LITTERIS
ET
ARTIBUS

Ministry of Education and Science of Ukraine
Lviv Polytechnic National University

5th INTERNATIONAL YOUTH SCIENCE FORUM “LITTERIS ET ARTIBUS”

Proceedings

November 26–28, 2015
Lviv, Ukraine

Electronic edition on CD-ROM

Lviv
Lviv Polytechnic Publishing House
2015

Міністерство освіти і науки України
Національний університет “Львівська політехніка”

V МІЖНАРОДНИЙ МОЛОДІЖНИЙ НАУКОВИЙ ФОРУМ “LITTERIS ET ARTIBUS”

Матеріали

26–28 листопада, 2015
Україна, Львів

Електронне видання на CD-ROM

Львів
Видавництво Львівської політехніки
2015

MECHANICAL ENGINEERING, MATERIALS SCIENCE, TRANSPORT

CHEMISTRY & CHEMICAL TECHNOLOGY

Analysis of the Process of Obtaining Methyl Esters of Fatty Acids from Waste Vegetable Oils

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Abstract* – *the technological features of the process of obtaining the methyl esters of carboxylic acids from renewable materials were analyzed. The results showed that the waste vegetable oil can be used as raw material for biofuels production. However, to increase product yield and its quality technological scheme of obtaining the product correction is needed.

Key words – methyl esters, catalyst, biodiesel, transesterification reaction, waste vegetable oil.

I. Introduction

The issue of global warming and greenhouse gas emission is becoming one of the major technological as well as social and political challenges. Increasing gap between the energy demand of the industrialized world and inability to replenish such needs are connected with the limited sources of energy such as fossil fuels and ever-increasing levels of greenhouse pollution from the combustion of fossil fuels. The problem leads to the perils of global warming and energy crisis. One quarter of the world`s CO2 emission are created by the transport sector which accounts for some 60% of the world`s total oil consumption. The greenhouse emission from widespread utilization of fossil fuels has a deleterious effect on climate temperature. There is a growing trend towards exploiting alternative, renewable and environmentally friendly fuels which are cost-wise competitive with fossil fuels.

Increasing the number of waste oils from catering facilities is a problem worldwide. Throwing out contaminated oil leads to problems of sewage treatment, pollution. Its reuse is a potential cause of health problems of people.

There are several options for disposal of these wastes, such as the manufacture of soap, thermal cracking [1], or biofuels. At the heart of the biodiesel production process is transesterification of a feedstock (Fig.1). The use of this fuel, which is a renewable resource, reduces pollution and leads to savings not renewable resources [2].

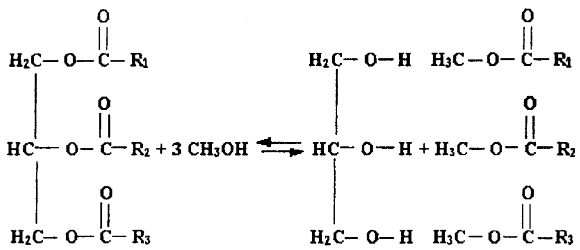

Fig. 1. Transesterification reaction

With the use of waste oil for biodiesel production, yield of methyl esters may differ from product yield compared with the case when the pure oil is used as a feedstock. Multiple heating and the presence of other substances in oil can significantly change its properties.

This circumstance requires additional experimental studies of transesterification reaction, when waste vegetable oil is used as a feedstock for biodiesel production.

II. Experimental part

In the biodiesel production as catalysts, the following substances are used: sulfuric, hydrochloric acid, sodium hydroxide or potassium. Overview of various methods of biodiesel production using different alcohols and catalysts are given in [3]. The alkaline catalyst is used in research because it has advantages over acidic catalyst due to the better speed of the reaction.

To analyze the process of obtaining biodiesel were conducted experimental studies of transesterification reaction of waste vegetable oil methyl alcohol. As feedstock used waste sunflower oil from fast food restaurants. A simplified flow-chart of the alkali-catalyst process for the transesterification of WCO is presented on Fig.2.

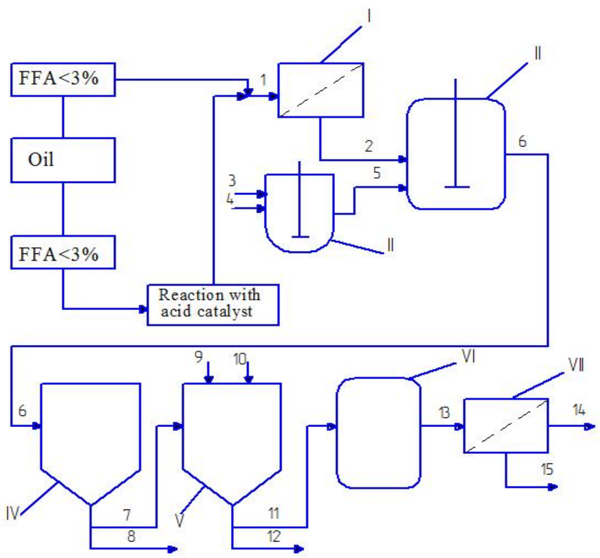

Fig. 2. The proposed scheme of biodiesel production: I – filter for oil; II – blender; III – transesterification stirring tank reactor; IV– decanter, V – separator; VI – tank reactor for biodiesel drying; VII – filtration unit. 1 – oil; 2 – treated oil; 3 – methanol; 4 – sodium hydroxide; 5 – methoxide solution; 6 – reaction products; 7 – biodiesel + methanol + impurities; 8 – glycerin; 9 – hot water; 10 – citric acid (0,4%); 11 – biodiesel+water; 12 – washing water; 13 – biodiesel with impurities; 14 – final biodiesel; 15 – impurities.

The experimental plant for biodiesel production is presented on Fig.3.

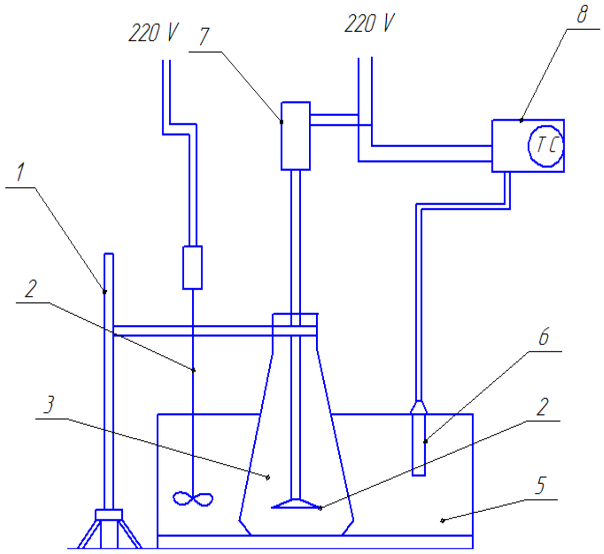

Fig. 3. Experimental plant for obtaining biodiesel
1 - tripod; 2 – mixing device; 3 – the reaction flask; 4 – mixing device; 5 – water bath; 6 – thermostat; 7 – engine of mixer; 8 – thermostat

In the first stage of processing to remove water from the feedstock, anhydrous sodium sulfate was used as dehumidifier. Then drained waste sunflower oil was filtered to remove food debris and other impurities from it.

For experiments with transesterification of waste vegetable oil has been produced reaction mixture, for which the following reagents are prepared: waste sunflower oil in an amount 100 ml and methyl alcohol in an amount of 12.5 ml. As a catalyst the potassium hydroxide in an amount of 0.8 g was used. These reagents have been added to the reaction flask 3 with stirrer 4. The flask was placed in a vessel with thermostat. The reaction begins in the two-phase system consisting of an alkaline solution of methanol and triglycerides. During the first few minutes of mixing, the system becomes a single-phase as a result of emulsification. After the formation of a significant amount of glycine the system again becomes a two-phase.

The reaction mixture, which consisted of waste oil, methanol and catalyst - potassium hydroxide, was mixed for 1.5 hours at 25 C. After stirring, the mixture was decanted for 16 hours. The result was formed two layers of liquids. The top layer is a lipophilic phase with a high content of methyl esters, and the bottom layer is a solution of methanol in glycerol

The top layer was separated and analyzed for the content of mono-, di-, and triglycerides and methyl esters of fatty acids. Depending on the materials used, the value of product yield was 62-71%.

Such relatively low yield is explained by repeated heating of oil and the presence of impurities in it, which significantly affect on its properties.

When oil is repeated heating to the boiling point, significant part of triglycerides forms a macromolecular products. Such reactions are determined by the presence of double bonds in the molecules of fatty acids that form the basis of triglycerides, which are part of the oil. Products, which are formed by polymerization have a large molecular weight and is not determined by chromatographic method. They have a boiling point higher than 360 ° C, so they can't be used as components of diesel fuel. According to accepted international standards, such products must be separated from the methyl esters of fatty acids.

This fact needs to be adjusted processing technology of vegetable oil for biodiesel. Before applying, the resulting product should be cleaned of contaminants (decomposition products, aldehydes, oxidation and polymerization products). The most appropriate method of separation - fractional distillation. In biodiesel must be used fraction with a boiling point not higher than 350 ° C.

Therefore, in technological scheme of the process should be used distillation column with vacuum stripping to separate the reaction by-products of the desired product.

Conclusion

The analysis of the of technological features of the transesterification process of the sunflower oil with methanol in the presence of potassium hydroxide allowed to choose a sequence of processes for biodiesel production.

Experimental studies of transesterification reaction of waste vegetable oil with methyl alcohol were conducted.

Based on the experimental results and their analysis, the correction of technological scheme for biodiesel process was proposed, which will provide a high enough yield the final product.

The introduction of this technology will reduce the environmental burden and get a quality product.

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Один електронний оптичний диск CD-ROM.
Об’єм даних у мегабайтах 58 Мб.
Наклад 50 прим. Зам. № 154163.

Видавець Видавництво Львівської політехніки

Свідоцтво суб’єкта видавничої справи ДК № 4429 від 27.12.2012 р.

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