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RESOURCES USED FOR BIODIESEL PRODUCTION

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ABSTRACT

According to available statistics more than 80 million cars are produced in the world every year. Significant motorization of world population leads not only to more dense highway and road infrastructure but also to increased amount of greenhouse gases emissions. Using of fuels from renewable sources appears to be suitable solution focused on reduction of emissions from traffic. The aim of this contribution is to describe sources used for biodiesel production.

KEY WORDS:

biodiesel, transesterification, catalyst, vegetable oil, animal fats

INTRODUCTION

Biodiesel can be considered as renewable, biodegradable and non-toxic fuel [1]. It is used as an alternative fuel in diesel engines. Biodiesel is made of monoalkyl ester of fatty acids with long chain. It is produced by transesterification of vegetable oils or animal fats which contain different proportions of saturated and unsaturated fatty acids. Transesterification is a chemical process in which alcohol, most often methanol (sometimes ethanol) is mixed with oil in the presence of a catalyst [2].

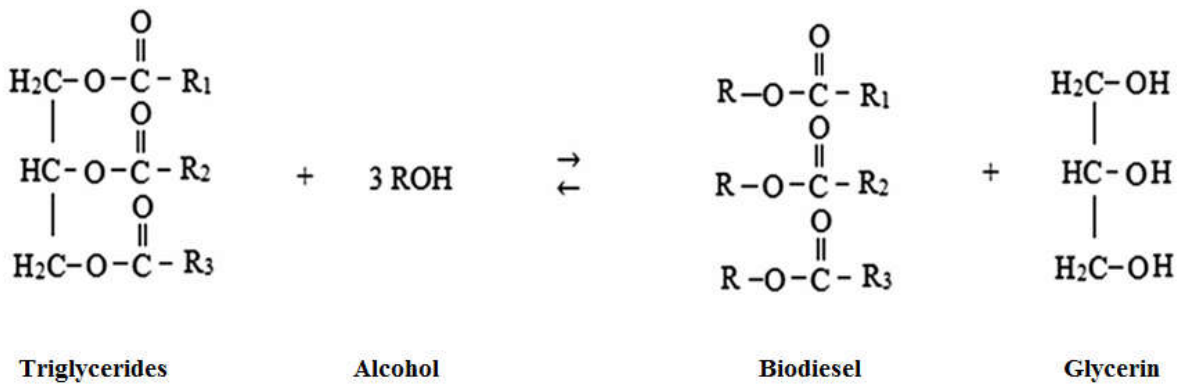

Fig. 1 Transesterification reaction of triglycerides [3]

Primary source for biodiesel production is vegetable oil obtained from different types of crops. Routinely tested vegetable oils used for biodiesel production are: soybean oil, rapeseed oil, sunflower oil, jatropha oil, karanja oil, palm oil, linseed oil, cottonseed oil, sesame oil, peanut oil, olive oil, mustard oil, corn oil, katrina oil, hazelnut oil, safflower oil, coconut oil, rice oil and rubber seed oil. Composition of biodiesel varies by materials used for its production. Table 1 shows overview of vegetable oils used for biodiesel production sorted by countries [2].

Table 1 Vegetable oil source for biodiesel production in different countries [2]

Country	Vegetable oil
India	Jatropha curcas
European countries	Rapeseed and Sunflower
United states of America	Soybean
Japan	Waste vegetable
Spain	Linseed and olive
Brazil	Soybean
Malaysia	Palm
Indonesia	Palm
Thailand	Palm
Philippines	Coconut
Australia	Rapeseed

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Primary sources used for biodiesel production can be divided into three groups: edible oils, inedible oils and other sources. Cottonseed oil, coconut oil, sunflower oil, soybean oil, castor oil, mustard oil, groundnut oil, palm oil and rapeseed oil can be included into edible oils group. Group of inedible oils consits of jatropha oil, karanja oil, eucalyptus oil, linseed oil and rubber seed oil. Last group consists of other sources such as microalgae, spirulina platentis, waste cooking oil, animal fats, beef tallow, poultry fat, fish oil, chicken fat or chlorella [4].

Edible oils

Eucalyptus oil

Other resources

Fig. 2 Primary resources for biodiesel production [5, 6, 7]

At present, oil seeds can be processed by two fundamental ways. The first way is to press seeds by pre-press / full-press system and the second way is to press seeds by system press / extraction by organic solvent. System pre-press / full-press consists from cleaning of seeds, shelling of seeds, conditioning of seeds, crushing of seeds, pressing, cleaning of oil by filtering or centrifugal separation and modification of moldings. Pressing of seeds is carried out in a screw press and after the process of pressing there is 6-12 % of oil in moldings which represents the level of yield about 80 %. During the process of press / extraction there is 12-25 % of oil in the moldings after pressing and consequently, the process of extraction of oil from moldings by hexane begins. Extraction by hexane is not applied in case where the amount of oil in moldings is 6-12 %. The mixture of hexane and oil (miscella) is then processed by distillation because of regeneration of hexane from vegetable oil. Solvent is separated to hexane and water and hexane then goes right back into process of extraction. Hexane, which is present in moldings is distilled with vapour so microorganisms in moldings are eliminated. Mixture of vapour hexane and water is used for regeneration of solvent as a power source during the process of distillation of miscella. Pressed residues of seeds (contain 1-2 % of oil, 98 % yield of oil) are then dried and cooled by air and finally, they are stored in silos. Obtained oil is filtered and crude oil is created. Crude oil has to be modified – removing impurities, minerals, seeds, cellulose tissues, proteins, carbohydrates and water which can cause coagulation of primary soluble elements in oil [8]. Presence of a catalyst in transesterification reaction is necessary to increase the speed of the reaction. As a catalyst, acid, alkali or enzyme can be used. Except catalyst, also molar ratio of alcohol and oil, purity of reaction elements (mostly amount of water) and amount of free fatty acids have an influence on speed of transesterification reaction. Alkali catalysed transesterification reach higher rate than reaction catalysed by acid which is the reason for using of alkali catalyst. Even though the fact that chemical transesterification by alkali catalyst reach high level of triglycerides in short reaction time, reaction has a lot of disadvantages too: high energy requirements, complicated separation of glycerol and excess of alcohol [9].

Methanol is most often used type of alcohol during biodiesel production by transesterification reaction. Amount of water in alcohol have essential influence on biodiesel production. Presence of water in process of transesterification cause hydrolysis of triglycerides to free fatty acids which leads to production of soap and poor occupancy of biodiesel. Alcohols with short chain are hygroscopic and they can easily absorb the water from the atmosphere. On the other hand, alcohols with long chain are generally sensitive on purity of water. Molar ratio of alcohol to oil is considered as one of the most important factors with influence on efficiency of biodiesel. By increasing of alcohol – oil ratio (pure vegetable oil), the yield of biodiesel and pure biodiesel is increasing too [10].

The process of transesterification consists of three consecutive reversible reactions. In this process, triglycerides are converted into diglycerides, monoglycerides and finally, glycerol. Overall reaction is characterized by three verification phases: transport of mass, kinetic verification and equilibrium verification. The slowest is the phase of mass transporting because of poor miscibility of oil and methanol. These two liquids are immiscible and their reaction occurs on the interface of their phases (the greater the interphase surface, the higher speed of reaction can be reached). The most commonly used molar ratio of alcohol / oil is stated as 6:1 [11].

Byproduct of biodiesel is crude glycerine which is separated from biodiesel after the process of esterification. Composition of glycerine phase is not constant and varies on input materials used and conditions of transesterification. Crude glycerine

contains about 55-60 % of glycerine, 14-16 % of alkalies mainly in the form of alkali soaps and hydroxides, 18-20 % of methyl ester, 10-12 % of methanol and 2-3 % of water and other compounds. Glycerol can be consequently modified and used. To modify and purify the glycerol, several processes can be used. Process of purification commonly begins by mineral acids neutralization (phosphoric acid, hydrochloric acid) in which higher fatty acids are separated. Consequently, water and methanol are removed and crude glycerine with amount of 80-88 % of glycerine is generated. By more sophisticated processes, crude glycerine can be distilled and purified to purity of 99 % which is enough to be used in pharmaceutical and cosmetic industry. At present, research is focused on searching new alternatives of using of crude glycerol. Several options such as combustion, composting, producing of feed for animals, thermo-chemical transformation and biological conversion are under research. Glycerol can be used as a biogas because of its high energy content and high content of organic compounds. Besides production of biogas, production of glycerol includes some advantages, such as low nutrients requirements, energy saving, easy to operate process, small production of sludge and good stabilization of waste. Crude glycerol can also be used as an individual substrate or co-substrate during processing of different types of wastes, sludges and energy crops [12].

CONCLUSION

Biodiesel can be considered as an important alternative fuel from the perspective of lowering the emissions in the sector of transportation. Primary sources which are used for biodiesel production come from edible oils, inedible oils or other sources, such as waste cooking oil. Cultivation of crops which can be used for biodiesel production is considered as relatively easy. By-products which are produced during the process of transesterification can be processed and applied in pharmaceutical and cosmetic industry.

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