

Researches on obtaining vegetable oils as a source of alternative energy

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Abstract. Biodiesel type fuel is widely used on a large scale in most of the European Union. Carbon dioxide is eliminated by combusting biodiesel, but not toxic emissions. Due to the more drastic European ecological demands to reduce the quantity of toxic emissions from automobiles, there is an increased interest to use biodiesel, because it is a bio-degradable and non-polluting fuel. Even by mixing diesel fuel with biodiesel in a percentage of 20%, the emission of toxic gases will be greatly reduced. Vegetable oils used as biofuels are obtained from oleaginous plant crops, without any prejudice to food security. The use of biodiesel can also bring benefits by prolonging the lifetime of diesel engines, ensuring a better lubrication. The paper presents a series of researches on obtaining vegetable oils from various oleaginous seeds (rapeseed, camelina, hemp) using a special installation for producing oils through cold pressing.

1 Introduction

According to European standards, Romania, together with all European countries, must take measures to replace fossil fuels used in transport with biofuels, which would represent 20% by 2020. EU Directive 2003/30 / EC provides the promotion of the use of biofuels and other renewable fuels, particularly in the transport sector, as part of EU policy to reduce energy import dependency and reduce greenhouse gas emissions [1].

Given that fuel consumption in transport is steadily increasing, generating significant amounts of greenhouse gas emissions, widespread use of biofuels is an important solution. However, it faces several obstacles: in Europe, their cost remains much higher than that of fossil fuels, and their impact on the environment remains limited as they are currently used in limited quantities. In addition, producing enough quantities to meet the consumption targets imposed in Europe is a real challenge. Research efforts should therefore be made to use a considerable amount of vegetal fuels [2].

Seed processing has seen significant progress in recent years in terms of endowment with high performance machinery, equipment and plant. This has been virtually dictated by qualitative development through continuous improvement of process technologies.

The knowledge of the physical characteristics of vegetable oils in general and rapeseed and camelina oils in particular is useful to specialists and workers in the field for the

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evaluation of the technological and functional parameters of the machinery that ensures their obtaining and for the establishment of technological parameters of the process of purification [3-6].

The possibility of using them in blending without the need for a dedicated distribution network is an important advantage over other alternative fuels, such as liquefied petroleum gas (LPG) or natural gas for vehicles (NGV), obtained through a distribution network specific and adaptation of vehicles.

Vegetable oils and fats are found in nature in plant tissue, being concentrated in seeds, pulp, or fruit kernels, tubers, or germs. For our country, the main raw material for obtaining vegetable oils is represented by oleaginous plants (sunflower, rapeseed, camelina).

Attempts to use vegetable oils as fuels are older than internal combustion engines. "Biodiesel" can cut CO₂ emissions by 70% compared to petroleum-based fuel, thus reducing greenhouse gases, which contribute to a great extent to global warming [11-14].

Biofuels compatible with Diesel engines are obtained from vegetable oils, especially rapeseed oil, sunflower, soybean, hemp, camelina etc. Flax or castor oil can also be used, but costs are higher.

The paper addresses the importance, the production and use of vegetable oils as biofuels. Romania has a sufficient land fund to cultivate farmland with oilseeds specific for the production of biofuels, especially rapeseed, hemp and newer cameline (for biokerosene).

1.1 Material and method

In the process of obtaining vegetable oils, oilseeds are subjected to technological treatments that provide them with the optimal quality to obtain oil with maximum yields and minimum expenses.

Vegetable oils can be obtained by cold or hot pressing the oilseeds and extracting the liquid component from them. The seed pressing process is carried out in 2 phases: in the first stage, the seeds are dried and crushed, and in the second phase the seeds are pressed cold or passed through a heating phase and then pressed.

The technological scheme for obtaining vegetable oil is shown in Figure 1.

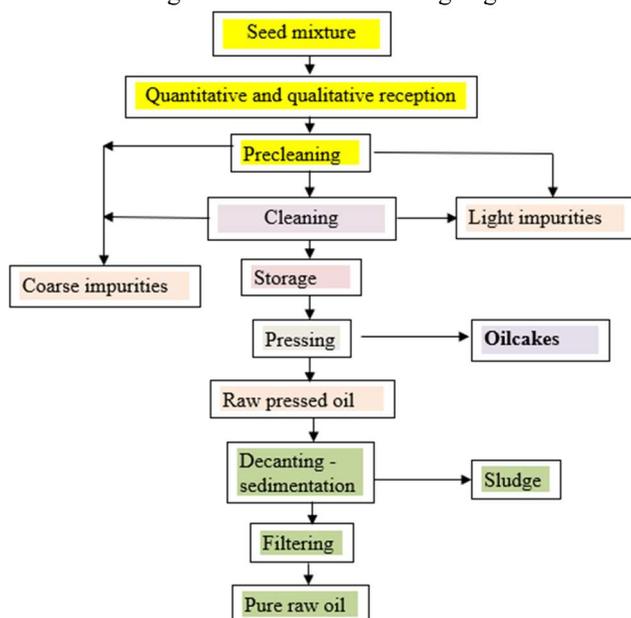


Fig. 1. Technological diagram for obtaining the oil [8]

Separation of oil from seed of oleaginous plants takes place under the influence of external forces, resulting in raw press and broken oil (cakes, pellets) [15-17].

Increasing the pressure on the grinding should be gradual because otherwise the fine particles of milling stop the capillaries and block the oil drain. Pressing can be considered as capillary filtration, a phenomenon that is expressed using the relation:

$$V = \frac{\pi P d \tau}{128 \eta l} [m^3] \quad (1)$$

where: V - volume of separated oil, [m³];
 P - applied pressure [daN/cm²];
 l - the length of the capillaries [m];
 τ - duration of pressure application [s];
 d - the distance between the oil outlet plates [m];
 η - yield [%].

The oil separation process is positively influenced by increasing the P , d , and τ values and decreasing η and l .

The calculation of the power required to drive the auger is done with the relation:

$$P = \frac{M_t \cdot n}{95.500} \quad (2)$$

where: M_t - is the twisting moment applied to the spindle shaft [daNm];
 n - is the revolution speed [rot/min];
 P - is power required to drive [kW].

The moment of twisting is evaluated considering that the resultant F of the pressure forces exerted by the oleaginous material on the spirals of the auger is actuated on the spindle, which is calculated with the relation:

$$F = \frac{\pi}{4} (D^2 - d^2) P \quad (3)$$

where: P - is the extraction pressure that takes values in the range 25-28 MPa or 40-200 MPa, depending on the press type - with one or two sections;
 D - is the external diameter of the spool of the auger in the pressing zone;
 d - is the inside diameter of the pressing area.

The force F is normal to the angle of the auger. β_m .

The force required to push the material along the spindle of the auger is marked with H . As the material is moved by the force H , its pressing occurs, developing the axial resultant pressure forces so that in the case of lack of friction.

$$H = H_0 = F \tan \alpha_m \quad (4)$$

The time to perform the pressing process according to the constructive and functional characteristics of the press is between 40 and 200 seconds. The pressing process is influenced by the rotation frequency of the auger, the physico-chemical properties of the seed from which the oil is extracted and the way the product is exhausted (cakes or pellets) [9, 10].

For cold pressing, the rotation of the auger is between 8 and 36 revolutions per minute.

Taking into account the above mentioned, technological fluxes were designed for 12 lines of oil extraction from seed oil plants consisting of 1, 2 or 3 presses whose pressing capacity is 130-150 kg / h of pressed seeds, depending on the species.

These can be successfully used in a small or medium-sized farm. Depending on where you want the installation to be installed, it can be used in horizontal or vertical flow. A vertical flow installation is more expensive to buy, but exploitation is cheaper with the advantage of gravity.

Starting from the operation diagram with 3 horizontal presses in the technological flow, a seed processing plant with a capacity of 450 kg seed / h consisting of 3 (three) modules (Figure 2) was used:



Fig. 2. Installation for extracting the oil



Fig. 3. Seed preparation module



Fig. 4. Oil extraction module



Fig. 5. Oil purification module

2 Results

The results obtained after pressing the camelina seeds are presented in table 1. The values shown in the table represent the average from three tests.

Table 1. Results for the extraction of oil from camelina seeds.

No.	Parameter	MU	Press I*	Press II*	Press III*	Total
			Average	Average	Average	
1	Sample weight	kg	5	5	5	15
2	Processing time	s	135.67	136.33	134	136.33
3	Productivity	kg/h	132.68	132.04	134.32	133.05
4	Oil quantity	kg	1.71	1.71	1.70	1.706
5	Extraction degree	%	34.13	34.13	34.07	34.11
6	Current intensity	A	13.17	13.17	13.13	13.16
7	Current tension	V	380	380	380	380
8	Cos φ	-	0.78	0.78	0.78	0.78
9	Power	kW	6.76	6.76	6.75	6.76
10	Specific energy consumption	kWh/t	51.07	51.19	59.25	50.80

The products obtained after processing Camelina seeds are shown in Fig. 6 (main product) and 7 (by-product).



Fig. 6 Decanted camelina oil



Fig. 7. Camelina pellets

The unfiltered and unheated oil obtained through the process was subjected to a test for determining the dynamic viscosity. The results are presented in table 2. The same test was conducted for the heated oil, the results being shown in figure 8.

Table 2. Dynamic viscosity of the unfiltered and unheated oil

No.	Viscosity η [mPa.s]	Temperature t [°C]
1.	40.9	32.5
2.	48.2	28.3
3.	50.3	27.3
4.	53.0	26.0
5.	54.7	25.2
6.	56.2	24.6
7.	57.9	23.9
8.	59.4	23.2

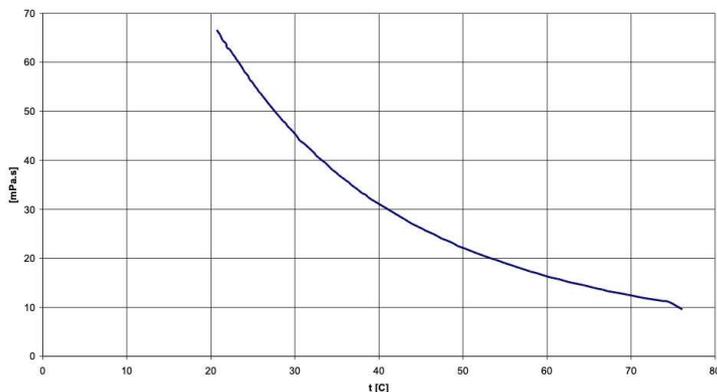


Fig. 8. Dynamic viscosity variation with the temperature for the heated oil

The dynamic viscosity has a tendency to decrease when the temperature is higher, both for the unheated and the heated unfiltered oil obtained.

Another important parameter verified for the unfiltered oil was density (fig. 9).

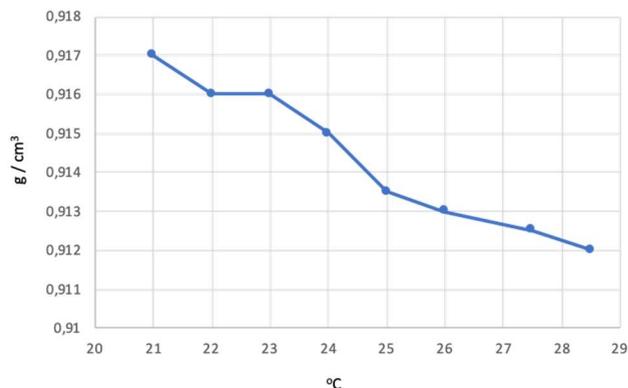


Fig. 9. Density variation with the temperature for the unfiltered and unheated oil

Density also had the tendency to slowly decrease (from 0.917 to 911 g / cm³) when the temperature increased from 21 to 28.5°C.

3 Conclusions

The production and use of biodiesel from vegetable oils is done within a complex system, integrated with strong interconnections between all levels of the system.

Within this system, besides the main levels, the secondary ones, as well as the use of the by-products (pellets, cakes), which also have a significant share in establishing the economic efficiency, stand out. It is also noted that oleaginous plants are also melliferous plants.

The quantity of oil obtained depends largely on the nature and quality of the pressed oleaginous material. The dynamic viscosity and the density of the oils obtained decreased when increasing the temperature, a fact that translates in a need to keep a low temperature during the process.

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