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Production of Biodiesel from a Blend of Jatropha Oil and Waste Frying Soybean Oil

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Abstract: *Biodiesel was produced from various blends of Jatropha Oil and Waste Frying Soybean Oil (WFSO). The process used was two step Transesterification, as Free fatty acid (FFA) content of Jatropha Oil was high. Esterification was done for two hours. After esterification the FFA content was reduced to <1%.WFSO having FFA 1.6% was used directly. Transesterification of blends were carried out for 90 minutes at 55°C, using KOH catalyst and Methanol alcohol. The Biodiesel produced was settled overnight and separated. It was observed that more amount of catalyst was consumed as the volume percent of Jatropha oil in the blend increases. Fuel properties of the Biodiesel products have been measured and found markedly enhanced compared to those of the parent oil. Also, the values satisfied the standard limits according to the ASTM.*

Keywords: Waste Frying Soybean Oil, Esterification, Transesterification, Blends, Fuel properties.

1. INTRODUCTION

During recent years, many activities can be observed in the field of alternative fuels due to the depletion of fossil fuels and fluctuations in their price. Methyl ester of oils or biodiesel has become more attractive because of its environmental benefits and is from renewable resources.Biodiesel fuel has potential to reduce the level of pollutants and probable carcinogens. Mustafa Balat et al. [1] expressed that biodiesel has become more attractive recently because of its environmental benefits and fact that it is made from renewable resources. The raw materials being exploited commercially for the biodiesel are edible fatty oils derived from rapeseed, soybean, palm, sunflower, coconut, peanut and linseed etc.In recent years, research has been directed to explore plant based fuels and have bright future. Although all oils can be used as a source for biodiesel production has to be ruled out because some of them are required for cooking and food purposes. Therefore, non-edible oils are the premier raw material for the production of biodiesel. Currently, compared to petroleum-based diesel, the high cost of biodiesel is amajor barrier to its commercialization. It is reported that approximately 70%–85% of the total biodiesel production cost arises from the cost of raw material [2].One way of reducing the biodiesel production costs is to use the less expensive feedstock containing fatty acids such as nonedible oils, animal fats, waste cooking oil and by products of the refining vegetables oils [3]. Fortunately, nonedible vegetable oils, mostly produced by seed-bearing trees and shrubs can provide an alternative. With no competing food uses, this characteristic turns attention to JatrophaCurcas, which grows in tropical and subtropical climates across the developing world [4].The fact that Jatropha oil cannot be used for nutritional purposes without detoxification makes its use as energy or fuel source very attractive as biodiesel.

The quantity of waste cooking oil generated per year by any country is huge. The disposal of waste cooking oil is problematic, because disposal methods may contaminate environmental water. Many developed countries have set policies that penalize the disposal of waste oil through the water drainage.[5] The production of biodiesel from waste cooking oil is one of the better ways to utilize it efficiently and economically. The data on the requirements of diesel fuel and availability of waste cooking oil in any country indicate that the biodiesel obtained from waste cooking oil may not replace diesel fuel completely [6].

The objective of the this research work was to produce Biodiesel by using the various blends of Jatropha Oil and Waste Frying oil to determine the effects of different operating variables for getting maximum yield.

2. MATERIALS AND METHODS

JatrophaCurcas oil used was brought from "JatrophaVikasSansthan", Delhi.Waste Frying oil was collected from a local restaurant in Aligarh (Golden restaurant). All Chemical reagents used in Transesterification experiments were analytical grade and supplied by Sigma & Merck.

First of all the undesirable impurities like gum and moisture content of Jatropha Oil and food particles and moisture content of Waste frying oil was removed by filtration and heating the oil at 70°C .After that the free fatty acid(FFA) content of oil was determined by titration method. The FFA ofJatropha oil was found to be more than 5%, exceeding the feasible concentration for base catalyzed Transesterification reaction.The FFA content of Waste frying oil was Less than 5% so it can be used directly without esterification. To lower the FFA content of the Jatropha oil acid esterification was performed. Measured quantity of Methanol (60 Vol. %) and Sulphuric acid (1Wt. %) were reacted to a known amount of oil. Reaction was carried out at about 55^{o}C under vigorous heating for 1.5 hours. The mixture was then left for separation of layers for 2 hours. The bottom layer was acid esterified oil that meets the required FFA content (<5%) for base catalyzed Transesterification reaction. initially the reactor was charged with blend of pre -esterified Jatropha oil and Waste frying soya been oil and heated up to the reaction temperature(55^{o}C). The desired amount of catalyst (KOH) was dissolved in the desired amount of Methanol, and the resulting solution was added to the agitated glass reactor containing blend of esterified Jatropha Oil and waste frying Soya been oil. The reaction was carried out till the desired reaction time. After that, the reaction mixture was placed in the separating funnel and allowed to settle overnight to ensure that the separation of methyl esters and glycerol phases separated completely. Glycerol phase (bottom phase) was removed and kept separately. In order to remove methanol, Methyl esters (biodiesel) phase were heated up to their boiling points. Remaining catalyst was extracted by successive washing with hot distilled water. Finally, water present was removed by heating at 110^{o}C. The Biodiesel produced was tested for different properties like flash point, viscosity, density, distillation characteristics copper strip corrosion etc, according to ASTM methods and found to follow ASTM6751

3. RESULTS AND DISCUSSIONS

3.1 EFFECT OF CATALYST

3.1.1 Effect of Catalyst Concentration on the yield of Biodiesel produced from pure Esterified Jatropha oil.

Transesterification reaction of Esterified Jatropha oil has been carried out with 16 vol.% methanol at 55^{o}C for reaction time of 90 min**,**by varying the concentration of catalyst . Biodiesel yield increases initially as the concentration of catalyst increases and we get maximum yield at 1.5 wt% catalyst concentration (91%), after which it starts decreasing. Below 1.5 wt% of catalyst, the quantity of catalyst is insufficient to carry out complete Transesterification process and above 1.5wt% catalyst, the amount of catalyst is too high so as to support the saponification reaction and thus biodiesel yield decreases because of soap formation.At 1wt.% catalyst concentration the yield obtained was only 76%.

3.1.2 Effect of Catalyst Concentration on the yield of Biodiesel produced from 90 Vol.% Esterified Jatropha oil and 10Vol.%WFSO.

The concentration of catalyst was varied with 16 vol.% methanol at 55^{o}C for reaction time of 90 min**,**andIt was found that as the conc. of catalyst increased yield of Biodiesel also increased but after certain concentration. of catalyst (1.25 wt.%) the yield was started decreasing.Maximum yield was obtained at 1.25wt.% of catalyst concentration which was 93%.At 1wt.% catalyst concentration the yield was 92%,which was much higher than earlier (pure esterified Jatropha case)

3.1.3 Effect of Catalyst Concentration on the yield of Biodiesel produced from 70 Vol.% Esterified Jatropha oil and 30Vol.%WFSO.

Different reactions were carried out to check the effect of catalyst (KOH) concentration on the yield of Biodiesel from the blend of 70 vol.% EsterifiedJatropha oil and 30 vol.% pure WFSO. The concentration of catalyst was varied and It was found that as the conc. of catalyst was increased yield of Biodiesel was increased but after certain conc. of catalyst (1wt.%) the yield started decreasing. Maximum yield of Biodiesel from 70:30 blend was obtained at 1 wt.% catalyst conc. It can be observed that the amount of catalyst consumed was further reduced to 1 wt.% as compared to 90:10 blend. Because amount of WFSO was increased to 30vol. %, which consumes less catalyst. Maximum yield obtained from 70:30 blend was 97% which is higher than the yield of 90:10 blend because of the increased amount of WFSO (30vol.%).

3.1.4 Effect of Catalyst Concentration on the yield of Biodiesel produced from 50 Vol.% Esterified Jatropha oil and 50Vol.%WFSO.

The concentration of catalyst was varied with 16 vol.% methanol at 55^{o}C for reaction time of 90 min**,**andIt was found that maximum yield of Biodiesel from 50:50 blend was obtained at 1 wt.% catalyst conc. It can be observed that the amount of catalyst consumed was further reduced to 1 wt.% as compared to 70:30 blend. Because amount of WFSO was increased to 50vol.%, which consumes less catalyst. Maximum yield obtained from 50:50 blend was 98% which is higher than the yield of 70:30 blend because of increased amount of WFSO(50vol.%).

3.1.5 Effect of Catalyst Concentration on the yield of Biodiesel produced from pure WFSO.

Different reactions were carried out to check the effect of catalyst (KOH) concentration on the yield of Biodiesel from pure WFSO. The concentration of catalyst was varied and It was found that as the conc. of catalyst was increased yield of Biodiesel was also increased but after certain conc. of catalyst (1 wt.%) the yield started decreasing. This was at lower conc. catalyst was insufficient for the Transesterification reaction to complete. For higher concentration of catalyst saponification reaction occurred resulting in the decrease in the yield of Biodiesel. Maximum yield of Biodiesel from pure WFSO was obtained at 1 wt.% catalyst concentration.

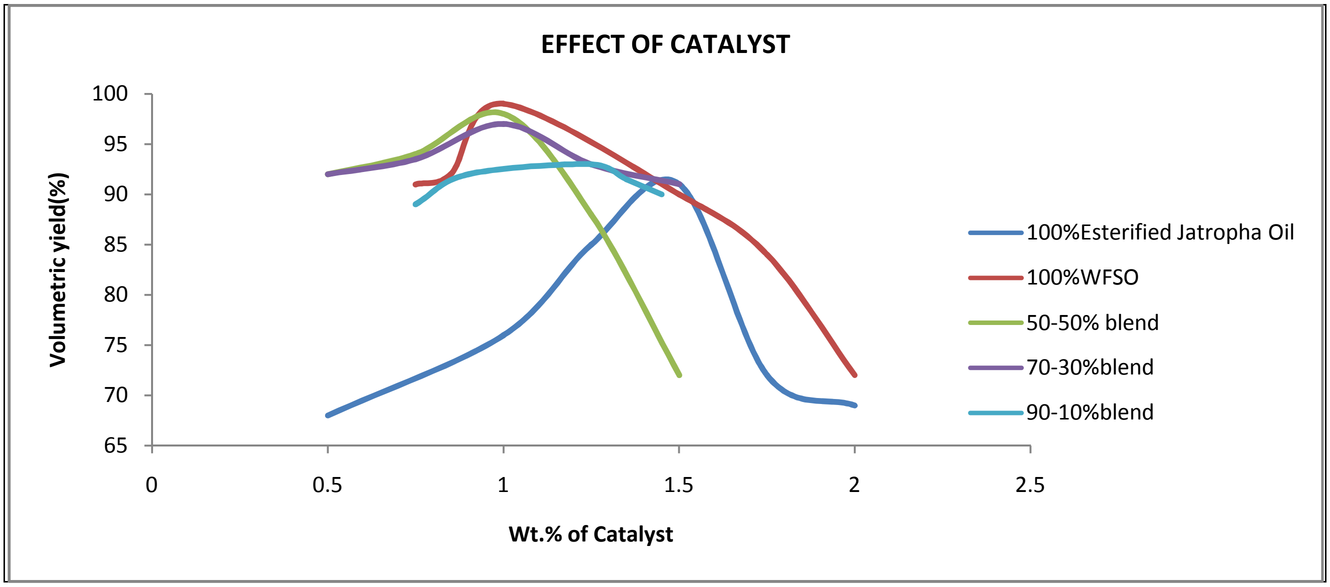

Fig. 1. Wt.% of Catalyst Concentration Vs Volumetric yield of Biodiesel produced at 16Vol.% Alcolhol, 55^{0}C temperature and for 90 minutes of reaction time of different blends of Esterified Jatropha oil and WFSO.

It was observed that for pure WFSO least amount of catalyst was used for the same yield of Biodiesel and maximum yield obtained was highest among all the blend at the same operating conditions which was 99% .

3.2 EFFECT OF ALCOHOL

3.2.1 Effect of Alcohol Volume % on the yield of Biodiesel produced from pure Esterified Jatropha oil.

Different reactions were carried out to check the effect of Alcohol (Methanol) vol.%on the yield of Biodiesel from pure EsterifiedJatropha oil. The alcohol vol.% was varied from 8-24vol.% at a catalyst conc. of 1.5wt.%. It was found that as the vol.% of methanol was increased yield of Biodiesel was also increased but after certain vol.% of methanol (16vol.%) the yield started decreasing. As the vol.% of methanol was increased yield increased because increase in alcohol vol.% of alcohol shifts the equilibrium towards right resulted in more conversion of oil in fatty acid methyl ester . But further increase in alcohol vol.% resulted in over dilution effect and also create problem during separation process and hence yield decreases .Maximum yield of Biodiesel from pure esterified Jatropha oil was 91%, obtained at 16 vol.% of Methanol. At 1 Wt. % catalyst concentration 76% yield was obtained for 16Vol.%alcohol consumption.

3.2.2 Effect of Alcohol Volume % on the yield of Biodiesel produced from 90Volume % Esterified Jatropha oil and 10 volume% WFSO.

The alcohol vol.% was varied from 12-20vol.% at a catalyst conc. of 1.25wt.% (The concentration that gave maximum yield in section 3.1.2). It was found that as vol.% of methanol was increased yield of Biodiesel was increased but after certain vol.% of methanol (16vol.%) the yield started decreasing. Maximum yield of Biodiesel from 90:10 blend was 93%,obtained at 16 vol.%. At 1 Wt. % catalyst concentration 92% yield was obtained for 16Vol.%alcohol consumption. The yield was much higher in this case for the same operating variables because of less amount of Jatropha oil (90%) as compare to earlier.

3.2.3 Effect of Alcohol Volume % on the yield of Biodiesel produced from 70Volume % Esterified Jatropha oil and 30 volume% WFSO.

The alcohol vol.% was varied from 8-24vol.% at a catalyst conc. of 1.0wt.% (The concentration that gave maximum yield in section 3.1.3). It was found that as vol.% of methanol was increased yield of Biodiesel was increased but after certain vol.% of methanol (16vol.%) the yield started decreasing. Maximum yield of Biodiesel from 70:30 blend was 97%, obtained at 16 vol.%. The yield was higher in this case for the same operating variables because of less amount of Jatropha oil (70%) as compare to earlier.

3.2.4 Effect of Alcohol Volume % on the yield of Biodiesel produced from 50Volume % Esterified Jatropha oil and 50 volume% WFSO.

The alcohol vol.% was varied from 12-20vol.% at a catalyst conc. of 1.0wt.% (The concentration that gave maximum yield in section 3.1.4). It was found that as vol.% of methanol was increased yield of Biodiesel was increased but after certain vol.% of methanol (20vol.%) the yield started decreasing. Maximum yield of Biodiesel from 50:50 blend was 99%, obtained at 20 vol.%. At 1 Wt. % catalyst concentration and 16Vol. % alcohol consumption,98.0% yield was obtained . The yield was higher in this case as compare to earlier for the same operating variables because of less amount of Jatropha oil (50%) as compare to earlier.

3.2.5 Effect of Alcohol Volume % on the yield of Biodiesel produced from pure WFSO.

Different reactions were carried out to check the effect of Alcohol (Methanol) vol.%on the yield of Biodiesel from WFSO. The alcohol vol.% was varied from 14-24vol.% at a catalyst conc. of 1.0wt.% (The concentration that gave maximum yield in section 3.1.5). It was found that as the vol.% of methanol was increased, yield of Biodiesel was also increased but after certain vol.% of methanol (20vol.%) the yield started decreasing. Maximum yield of Biodiesel from WFSO was 99.5%, obtained at 20 vol.%. At 1 Wt. % catalyst concentration and 16vol.% Methanol 99% yield was obtained for 16Vol.%alcohol consumption. The yield was higher in this case as compare to earlier for the same operating variables because of pure WFSO.

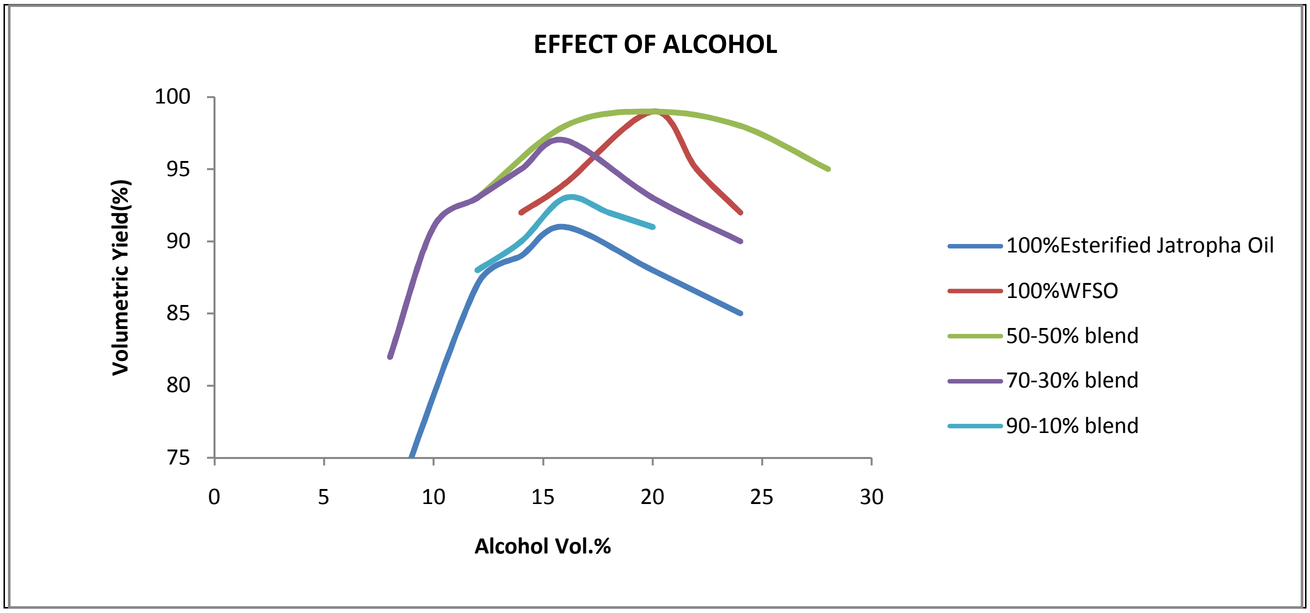

Fig. 2. Vol.% of Alcohol Vs Volumetric yield of Biodiesel produced at 1Wt.% Catalyst Concentrationl,55^{0}C temperature and for 90 minutes of reaction time of different blends of Esterified Jatropha oil and WFSO.

4. CONCLUSIONS

We can produce Biodiesel from different blends of EsterifiedJatropha oil and WFSO at different concentrations of KOH and different vol.% of methanol, at 55^{o}C for 90 min of reaction time. Biodiesel produced contains properties that confirms ASTMD6751.As the percentage of EsterifiedJatropha oil in the blend with WFSO was increased the consumption of Catalyst (KOH) and alcohol(Methanol) was also increased for the same yield at 55^{o}C reaction temperature and 90 min. of reaction time.

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REFERENCES

[1] Balat, Mustafa.; Balat,Havva.; Progress in Biodiesel Processing, J. Applied Energy Vol, 87, p.p, 1815-1835 (2010).

[2] Tiwari, A.K.; Kumar, A.; Raheman, H.; Biodiesel production from jatropha oil (Jatrophacurcas) with high free fatty acids: An optimized process, Biomass and Bioenergy 31,569–575, (2007)

[3] Veljkovic´, Lakicevic, V.B.; Stamenkovic, S.H.; Todorovic, O.S.; Lazic, Z.B.; K.L.,. Biodiesel production from tobacco (Nicotianatabacum L.) seed oil with a high content of free fatty acids.Fuel 85: 2671–2675, (2006)

[4] Openshaw, K., A review of Jatrophacurcas: an oil plant of unfulfilled promise.Biomass *and* Bioenergy 19:1-15(2000)

[5] Kulkarni, M.G.; Dalai, A.K.; Waste Cooking OilsAn Economical Source for Biodiesel: A Review, Ind. Eng. Chem. Res., 45, p.p 2901-2913,(2006).

[6] Zheng, S.; Kates, M.; Dube, M.A.; McLean, D.D.; Acid-catalyzed production of biodiesel from waste frying oil, Biomass and Bioenergy 30,267–272, (2006).