Edgar Remmele, Jochen Breun and Anja Rocktäschel, Freising, and Bernhard Widmann, Straubing

Filtration of cold-pressed rape oil from decentralised plants

In decentralised processing of oilseed the vegetable oil quality is considerably influenced by the cleaning. The largest proportion of particles in the vegetable oil is separated out through sedimentation or filtration. The additional application of so-called security filters with defined pore size at the end of the oil cleaning process is especially important. With this, the last foreign particles can be removed and processing errors in oil cleaning caused by excessive increase in pressure differences at the security filter identified. Here, the filtration of cold-pressed rape oil by chamber filter press and suitability of different security filters is investigated.

Oilseed processing in decentralised plants, at least in the countryside, has increased in importance in recent years. Meantime there are around 180 decentralised oil mills working in the federal republic. The possibility of producing rape oil as fuel for converted diesel engines and rapeseed cake as protein feed can play a worthwhile contribution to resource saving and increasing added value of agricultural production, compared with large central oil mills where the winning of the oil, simply put, is through the system steps warm pressing, solvent extraction and refining. In decentralised plants the oilseed is cold-pressed with subsequent cleaning which features separation of solid contaminating particles (mainly seed parts) from the oil (solid/liquid separation). Cleaning systems can be based on sedimentation or filtration. Because the cleaning is at the end of the process in the decentralised oil producing systems and refining is not applied, the cleaning of the vegetable oil has a decisive influence on the quality [2, 3]. Analyses of rape oil fuel show that trying to remain within the fixed thresholds of contamination of maximum 25 mg/kg in the „Quality standard of rape oil as fuel 05/2000“ 3] often causes problems [6].

Targets

In the Landtechnischer Verein in Bayern e. V., research project „Cleaning of cold-pressed vegetable oil from decentral plants“, cleaning of cold-pressed rape oil by filtration with chamber filter press and the assessing of suitable security filters was investigated.

Material and method

First, the influence of the rapeseed and the oil production process on the amount of particles (total contamination) and on the distribution of particle sizes within the rape oil was determined as starting parameter for the oil cleaning procedure. The investigation of the influence factors during filtration of rape oil with a chamber filter press followed taking account of the initial factors of total contamination and particle size distribution in unfiltered oil and through variation of the factors of influence filter material (filter cloths of polyamide and polypropylene material) and filtering aids (without and with addition of cellulose fibre and wood fibre materials). As target factor the total contamination and particle size distribution in

Dipl-Ing. agr. Edgar Remmele is a member of the scientific staff, Jochen Breun and Anja Rocktäschel are technicians at the Bavarian Agricultural Engineering Institute, Vöttinger Straße 36, 85356 Freising; e-mail: *remmele@tec.agrar.tu-muenchen.de*
Dr. Bernhard Widmann is specialist department manager in the Technology and Support Centre within the Competence Centre for Regenerative Raw Materials, Schulgasse 18, 94315 Straubing; e-mail: *bernhard.widmann@tfz.bayern.de*
The authors thank the BayStELF for financing the investigations and the firms Seitz-Schenk Filtersystems GmbH, Amafilter Deutschland GmbH and Braun Filtrationstechnik for lending filter equipment and their good cooperation.

Keywords
Vegetable oil, quality, filtration, particle

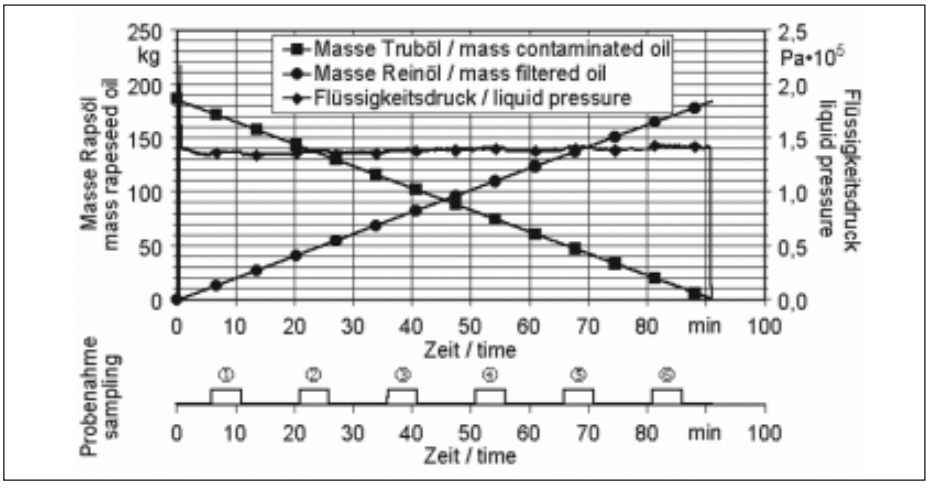

Fig. 1: Alteration of mass and liquid pressure as well as sampling during the filtration of rape oil with a cotton-candle filter

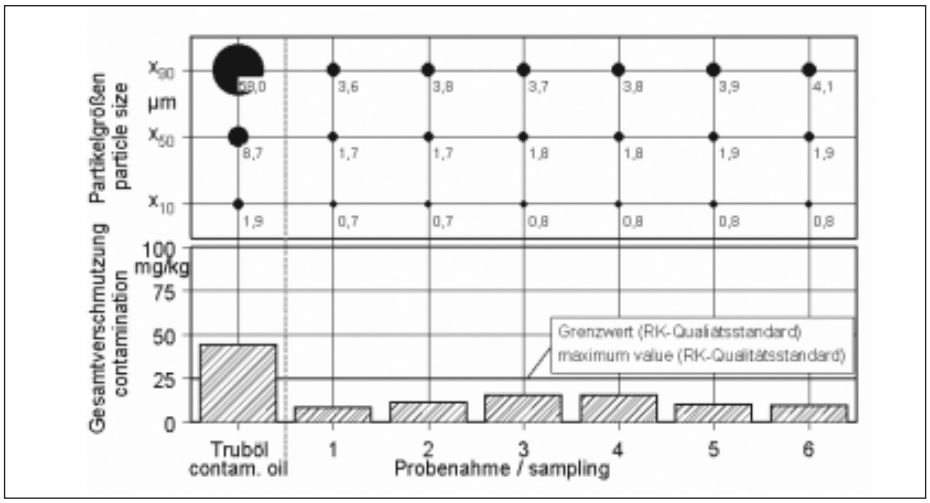

Fig. 2: Particle size and contamination in non-cleaned rape oil and that put through a cotton-candle filter.

cleaned oil, as well as oil content in filter cake, was analysed. The alterations in weights of the non-cleaned and the cleaned oil, and the liquid pressure in filters were documented.

Pouch filter, candle filter, deep filter and layered deep filter were tested for their suitability as security filter. Used as filter pouch was a polyester felt with a fineness of 1 µm and a three-layer filter pouch of polyester felt with the fineness degrees 5 µm/3 µm/ 1 µm were investigated. Tested as filter candle was a candle of wrapped bleached cotton and a candle of melted-blown polypropylene, in each case with a filter fineness of 1 µm. The deep filter was one used in lubricant production with a filter cartridge of pressed cellulose with a given filter fineness of < 1 µm. The applied filter layers are of a prefabricated special cardboard made of different materials with cellulose as main component available in a variety of filter finenesses. In the testing of the security filter, on the other hand, the total contamination and the particle size distribution are analysed in non-cleaned and cleaned oil and the process data documented.

The analytic of the total contamination was through triple determination according to DIN EN 12662 [1]. Particle size distribution was determined with a Sympatec Helos measuring instrument via laser refraction spectroscopy [4]. The results were determined from five one-minute individual measurements.

The temperature and thus viscosity of the rape oil was held as constant as possible at 30 °C for all trials. In each investigation around 200 l of rape oil was filtered. The pure oil sampling during the filtration process took place as main or part flow. The sample in the unclean rape oil was taken as an all layer sample from the holding container.

Trial results using the cotton-candle filter as security filter are presented below.

Candle filter as security filter

The candle filter, fitted with a filter candle of rolled bleached cotton proved itself in the trials as satisfactory security filter in the cleaning of rape oil.

Figure 1 shows the change in mass between non-cleaned and cleaned rape oil as well as the liquid pressure progression during filtration of a 186 kg charge of rape oil. The sampling time in the pure oil and the length of the respective sampling period during the filtration procedure are noted. Average mass flow of the pure oil was 2.0 kg/min. The difference pressure at the filter rose only minimally during the filtration procedure and averaged around 1.4 bar. The efficiency of the cotton candle filter filtration can be assessed from *figure 2*. Presented are total contamination and particle size distribution in non-cleaned (cloudy) oil and cleaned oil at the different sampling times. The cloudy oil was rape oil previously filtered with a chamber filter press. The total contamination in cloudy oil was 44 mg/kg and could through filtration be decreased to an average 11 mg/kg. The six pure oil samples investigated differed in terms of total contamination only minimally from one another. The threshold value for total contamination in rape oil fuel according to „Quality standard for rape oil as fuel 05/2000“ (RK quality standard) is met after this treatment. The proportion of larger particles in oil could be substantially reduced through the filtration. Shown here are x_{10}, x_{50} and x_{90} values. The values represent the 10, 50 and 90 percentage part (throughflow) regarding smallness of particle size (given in µm) of a total distribution. If 90% of all particles in the cloudy oil were smaller than 58 µm, there was, e.g., after the filtration with sample 1 90% of all particles already smaller than 3.6 µm, 50% smaller than 1.7 µm and 10% under 0.7 µm. The particle size distribution in pure oil remained constant through the whole filtration procedure, deviations remaining within the range of measurement errors for the method.

The working life of a filter and, with that, the cost of filtration is strongly reliant on the total contamination and particle size distribution in non-cleaned oil. The trial results, however, point to a reasonable expectation of material cost for application of a cotton-candle filter with a chamber filter press at under 0.01 per litre rape oil.

Literature

Books are marked with •

[1] Deutsches Institut für Normung e. V.: DIN EN 12662: Flüssige Mineralölerzeugnisse – Bestimmung der Verschmutzung in Mitteldestillaten. Beuth Verlag GmbH, Berlin, 1998

[2] • *Kaltschmitt, M. und H. Hartmann* (Hrsg.): Energie aus Biomasse – Grundlagen, Techniken und Verfahren. Springer Verlag, Berlin, 2001

[3] • -: Dezentrale Ölsaatenverarbeitung. KTBL–Arbeitspapier 267. Landwirtschaftsverlag GmbH, Münster-Hiltrup, 1999

[4] *Remmele, E., K. Wanninger, B.A. Widmann und H. Schön*: Qualitätssicherung von Pflanzenölkraftstoffen. Analytik zur Bestimmung der Partikelgrößenverteilung in Pflanzenölen. Landtechnik 52 (1997), H. 1, S. 34-35

[5] *Remmele, E. und B. Widmann*: Pflanzenölreinigung in dezentralen Anlagen. Landtechnik 52 (1997), H. 4, S. 194-195

[6] • *Remmele, E. et al.*: Begleitforschung zur Standardisierung von Rapsöl als Kraftstoff für pflanzenöltaugliche Dieselmotoren in Fahrzeugen und BHKW. „Gelbes Heft“ Nr. 69, Eigenverlag Bayerisches Staatsministerium für Ernährung, Landwirtschaft und Forsten, München, 2000

[7] • *Remmele, E und B. Widmann*: Reinigung kaltgepresster Pflanzenöle aus dezentralen Anlagen. Eigenverlag Landtechnischer Verein in Bayern e. V., Freising (2002, in Vorbereitung)