PURIFICATION OF COLD PRESSED RAPESEED OIL TO USE AS A FUEL FOR ADAPTED DIESEL ENGINES

E. Remmele[1], B. Widmann[2]

[1]Bayerische Landesanstalt für Landtechnik (Bavarian Research Center of Agricultural Engineering)
Vöttinger Straße 36 • D-85354 Freising • Germany
Phone: ++49/8161/71-4200 • Fax: ++49/8161/71-4048 • Email: remmele@tec.agrar.tu-muenchen.de

[2]Technologie und Förderzentrum im Kompetenzzentrum für Nachwachsende Rohstoffe
Schulgasse 18 • D-94315 Straubing • Germany
Phone: ++49/9421/300-112 • Fax: ++49/9421/300-112 • Email: bernhard.widmann@tfz.bayern.de

ABSTRACT: Rapeseed oil can be used as a renewable fuel for adapted diesel engines. In the “Quality Standard for Rapeseed Oil as a Fuel (RK-Qualitätsstandard) 05/2000” a contamination (DIN EN 12662) lower than 25 mg/kg is demanded. Rapeseed oil fuel is not only processed as refined oil but also as cold pressed oil in small scale oil mills. An effective clarifying of these cold pressed rapeseed oil depends on several factors. Therefore, the contamination in rapeseed oil fuels from small scale oil mills often does not meet the requirements. The influence of different rapeseeds and various parameters of the oil processing on the contamination and the particle size distribution of muddy-oil samples was investigated. Afterwards two methods of purification “continuous sedimentation” and “filtration with a chamber filter press” were checked for their suitability. Finally different safety filters (candle-filter, bag-filter, depth-filter, sheet-filter) were tested for separation efficiency. All muddy-oil and blank-oil samples were analyzed for contamination (DIN EN 12662) and particle size distribution (laser diffraction Fraunhofer method).
Keywords: biofuels standardization, cold pressed vegetable oils, rapeseed oil

1 BACKGROUND AND PROBLEM

Oil processing in decentral small scale oil mills has become an important source of income for farmers in Germany in the last years. Up to now about 180 small scale oil mills are operating in Germany. The production of rapeseed oil as a fuel for adapted diesel engines and press cake as a valuable protein feed contribute to protect energy resources. In contrast to the industrial central oil mills, where the oil milling encloses the processes warm pressing, extraction and refining, the process in small scale oil mills is confined to cold pressing and purification [7]. Purification is defined as the separation of solid particles (mainly particles of seed peel and seed pulp) from the oil (solid/liquid-separation). The processes of purification are subdivided in sedimentation and filtration [3]. Because of the fact that purification is at the end of the oil production in decentral plants, the oil quality is strongly influenced by the purification process [1, 3]. The application of a safety filter at the end of the purification process is very important. Safety filters hold back remaining particles in the oil and help to recognize problems during the purification process by a disproportionate rise of the pressure difference at the filter unit.

However, the content of solid particles (contamination) is an important criteria, when rapeseed oil is used as a fuel in adapted diesel engines. Analyses of rapeseed oil fuels showed, that in practice there are problems to meet the quality requirements for contamination (maximum 25 mg/kg) of the “Quality Standard for Rapeseed Oil as a Fuel (05/2000)” [4, 6].

2 PURPOSE

The purpose of the research project “Purification of cold pressed rapeseed oils from decentral oil milling plants” [5] (financial support: Bavarian State Ministry of Agriculture and Forestry) was, to investigate two different processes of purification and the suitability of various safety filters. First, the effect of different rapeseeds as well as various oil milling process parameters on the contamination and particle size distribution in the muddy-oil (unpurified oil) should be determined. Then the efficiency of two purification processes “continuous sedimentation” and “filtration with a chamber filter press” should be examined. Finally, different safety filters should be tested for their suitability in decentral oil processing.

3 APPROACH

First of all more than 20 different varieties and qualities of rapeseed were processed with a “Komet” oil press (IBG Monforts Oekotec) with the same settings of the oil press. To check the effect of oil pressing, process parameters were varied, like e.g. rotation speed of the worm, stuffing of the worm and wear of the press components. The produced muddy-oil samples were analysed for contamination and particle size distribution.

In a second step the two different methods of purification were tested: The new developed type of a “continuous sedimentation system” for vegetable oil purification is shown in Figure 1.

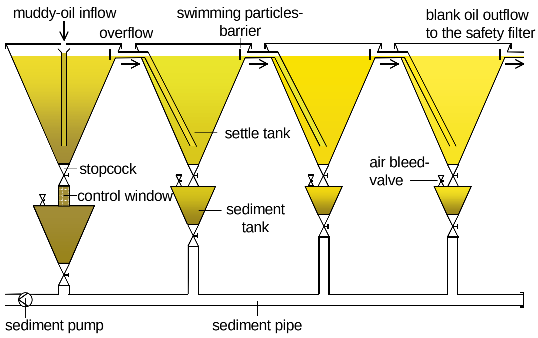

Figure 1: Continuous sedimentation system [5]

The effect of solid/liquid-separation was determined by taking oil samples at the overflow after each settle tank. The grade of contamination and the mass flow of the muddy-oil was varied.

The "filtration with a chamber filter press" was investigated by using different filter media and filter aids. The two straining clothes were made of polyamide and polypropylene. The filtration tests run without and with addition of filter aid (cellulose or wood fiber). The filtration process was monitored by measuring the mass of muddy-oil, mass of blank-oil and liquid pressure at the filter. All muddy-oil and blank-oil (purified oil) samples were analysed for contamination and particle size distribution. For the filtration tests additionally the oil content of the filter cake was analysed.

Bag-filters, candle-filters, a depth-filter and sheet-filters were proved for their suitability as safety filters. Figure 2 shows a scheme of the assembly of the components for testing safety filters.

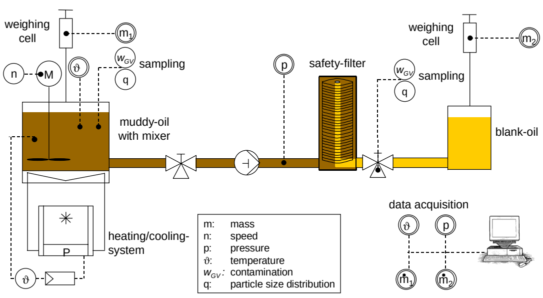

Figure 2: Scheme of the assembly of the components for testing safety filters

Both tested bag-filters were made of polyester felt. The first one had a porosity of 1 µm, the second one was a three-layer filter with a porosity of 5 µm / 3 µm / 1 µm, according to the information of the manufacturer. Two filter-candles, made of bleached cotton fibers and melted polypropylene, were tested. Both had a porosity of 1 µm. The chosen depth-filter is usually used for the processing of used engine-oils. The filter cartridge is made of pressed cellulose with a porosity of 1 µm. The used filter-sheets are manufactured cardboards with the main component cellulose and were available in different porosities. For the testing of the safety-filters, the muddy-oil and blank-oil samples were analysed with regard to contamination and particle size distribution. In addition the parameters of the filtration process were monitored.

The contamination was analysed using the method DIN EN 12662 as a triple analysis. The particle size distribution was determined with the testing instrument "Helos" (Sympatec) by laser diffraction (Fraunhofer method) [2]. The particle size distribution was calculated as a mean value of five one minute measurements. In the following, the particle size distribution is given as the x_{10}-, x_{50}- and x_{90}-value. The x_{90}-value for example describes that particle size in µm of a particle size distribution, of which 90 % are smaller than the mentioned particle size.

The temperature and therefore also the viscosity of the rapeseed oil was held as constant as possible at 30 °C. For each single test, about 200 l rapeseed oil was filtered. The sampling of the blank-oil took place either in the main or in the partial stream. The muddy-oil samples were representatively over the whole muddy-oil tank.

4 RESULTS

The contamination and the particle size distribution in the muddy-oil immediate after the oil pressing vary in a wide range. The contamination reaches values from 7000 to 40000 mg/kg, with an average of about 25000 mg/kg. This result relates only to the investigated oil press "Komet". The wear of the press components and the settings during the oil milling process have more influence on the contamination and the particle size distribution than the properties of the rapeseed.

Both, the continuous sedimentation as well as the filtration with a chamber filter press proved their suitability for clarifying rapeseed oil in decentral oil milling plants. However the contamination in the oil after the sedimentation process is much higher than after filtration with a chamber filter press. In dependence on the particle mass, the particle size distribution and the mass stream of the muddy-oil, with the tested sedimentation system a remaining contamination in the oil of about 150 – 350 mg/kg after the fourth settling tank was analysed. With a chamber filter press it is possible to reduce the contamination to about 50 mg/kg.

The tested bag-filters showed problems, whereas the depth- and the sheet-filters fulfilled the demands for safety filters. An example of the efficiency of the bag-filter (1 µm polyester felt) is shown in Figure 3.

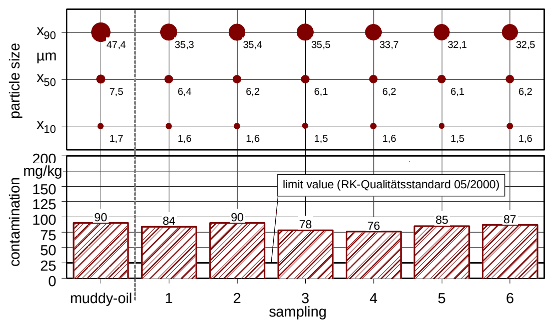

Figure 3: Contamination and particle sizes of rapeseed oil, filtered with a bag-filter

The contamination in the unpurified oil of 90 mg/kg was almost not reduced after filtration. The limit value for contamination according to the Quality Standard for Rapeseed Oil as a Fuel was not met.

A candle-filter made of cotton fibers is proved to be a good safety-filter. Figure 4 shows exemplary the course of filtration of rapeseed oil with this candle-filter. Both, the change of mass of contaminated oil and filtered oil and the change of the liquid pressure at the filter is described. The time and the duration of sampling is marked.

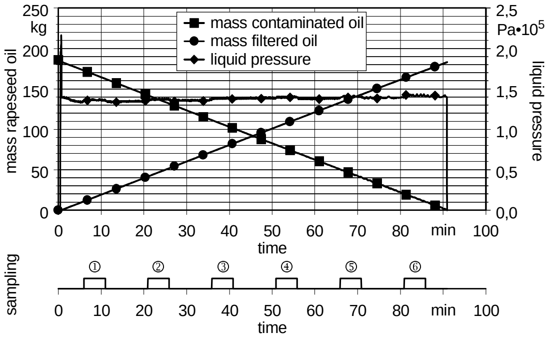

Figure 4: Course of filtration of rapeseed oil with a cotton candle filter

The mass stream of the filtered oil is in average 2,0 kg/minute. The difference pressure at the filter is rising slightly during the filtration process with an average of about 140 kPa. The efficiency of the filtration process is shown in Figure 5.

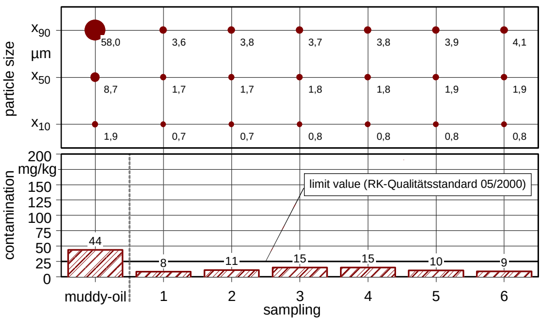

Figure 5: Contamination and particle sizes of rapeseed oil, filtered with a cotton candle-filter

The contamination in the muddy-oil was 44 mg/kg and could be reduced to an average of 11 mg/kg by filtration with the candle-filter. Thus, the limit value for contamination according to the “Quality Standard for Rapeseed Oil as a Fuel” is met. The share of larger particles in the oil decreases by filtration. In the muddy oil 90 % of particles were smaller than 58 µm. After filtration for example in sample 1, 90 % of all particles were smaller than 3,6 µm, 50 % smaller than 1,7 µm and 10 % were smaller than 0,7 µm. The particle size distributions in the blank-oil samples during the whole filtration process were constant. The deviation is within the measurement mistake of the method.

5 CONCLUSIONS

Because of the wide range, in which the contamination and the particle size distribution of unpurified rapeseed oil could vary, the purification process must be adjusted specifically to the properties of the muddy-oil.

If a sedimentation system is used for purification, the safety filter has to take up more particles than after filtration with a chamber filter press.

A candle-filter with a candle made of cotton fibers is very appropriate to be used as a safety filter.

The lifespan of a filter and therefore the costs of filtration strongly depend on the contamination and the particle size distribution in the oil.

The limit value for contamination in rapeseed oil as a fuel can be met in decentral oil milling plants, clarifying technologies are available.

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ACKNOWLEDGEMENT

The authors thank the Bavarian State Ministry of Agriculture and Forestry for the financial support in this research project and also SeitzSchenk Filtersystems GmbH, Amafilter Deutschland GmbH, Braun Filtrationstechnik and IBG Monforts Oekotec for their kindly support.