Biodiesel Production from Waste Cooking Oils as Alternative Way to Manage WCO

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Abstract: - Biodiesel is an alternative promise to ensure the need for successful resources to save. Biodiesel has proven to be the best substitute for fossil oil due to its unique properties such as: low toxicity, no sulfur emission, no particulate pollution, significant reduction in greenhouse gas emissions and biodegradability. The production of biodiesel can be the solution to the problem of how to deal with the problems of cooking oils (WCO) and the problem related to environmental pollution. Every year, tons of WCO are flushed down toilets and drains, polluting water and creating serious problems in people's sewage plants. WCO is a list that can be used to produce biodiesel. The main basis of the study is to determine how the type of WCO (and how much it is related) in the obtained biodiesel information. Several processes have been created for the initiation of biodiesel, among which transesterification using alkaline catalysis gives high levels of conversion of triglycerides to their corresponding methyl esters in short reaction times. All cooking oils are used as raw materials, transesterification processes are adapted to occur and the recovery of high-quality glycerin from biodiesel by-products (glycerin) are the main options to be considered to reduce the cost of biodiesel. Some four main ways to make biodiesel are direct and extensive use, microemulsions, thermal cracking (pyrolysis) and transesterification. The most common method is transesterification of vegetable oils and animal fats.
The transesterification reaction is affected by the molar ratio of glycerides to alcohol, catalysts, reaction temperature, reaction time, and the free fatty acids and water content of the oils or fats. The mechanism and kinetics of transesterification show how the reaction occurs and progresses.

Key-Words: - waste cooking oils (WCO), biodiesel production, alcohol, transesterification, recycle.

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1 Introduction
Trans-esterification and esterification are similar chemical processes in this matter of biodiesel/biofuels from animal fats, [1], [2]. Biodiesel produced from vegetable oils, animal fats and cooking oils is biodegradable, non-toxic and has low emissions relative to fossil fuel. Since fossil fuels are decreasing year by year, the emergence of new technologies should be

important to find fuels from waste and renewable biomass.

In the early 1970s, acute fuel shortages culminated in the diversification of fuel sources and thus biodiesel as well as fatty esters in food as an alternative to. Nowadays, diesel engines burn cleaner, stable fuel that will work in different conditions. However, the renewed interest in biodiesel from animal fats and regulations is influenced by regulations and rules in various to minimize and compete the food industry. Many of the regulations and laws focused on promoting agro-economics, national security and climate change reduction, [3].

Today, the use of alternative fuels is much needed to help energy security, environmental concerns and socio-economic reasons. Rising oil prices and depleting oil reserves have made us turn our eyes to better energy alternatives from fossil fuels. With the growing concern about pollution caused by fossil fuels of oil, coal and natural gas, renewable energy sources such as biodiesel have become the light of the future. In addition, the side effect of petroleum-based fuels is that over the years there has been a steady increase in the amount of pollution produced by these fuels. In this perspective, considerable attention has been paid to the direction of biodiesel production as an oil substitute, [4], [5]. Furthermore, biodiesel as a fuel has become more attractive due to the environmental benefits and the fact that plants, vegetable oils and animal fats are renewable sources of biomass.

Biodiesel represents a largely closed cycle of carbon dioxide (about 78%), as a result of which it is derived from renewable biomass sources.

Trans-esterification is a technique used in the industry for the production of soaps and detergents. Biodiesel is produced by a chemical process similar to saponification using trans-esterification. Figure 1 presents the trans-esterification reaction of fatty acids.

During the trans-esterification process, the fatty acid reacts with the alcohol in the presence of a catalyst, usually a very strong alkaline catalyst, such as potassium hydroxide or sodium hydroxide. The alcohol reacts with the fatty material in the presence of a catalyst to form biodiesel or mono-alkyl ester and glycerol. The successful transesterification reaction is characterized by the separation of methyl ester (biodiesel) and glycerol layers after the reaction, [6]. The heavier component, glycerol, precipitates at the bottom, while the lighter biodiesel takes first place. The solid part, glycerin, can be collected and sold for other industrial uses, in cosmetics, detergents or pharmaceuticals. The crude glycerol phase remaining after transesterification may require purification before use.

In this study, methanol was used and catalyzed with potassium hydroxide to form biodiesel and crude glycerol. Production of the product according to the literature emits less than (10%) carbon dioxide, with no other gas emissions that can be seen in the fossil-based oil blend, [7], [8]. The low amount of carbon dioxide emitted can be used by green plants for the process metabolism during photosynthesis. These will reduce to a minimum the amount of other gaseous pollutants of flora and fauna. The biodiesel produced can affect industrial, cosmetic, detergent or pharmaceutical products and will probably minimize the current issue of climate change that is destroying the global economy at the moment. The crude glycerol phase remaining after transesterification may require purification before use, [9], [10], [11].

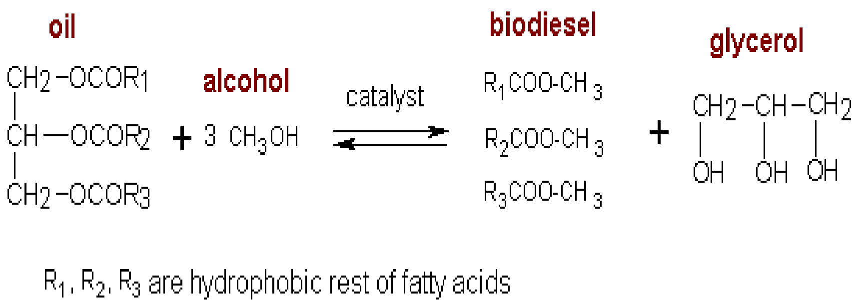

Fig. 1: Transesterification reaction

2 Materials and Methods

Transesterification is the general term used to describe the important class of organic reactions in which one ester is converted into another through exchange of the alkoxy moiety. It turns out that the transesterification process with a basic catalyst is the most used technique because it is the cheapest process and requires only low temperatures and pressures, the conversion rate is 98% and involves the direct conversion of biodiesel without including secondary products, [12].

Base catalyst transesterification, however, has several limitations, including the sensitivity of the process to the FFA (free fatty acid) content of cooking oils. High FFA content (> 1% w/w) will lead to the formation of soap which reduces the efficiency of the catalyst, causes an increase in viscosity, leads to gel formation and makes the separation of glycerol very difficult. The presence of water causes the hydrolysis of some of the esters produced, with the formation of a stable soap. The all details are described below and in the Figure 2 we see the block - diagram of the production process of biodiesel from waste cooking oil.

Other disadvantages of basic transesterification are that the process is energy intensive, the extraction of glycerol is difficult, the alkaline catalyst must be removed from the product, and the alkaline aqueous waste requires treatment. It is known that the product of cooking oils will be a function of the temperature applied while using these oils and also the time of their use, [13], [14], [15].

In this experiment, cooking oils were collected from a local restaurant in Durrës, which serves fast food. The oil used for cooking was sunflower oil. The used oil sample was taken from the fryer used for frying potatoes and other vegetables.

The oil sample was heated in a beaker to 110 ^{o}C to remove water. The oil was filtered using gauze (75 micron) to separate the particles.

To determine the required amount of catalyst for transesterification, titration was performed using a standard solution of KOH (0.1%), since KOH was used as a catalyst in this process. By titration, the total amount of catalyst per liter of cooking oil turns out to be 8 grams of KOH per liter of cooking oil, [16], [17], [18].

The transesterification reaction was carried out using 100% technical grade methanol. The alcohol used was 320 ml per liter of oil. First, the alcohol and catalyst are mixed to form the methoxide. Then the oil is poured into the mixer and heated up to a temperature of 57°C, when this temperature is reached, the methoxide is poured into the container with continuous mixing. The average reaction temperature was 60°C. The reaction was continued at this temperature and with continuous stirring for 60 minutes. The mixture is then poured into a separatory funnel and allowed to stand at room temperature for 48 hours in order to achieve maximum separation of glycerin from the desired product, [19].

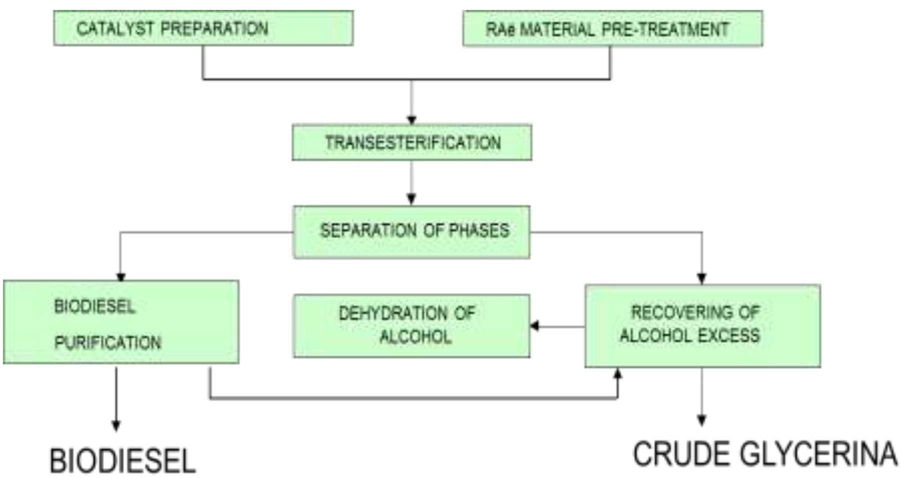

Fig. 2: Block - diagram of the production process of biodiesel from waste cooking oil

2.1 Separation of Biodiesel from Soap

Another task after the separation of the phases which is shown in the Figure 3, is the process of removing the soap.

Fig. 3: Visual presentation of the process from cooking oil waste and separation process to the desired Biodiesel product.

For this, the biodiesel was washed with warm distilled water. After this step, we place it under the action of blowing with oxygen continuously by means of the pump, helping to precipitate the soap.

3 Results and Discussion

The three different conditions (temperature, time and catalyst) were used to evaluate the optimal process conditions for biodiesel production. The study of temperature was used to estimate the optimum condition required for the conversion of waste cooking oils to biodiesel production. By following step by step the method of biodiesel production, we reached the desired final product. In the Table 1, below, we have summarized the physico-chemical parameters of the development of the reaction and also of biodiesel.

Table 1. The physico-chemical parameters of the development of the reaction and of the biodiesel.

Nr	Work parameters and physico-chemical indicators	Used restaurant oil
1	**Initial color**	**purple (in red)**
2	**View**	**Clear**
3	**Oil density**; (t = 27 ºC); (g/cm3)	**0.902**
4	**Oil density**; (d420); (g/cm3)	**0.922**
5	**Oil volume**; (ml)	**800**
6	**Volume of methyl alcohol**; (ml)	**320**
7	**Amount of KOH**; (gr)	**6**
8	**Volume of acetic acid**; (ml)	**8**
9	**Reaction temperature**; (ºC)	**58**
10	**Reaction time**; (hours)	**1**
11	**Decantation time**; (hours)	**24**
12	**Initial pH**	**10.45**
13	**Final pH**	**9.7**
14	**Washing time**; (hours)	**6**
15	**Decantation time after washing**; (hours)	**48**
Nr	**Physico-chemical indicators**	**Biodiesel**
1	**Density of biodiesel**; (t= 24 ºC)	**0.874**
2	**Density of biodiesel**; (d420); (g/cm3)	**0.8902**
3	**Angle of refraction**; (nD24)	**1.462**
4	**flash point**; (ºC)	**192 ºC**
5	**Aniline drop**; (ºC)	**was not reached until the temp(-3 ºC)**

4 Conclusions

With the exception of hydroelectric and nuclear power, the majority of all energy consumed in the world comes from oil, coal and natural gas. However, these resources are limited and will be depleted in the near future.

While the transesterification process is well established and growing significantly, the inefficiencies of existing processes remain to be considered. There is an imperative need to improve existing biodiesel production methods economically and environmentally and to investigate innovative biodiesel production methods. The identification of some key parameters is a prerequisite for determining the sustainability of the transesterification process and is essential for identifying the appropriate processes that can be performed to obtain the best results with the highest yield and purity for the biodiesel produced.

It is clear from the reviewed literature that methanol has been reported to give the best result in terms of producing the desired product and recycling the by-products. The optimal reaction conditions for the transesterification process with a basic catalyst using methanol foresee the use of alcohol in a stoichiometric proportion (preferably 100%) and the use of KOH as a catalyst at a concentration of 1% over the weight of the oil. Most studies have observed an optimal reaction time of about one hour, because excessive residence time can negatively affect biodiesel production by favoring the reverse reaction (ester hydrolysis) resulting in reduced product yield.

The production of biodiesel from cooking oils as a substitute for diesel fuel is particularly important due to the declining trend of fossil fuel reserves and the environmental problems caused by the use of fossil fuels.

Cooking oils can be an important source for biodiesel production in Albania, because there are quantities of cooking oil available. The use of cooking oil helps to improve the economy of biodiesel but also the economy of the population.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- **Armela Mazrreku, Ilirjan Malollari and Basanja Shtylla** have worked in finding the methodology for experiment and investigation of experimental process.
- **Armela Mazrreku Belinda Hoxha, Marilda Osmani** are responsible for project administration and formal analysis, especially in physico-chemical properties of biodiesel.
- **Jonilda Llupa** has worked in visualization of the published work.

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Conflict of Interest
The authors have no conflicts of interest to declare that are relevant to the content of this article.