills showed a various quality on the market with partially enormous deviation from limiting values of pre-standard DIN V 51605. Only four oil mills could achieve a standard conform quality in every of the six samplings. 12 oil mills failed only for one parameter once (fig. 2). Fuel quality improved significantly with raising awareness of the importance of quality assurance measures and increasing skills of the oil miller.

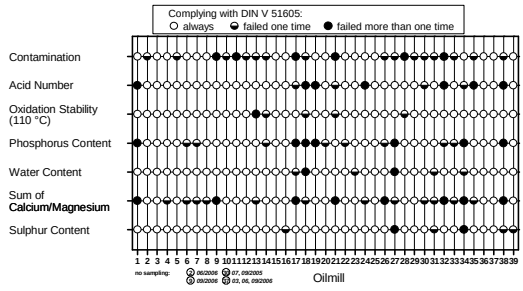

Figure 2: Compliance with the standard of quality checks of 39 decentral oil mills

The systematic investigations on the small scale pilot oil press showed no obvious influence of the seed variety on oil quality. Solely high oleic varieties have advantages in regards of oxidation stability. Both acid number and oxidation stability are negatively influenced by contamination of the seed with weeds. The ripeness of seed appears as an important factor: With increasing ripeness of the rapeseed, acid number, oxidation stability and the content of P, Ca and Mg in the oil are positively influenced (fig. 3). Germinated seed has an unfavourable influence on acid number, oxidation stability and P-, Ca- and Mg-content. Peeling of the seed might improve the acid number and element content in the oil but has no influence on oxidation stability. Neither acid number nor oxidation stability and element content in the oil were influenced negatively, when seed was dried at different temperatures of up to 80 °C. The trials in two practice plants, regarding the variation of screw rotation speed could confirm results of previous research works, that an optimised adjustment of screw presses for low P-, Ca- and Mg-content in the oil is possible [1], [2], [3], [4].

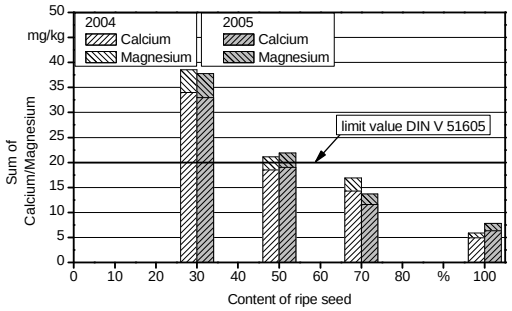

Figure 3: Influence of seed ripeness on the content of Ca and Mg in rapeseed oil fuel

Multi-layer security filters of the manufacturer Pall SeitzSchenk achieved the best results among the tested products. Good results also showed the bag filter type 2-AXL-1 µm from Jäger Filtertechnik. Low contents of suspended solids in the oil could be reached with cartridge filters GP 0,45 – 10U – X4N, EP 001 – 10 – U – X4N and ES 001 – 0 – U – X0. Since the absorbing capacity of filter cartridges is rather small, they are only recommended for applications with a highly effective first purification step.

Under ideal conditions, rapeseed oil is storable for about one year. Under inappropriate conditions, the limiting value of oxidation stability of the pre-standard DIN V 51605 is failed already after three months (fig. 4). Regarding oxidation stability, high-oleic varieties bring some advantages. Storage is best at darkness and at a temperature of 5 °C, to prevent quick oil ageing. Materials for storage tanks can be steel, stainless steel or High-Density-Polyethylene (HDPE), whereas HDPE is transparent and thus, the tank has to be protected from sunlight.

4 CONCLUSIONS AND OUTLOOK

Quality of rapeseed oil fuel, which is available on the market, is still dissatisfying in some cases. However, an improvement of quality can be observed, when oil quality is monitored carefully and with improving skills of the producer. The determining factors on rapeseed oil fuel quality are widely revealed. The whole production process, reaching from seed quality management over the pressing and purification technique to storage and distribution need to be optimized for high quality rapeseed oil fuel, according to pre-standard DIN V 51605. Therefore a proper quality management has to be worked out and introduced in practice, to raise the

producers' awareness and to provide the knowledge and tools to ensure a constant and high rapeseed oil fuel quality.

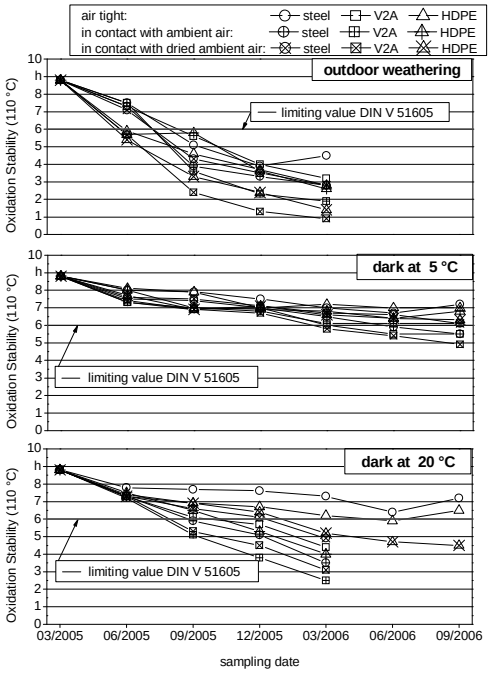

Figure 4: Development of the oxidation stability of rapeseed oil fuel samples, stored under different conditions

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