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Decentralized Oil Seed Processing

Procedures and Quality Aspects in Producing Rape Seed Oil Fuel

With rising energy costs, enhanced by general political conditions, agricultural enterprises are becoming increasingly interested in producing rape seed oil motor fuel in decentralized plants to attain self-sufficiency. The following paper gives an overview on procedures and the quality aspects of decentralized oil seed processing. The report is based on investigations in existing facilities and on results from experiments conducted there.

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Since interest in closed-cycle production and in value-added chains for supplying own fuels and livestock feed is rising, oil seed processing in decentralized oil mills has considerably increased in recent years. The number of decentralized oil mills is up from 79 in the year 1999 to the current number of about 300 [1, 2].

Different product qualities arise from different ways of processing oilseeds in decentralized oil mills. This can cause problems in the technical process of oil pressing and purification and in the later use of the oil as fuel. The production of rape-seed oil fuel for use in modified engines is the major goal of the process. About two thirds of the final product gained after pressing is rape-seed oilseed cake. This by-product can be used as livestock feed.

When using rape-seed oil in modified engines it is very necessary to comply with the quality guidelines of the preliminary standard DIN 51605 "Fuels for vegetable oil compatible combustion engines - Fuel from rape-seed oil - Requirements and test methods" [3]. Of special importance in the oil quality are the standards for the general contamination, the phosphorus content, the sum of calcium and magnesium content, the acid value and the oxidation stability. These criteria result from factors such as seed quality, seed treatment during and after harvest and processing, and from the storage of the final products.

Definition

Decentralized oil mills receive the raw material in the form of winter rape-seed from nearby regions. Also the products of the mills are prevalently sold in this region. The processing of the seeds is based on a mechanical pressing without thermal and mechanical seed conditioning, industrial hexane extraction (solvent extraction), or further refining of the oil. The capacity of decentralized oil mills is about 0.5 to 25 t seed per day and an annual processing quantity of about 125 to 9 000 t seeds.

Seed quality and seed treatment before pressing

For the production of rape-seed oil fuel the seeds must be mature, have no sprouting and a minimum content of broken seeds or dockage. The rape-seeds should have been stored for at least one month before pressing. Fresh seeds are more difficult to press and the resulting crude oil is hard to purify. Optimal purification and storage of the rape-seed are important conditions for the best possible processing in decentralized oil mills and for the adherence to oil quality standards. According to well known standards, a moisture content of 7 to 8 mass-percent (W.B.) is essential for maintaining the seed quality during storage and processing. If drying of the seeds is necessary after harvest it should be done without delay and should occur at temperatures below 50 °C in continuous or circuit dryers. Furthermore the dockage content should be below one mass-percent. All seed batches, which do not meet these quality standards, must be immediately cleaned and dried after harvest. Drying at too high temperature may reduce the oxidation stability of the oil and increase the content of free fatty acids, which consequently results in a high acid value of the oil. For longer storage, temperatures below 12 °C should be maintained in the storage facilities.

Oil pressing

Oil pressing in decentralized mills is a mechanical process in which screw presses are used. Different types of presses can be used such as a hole-cylinder-type oil press or a spiral-type oil press. The choice of the press type depends on the intended annual capacity, oil quality and oilseed cake quality. The residual oil content of the press cake produced in decentralized oil mills is about 10 to 20 mass-percent, with an average of 14 mass-percent; therefore, the degree of extraction lies between 70 and 85 % (with an average of 80 %). The design of the oil mills should guarantee a year round and sustainable operation of the oil press.

Table 1: Influencing factors of the characteristic values of rape seed oil fuel

Kennwerte von Rapsölkraftstoff characteristics of rape seed oil fuel	Rapssaat rape seed								Ölpressung oil pressing	Öleinigung oil purification	Öllagerung oil storage	Ölabgabe oil release
	Sorte variety	Staubanteil dust content	Bruchkorn broken seeds	Ausreife maturity	Auswuchs sprouting	Besatz dockage	Trocknung drying	Lagerung storage				
Dichte density	rapsölspezifisch – nicht beeinflussbar specific for rape seed oil – no influence											
Flammpunkt flash point	rapsölspezifisch – nicht beeinflussbar specific for rape seed oil – no influence											
Kinematische Viskosität kinematic viscosity	rapsölspezifisch – nicht beeinflussbar specific for rape seed oil – no influence											
Heizwert calorific value	rapsölspezifisch – nicht beeinflussbar specific for rape seed oil – no influence											
Zündwilligkeit ignition quality	rapsölspezifisch – nicht beeinflussbar specific for rape seed oil – no influence											
Koksrückstand carbon residue	(✓)[1]											
Jodzahl iodine value	(✓)[1]											
Schwefelgehalt sulphur content				✓			✓					
Gesamtverschmutzung contamination									✓	✓	✓	✓
Säurezahl acid value	(✓)		✓	✓	✓	✓	✓	✓			✓	
Oxidationsstabilität oxidation stability	(✓)[1]		✓	✓	✓	✓	✓	✓			✓	
Phosphorgehalt phosphorus content			✓	✓					✓			
Calciumgehalt calcium content			✓	✓					✓			
Magnesiumgehalt magnesium content			✓	✓					✓			
Aschegehalt ash content		✓	✓	✓					✓			
Wassergehalt moisture content							✓				✓	✓

[1] HighOleic-rape variety in comparison with common 00-rape seed varieties

The pressing technique affects the phosphorus, calcium and magnesium content of the oil. The amount of these undesirable substances grows with increasing energy input and heating during pressing, seed conditioning and increasing number of press revolutions. The setting of the oil press and the way of processing determines the mass and the particle size distribution of the solids in the oil. Special parameters to be adjusted in setting and processing are the amount of seeds per batch, the number of revolutions, the pressure of the mill, the choice of press nozzles and the distance between the spirals.

Oil purification

The last step of oil extraction is the purification of the oil, which means the clearing of solids. Purification has the largest affect on the oil quality. Crude oil contains 1 to 13 mass-percent of contaminating solids after pressing. These contaminations vary with the type, wear, and flow-rate of the press as well as with the moisture content of the rapeseed. The solids in the crude oil should be removed in at least two steps of cleaning: the main purification (raw clearance) and the safety settling (end percolation).

The two possibilities to separate solids and fluids are sedimentation and percolation. Due to the long time needed for sedimentation, this process can only be used in small oil mills with a seed flow-rate of about 50 kg per hour.

The main purification of rape oil can be done with chamber filter-presses, pressure leaf filters, or pressure cartridge filters, which all require the formation of a filter cake. The oil is circulated through the cake and the filter until the thickness of the filter cake indicates that a sufficient amount of solids has been removed.

A second step of purification, which is called end or safety percolation, follows this process. Cartridge filters made of wrapped cotton are very well suited here. It is necessary to adjust the flow-rate and the pressure of the oil according to the filter-surface to avoid large pressure differences at the filter when the oil passes through. Furthermore it is recommended always to filter the oil when it is conveyed. This step does not require much additional time, and it can be considered further insurance to help minimize complaints about oil quality.

Oil storage

The goal of oil storage is to prevent oxidation, hydrolysis, polymerisation and enzymatic degradation. The oil should be stored in a dark, controlled environment at temperatures between 5 and 10 °C. Changes in temperature, which may result in condensation or the entry of water and air, should be avoided. For long term storage of rape-seed oil fuel, the use of special high-grade steel tanks is recommended. Special pumps made for viscous fluids should be chosen to convey rape-seed oil fuel.

Storage of oilseed cake

The oilseed cake leaves the screw press as pellets or disks. The internal moisture of the press cake should be allowed to decrease, and it should also be allowed to cool down while being transported to the storage room. It is necessary to dry the press cake for storage in silos. High moisture contents can cause mould and agglutination. This effect is exacerbated by a high fat content. Oilseed cake used as livestock feed can be stored for about six months if the storage facilities are dry and well aerated.

Conclusion

There is high demand for a strong quality management program for all the different oil production processes such as harvest, treatment and storage of seeds, pressing and purification procedures and storage of the oil and cake. This is needed to meet the oil quality standards of the DIN 51605 and to sell the oilseed cake as livestock feed.

The quality of the rape-seeds and the treatment of the seeds before pressing are influencing the rape-seed oil quality in decentralized oil mills for the use as fuel. The rapeseeds used for the processing in decentralized oil mills have to comply to stricter requirements as it is necessary for the industrial plants.

The discussed stricter parameters for phosphorus, calcium and magnesium in rape-seed oil fuel make additional steps in processes for the cleaning of the oil mandatory. Processing of refinery, like degumming and refining require large investments for installation and do not fit into the concept of the decentralized oil mills.

Rape-oilseed cake competes with extracted rape-seed and soybean meal. The profitability of decentralized oil mills needs the marketing of the rape-oilseed cake at a price, according to the feed value. The feed characteristics, like glucosinolate and residual oil content in the oilseed cake have to be more uniform, so that the cake can be used in a constant ratio in feed mix rations.

Literature

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