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Comparison of Biodiesel Production From Karanja Seeds, Jatropha Seeds and Thumba Oil

Authors

Amruta Gore[1], Kavita Kulkarni[2]

[1]M.Tech Student, Department of Chemical Engineering, Bharati Vidyapeeth Deemed University, College of Engineering, Pune, India
E-Mail: *gore.amruta17@gmail.com*

[2]Associate Prof. Department of Chemical Engineering, Bharati Vidyapeeth Deemed University, College of Engineering, Pune, India
E-Mail: *kskulkarni@bvucoep.edu.in*

Abstract

The transesterification process was carried out for karanja oil seed, jatropha oil seed and thumba oil by using alkali catalyst KOH. The properties of biodiesel like density, viscosity, flash point, pour point, cloud point was compared with conventional diesel at 70^0c. The Effect of temperature on karanja oil methyl ester (KOME), jatropha oil methyl ester (JOME) and thumba oil methyl ester (TOME) were studied and yield for karanja, jatropha, thumba methyl ester was obtained 85%, 86%, 81% respectively. Maximum conversion of the methyl ester was achieved at 0.3 (v/v) methanol/oil ratios for karanja oil seed, jatropha oil seed, thumba oil.

Keywords - Karanja Oil Methyl Ester (KOME), Jatropha Oil Methyl Ester (JOME) and Thumba Oil Methyl Ester (TOME)

1. Introduction

Bio-diesel is nothing but a clean burning alternative biofuel, which is produced from karanja, jatropha, waste cooking oil, thumba, soybeans, animal fats sunflowers, alge. These are domestic and renewable source. The extracted crude oil can not be used as a directly in diesel engine because it has a high viscosity; due to high viscosity of pure vegetable oils it will be responsible for high engine deposits and lubricating oil thickening. That would reduce the fuel atomization and increase fuel spray penetration. To create a biodiesel blend it can be blended with conventionl diesel. Biodiesel is manufacture from a chemical process which is known as transesterification. In transesterification reaction primary alcohol reacts with triglycrides of fatty acid which is present in vegitable oil in presence of catalyst to form glycerol and methyl ester. Generally in a batch reactor transesterification reaction is carried out. For production of biodiesel from jatropha oil author found optimum parameters at 6:1 alcohol to oil molar ratio, NaOH catalyst 0.92%, temperature 60^0c and time 1 hour. After transesterification reaction viscosity of Jatropha oil reduces greatly and comparable to conventional diesel [1]. Biodiesel production from crude jatropha curcus oil (CJCO) with a high content of FFA (15%) was studied**.** Author found that using a two-step pretreatment process FFA was reduced to less than 1%. To carry out esterification reaction 0.60 w/w% methanol to oil ratio in the presence of 1% H_2SO_4 as an acid catalyst in 1 hr reaction at 50 ^{0}c was used. In next step transesterification reaction they observed

methyl ester yield 90% in 2 hour, for that author used 0.24 w/w % methanol to oil and 1.4 % NaOH as a catalyst at 65 ^{0}c [2]. Jatropha oil was extracted from the seeds which has an oil content of 25-35%. Methanol was used as alcohol. Catalyst used as NaOH or KOH. After the completion of forming emulsions, emulsions were tested in the Kirloskar TAF 1 single cylinder. They found lower calorific value of the emulsions which causes higher fuel consumption to produce the same power output [3]. Production of Biodiesel from chemically extracted oil of was observed for jatropha seeds. Yield from the Jatropha curcas seed and biodiesel was 39.7% and 80.2% respectively. Comparison of the properties evaluated for the biodiesel conforms to the ASTM and EN standard values [4]. By using Zinc oxide as a catalyst effect of different parameter that affect the conversion of Jatropha oil and the optimum conditions in a batch reactor was studied. The highest 98% yield of methyl ester was obtained at 67°C temperature, 18:1 methanol to oil ratio, 1% ZnO. Biodiesel production using ZnO as a heterogeneous catalyst was studied [5]. Castor seeds obtained from Arusha and Jatropha seeds from Dodoma. From crude jatropha oil methyl ester yield was obtained 76% and from neutralized jatropha oil it was obtained 91%. From crude castor oil biodiesel yield was 61% while from neutralized oil 76% obtained. Hence it was concluded that biodiesel yield improves as the neutralization of the oil done. From the castor oil biodiesel yield was obtained low [6]. Biodiesel was manufacured by non-edible karanja oil by transesterification reaction. Methanol was used with NaOH as a catalyst. 6 kg of veg oil was heated at 60-70°c and 22.8 grams of NaOH in 1.2L methanol was added. This type of combined mixture produced sodium methoxide. The conversion was obtained at 60^{0}c i.e.92%. The fuel properties like flash point, density, viscosity, fire point and calorific value of the transesterified product (biodiesel) compared well with standard biodiesel [7]. Experiments were performed by using Neem Oil Methyl Ester (NOME) by varying different factor like reaction time, concentration of acid and base catalyst, oil/alcohol molar ratio. The optimum conditions obtained in a batch oscillatory flow reactor for the production of biodiesel from Neem oil found, oil to methanol mole ratio 1:9, catalyst concentration 1 wt% and reaction time of 10 minutes. Biodiesel production from Neem needs less catalyst concentration and requires more mole ratios of oil to alcohol [8]. At supercritical conditions transesterification reaction of triglycerides carried out. Beef tallow or high acidity yellow grease was used as raw materials. The reaction started without alkali or acidic catalysts, thus eliminat the neutralization step [9]. Transesterification of karanja oil was carried out which gives 907ml of karanja oil methyl ester (KOME) and 109ml of glycerol using methanol 13% and NaOH as a catalyst 1%. The biodiesel recovery from karanja oil was 907ml per liter of oil and the glycerine recovery per liter of karanja oil was 109ml. The biodiesel recovery was nearly 90% [10]. Production of biodiesel from Palm oil and Ghee using transesterification process were carried out with sodium hydroxide catalyst and methanol. The methyl ester yield increased with increase in alcohol/oil ratio, whereas, for ghee, the methyl ester yield was comparatively low with same amount of methanol/ghee ratio [11]. Experiments were carried out to find out the different properties of jatropha oil. Production of Biodiesel from jatropha oil seed through esterification by using acid catalyst 5% H_2SO_4 and methanol 20% of oil. The yield obtained from jatropha oil methyl ester was 97% [12]. Production process of biodiesel from oils content, karanja oil, engines testing, and performance analysis of biodiesel, fuel properties was studied. Engine tests were carried out in water cooled four stroke diesel engines and experimental investigation was carried out to examine emission of different blends of KOME, performance and properties. At B20 blend brake power was observed maximum higher load. NOx emissions are found to be more for KOME blends while CO_2, smoke and HC emissions are lowered as compared to standard diesel [13]. Compression ignition engine fuelled with mineral diesel, the emission and performance characteristics of a single cylinder 3.67 kW, diesel-biodiesel blends

at an injection pressure of 200 bar was checked. The performance parameters like break thermal efficiency and the emissions measured were carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbon (HC), and oxides of nitrogen (NO_x). Oil recovery percentage from Jatropha and Karanja seeds found to be 22.5% for karanja and 25%for jatropha, oil was processed in the bio-diesel processor [14]. Surendra R. Kalbande et al. studied the karanja and jatropha biodiesel is an alternate fuel for diesel engine was studied. Biodiesel processor was tested for biodiesel production from Karanja and Jatropha oil. Oil recovery from Jatropha and Karanja seeds were found to be 22.5% and 25%, respectively. Biodiesel recovery from transesterification reaction was 908.3 ml from jatropha and for same batch it was 106 ml glycerin, for karanja oil biodiesel recovery was 910 ml and glycerin 107 ml [15].

2. Materials and Method

The seed were collected from local market. The seeds were selected according to their conditions whereas damaged seeds were discarded. Seeds were cleaned, deshelled and moisture removal at higher temperature at 100-105 ^{0}c for 20-30 minutes. The oil extraction from karanja and jatropha seeds were done by mechanical expelling method, yield obtained from these seed 24 % and 22% respectively. In this experiment, karanja oil, jatropha oil, thumba oil were first taken for filteration to remove solid particls then preheated at 110^{0}c for 20-30 minutes to remove moisture and then dried.

A three necked round –bottom flask of 2000 ml reactor was used for biodiesel production. The reactor was placed in heating mantle, temperature is controlled within $\pm 2^0$ c. Reactor is equipped with two side necks, condenser and thermo well. a thermometer was placed in the thermo well inside the reactor. From central neck a stirrer is passed through it, which is connected to a motor along with speed regulator nob and controlls the stirrer speed. Acid catalyzed reaction carried into closed reactor 0.5-0.7% H_2SO_4 concentration and 50-100% methanol as a alcohol mixed into 1000 ml of oil and reaction temperature is near about boiling point methanol(60-65^{0}c) for 60 minute. If first step reaction is complete then second step reaction carried out. Reaction condition and chemical applied same as first step. Acid catalysed reaction is used to check the free fatty acid. Reaction carried with 1000 ml raw oil, methanol to oil ratio-6:1, concentraction of H_2SO_4-0.7%, concentraction of KOH- 0.7% were selected. The karanja crude oil was first heated to 50 ^{0}c and 0.5% (by wt) sulfuric acid was added to oil then methyl alcohol added. Methyl alcohol is added in excess amount to speed up the reaction rate. This reaction was proceeding with stirring at 760 rpm and temperature was controlled at 55-57 ^{0}c for 90 min with regular analysis of FFA every after 25-30 min. When the FFA is reduced upto 1%, the reaction is stopped. KOH catalyst was used with 0.7% of total quantity of oil mass. It was dissolved in methanol using an agitator at 700 rpm speed for 20 minutes. The alcohol - catalyst solution was to maintain the catalytic activity and prevent the moisture absorbance. After completion it was slowly charged into preheated esterified oil. Esterified oil was taken into reaction vessel, and then addition of KOH catalyst in oil was done. The temperature of reaction mix was maintained at 60 to 65^{0}c i.e. near to the boiling point of methanol to speed up the reaction. The stirring speed was maintained at 560- 700rpm. For higher conversion excess of alcohol was used. The reaction mixture was taken each after 20 minute for FFA analysis. After reduction of FFA reaction was said to be complete. Then heating was stopped and the products were taken for cooling and separation takes place in separation funnel. After complition of reaction it was allowed for settling for 10-12 hours in separating funnel. At this stage two major products obtained that were glycerin and biodiesel. The glycerin was much denser than biodiesel. Separation of two phases was done by gravity separation method. Glycerin was taken from the bottom of the separation funnel. Two phases were formed glycerin and biodiesel; the excess of alcohol was taken off by distillation unit. Distillation unit was used for recovery of excess alcohol and that alcohol was resued. The methyl ester was purified by using warm water to remove residual catalyst. At

the end of biodiesel production process removal of moisture present in the final product.

3. Results and Discussion

3.1 Effect of Temperature

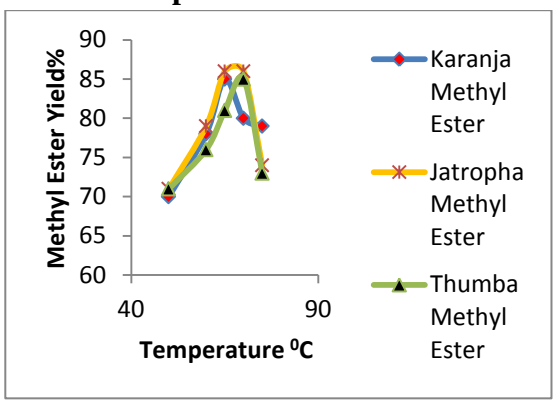

Figure 1: Effect of Operating Temperature on methyl ester yield

The effect of temperature on yield was observed at 50, 60, 65, 70, 75 ^{0}c keep the other parameter constant. Biodiesel yield was maximum near to the boiling point of methanol observed. At 70^{0}c methyl ester yield was obtained for karanja, jatropha, thumba around 85%, 86%,81% respectivly. For completion of reaction time required was one and half hour, whereas at 40 ^{0}c methyl ester yield was low and time for reaction was more. It was observed that as the temperature increases methyl ester conversion also increases.

3.2 Effect of alcohol

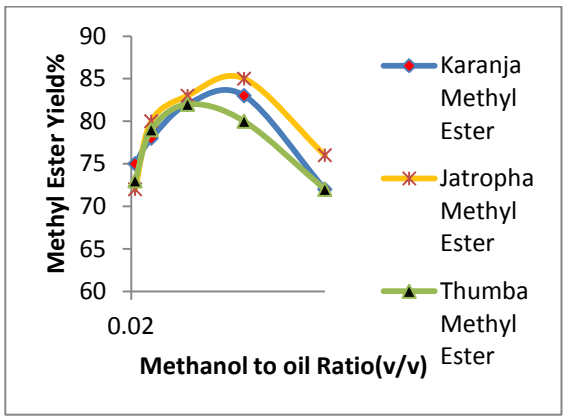

Figure 2: Effect of alcohol on methyl ester yield

The important factor was ratio of methanol to oil which affect the yield of methyl ester. The above graph shows that as the methanol/oil ratio increases methyl ester yield also increase. It was observed that for karanja and jatropha the yield was high as compared to thumba. Higher molar ratio of methanol to oil affect the greater methyl ester production in a short period of time. The effect of methanol on yield of methyl ester in the range of 0.03-0.5 (v/v ratio) at 65 ^{0}C was observed, at constant parameters. Hence it is observed that the maximum conversion of methyl ester was obtained at a ratio of 0.3 %(v/v) methanol/oil.

3.3 Effect of catalyst concentraction

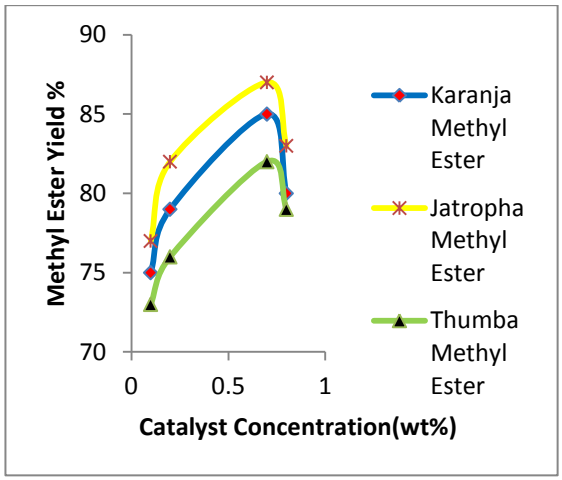

Figure 3: Effect of catalyst concentration on methyl ester yield

The effect of catalyst concentration (KOH) on methyl ester yield was studied for three different oil i.e. karanja, jatropha, thumba from 0.1-0.8 wt/wt % at 65^{0}c and 0.3 methanol to oil v/v ratio. It was found that yield of the methyl esters was less at lower catalyst loading due to incomplete reaction, and then increased as the catalyst loading was increased. The maximum methyl ester yield was observed at 0.7 wt% of KOH catalyst. After higher catalyst concentrations 0.5 wt% yield increase, but as we observed that at 0.8% catalyst loading yield decreses. However, using than 0.5 wt%, the yield decreased at 0.8 wt% catalyst, and during washing process of final product with warm water more soap was obtained, due to the excess catalyst and saponification reaction occour. Therefore at 0.7 wt% of KOH catalyst concentration obtained as optimum for maximum methyl ester production.

Table 1: Comparison of karanja biodiesel with Diesel

Properties	Karanja methyl ester	Diesel
Specific gravity	0.81	0.84
Kinematic Viscosity @ 41°C	4.78 cs	2.9cs
Acid value	0.40 mgKOH/gm	0.32 mgKOH/gm
Cloud point	8 °C	-14°C
Flash point	137°C	50°C
Cetane number	42.1	49
Calorific value	3700 Kcal/KG	4285 Kcal/KG
Saponification value	187	

Table 2: Comparison of Jatropha biodiesel with Diesel

Properties	Jatropha methyl ester	Diesel
Specific gravity	0.93	0.84
Kinematics Viscosity @ 41°c	50.73 cs	2.9 cs
Acid Value	0.32 mgKOH/gm	0.32 mgKOH/gm
Cloud point	10^0c	-14°C
Flash point	196°c	50 °C
Cetane value	43	49
Calorific value	9 470 kcal/kg	4285 Kcal/KG
Pour point	8 °c	10 °C
Solidfying Point (°c)	2.0	0.14

Table 3: Comparison of Thumba biodiesel with Diesel

Properties	Thumba methyl ester	Diesel
Specific gravity	0.928	0.84
Kinematics Viscosity	6.12 cs	2.9 cs
Flash point	67^0c	50 °c

4. Conclusion

Karanaja, jatropha and thumba oil was transesterified using KOH catalyst and methanol was used as alcohol. The conversion was 85% at 70^0c for karanja for jatropha conversion was 86% and for thumba 81%. The fuel properties like viscosity, density, flash point, and calorific value of the biodiesel compared well with standard biodiesel.

5. References

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