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Comparative Study on Biodiesel using Trans – esterification Reaction

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***Abstract*— Present study includes a comparison between the biodiesel samples prepared from commercially available coconut oil and sunflower oil using trans – esterification reaction and in – situ generated sodium methoxide catalyst under similar experimental conditions. The products are compared with respect to boiling point, flash point, kinematic viscosity, acid value, density and % yield.**

***Index Terms*— trans – esterification, kinematic viscosity, flash point, acid value.**

I. Introduction

In the recent years, global warming and climate change has been threatening to the nature due to excessive industrialization and urbanization. Mostly carbon - based fuel are significantly responsible for the emission of green - house gases. In view of environmental protection, there is a need to switch to the alternative fuel technology [1]. Recently, enormous research is carried out on synthesis [2] – [4], physical and chemical properties of biodiesel [5].

Biodiesel is highly promising and encouraging method to largely mitigate the carbon pollution, as it, being derived from natural oil, does not emit Sulphur oxides and Nitrogen oxides, unlike petroleum oil which are obtained from fractional distillation of crude petroleum. Trans esterification reaction has gained attention in recent years for the synthesis of bio – diesel using waste cooking oil. As the reaction proceeds through catalyst and plant - based oil and therefore it fosters eco-friendly practices.

Present paper includes a comparative study on synthesis of two biodiesel samples prepared by trans – esterification reaction "Fig. 1" using coconut oil and sunflower oil. The sodium hydroxide when added to dry methanol produces sodium methoxide catalyst which accelerates the reaction. The biodiesel is separated from glycerol using density-based separation techniques.

II. Materials and Methods

Sodium hydroxide pellets AR grade and Methanol were obtained from Qualigens company. Coconut oil and sunflower oil were purchased commercially. Magnetic stirrer with hot plate was procured from LABPRO Brand SSU.

The boiling points [6] were determined using Thiele's tube and Flash point [6] using Pensky Marten's Flash point Apparatus. Kinematic Viscosity [6] was determined using Redwood Viscometer No. 2. Distilled water used for washing, is obtained using SSU 4 L Steel Body Water Distillation Unit.

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II. Experimental

In a clean and dry 500 mL conical flask, 0.1 mol of pure sodium hydroxide was dissolved in 500 mL of dry methanol (Catalyst amount = 1% by weight of oil) and stirred on magnetic stirrer at 480 rpm and at room temperature. On complete dissolution, was added 100 mL of commercial coconut oil, previously warmed to 60°C. Oil to Methanol ratio was found to be 1:5. The reaction mixture was stirred at 500 rpm, and temperature set at 70°C for two hours. The mixture was then, poured into a separating funnel and allowed to stand for 24 hours for effective separation of biodiesel and glycerol. The biodiesel was washed several times with warm distilled water (40°C) to remove any impurities and dried over anhydrous calcium chloride as desiccant.
Similarly, trans – esterification was conducted using sunflower oil under same experimental conditions and the product was separated from glycerol using separatory funnel and dried.
The two products were tested for boiling point and flash point using Thiele's tube and Pensky Marten's Flash point apparatus respectively. The density of biodiesel is determined by pycnometer method [7]. The trans – esterification reaction occurs due to various fatty acids present in these oil samples. The details of fatty acids present in the oil samples are shown in table I.

Table I. Fatty Acid Composition of the Oil Samples and their Molecular Weights

Fatty Acid	M. W. of Fatty Acid (g/mol) [8]	Wt % in coconut oil [9]	Wt % in sunflower oil [10]
Capric Acid (C10:0)	172.26	4.53	0
Lauric Acid (C12:0)	200.31	55.28	0
Myristic Acid (C14:0)	228.37	21.8	0
Palmitic Acid (C16:0)	256	7.34	6.99
Stearic Acid (C18:0)	284	3.13	4.16
Oleic Acid (C18:1)	282	4.97	34.51
Linoleic Acid (C18:2)	280	2.12	52.38

IV. Results and Discussion

% Yield was better in coconut oil (78.4) than in sunflower oil (68.1). The comparative results are presented in the table II.
The kinematic viscosities of the two samples were determined using Redwood viscometer No 2 at various temperatures and shown in table III and comparative graphs are depicted in "Fig. 2". The Acid value of both the samples were determined as per literature and reported in table II.

Table II. Comparison Parameters for Biodiesel Samples Obtained from Coconut Oil & Sunflower Oil

Parameter	Coconut oil based biodiesel	Sunflower oil based biodiesel
Density (ρ)	0.91 g/cm3	0.918 g/cm3
Actual weight of product obtained	170.2 g	132.72 g
B. P.	197°C	191°C
Density	0.88 g/cm3	0.82 g/cm3
Flash Point	134°C	129°C
Acid Value	0.38 mg KOH/g	0.29 mg KOH/g

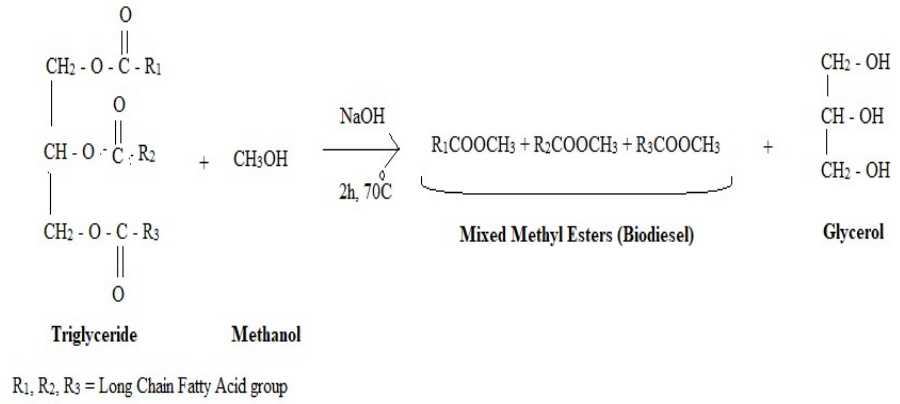

Figure 1. Trans – esterification reaction

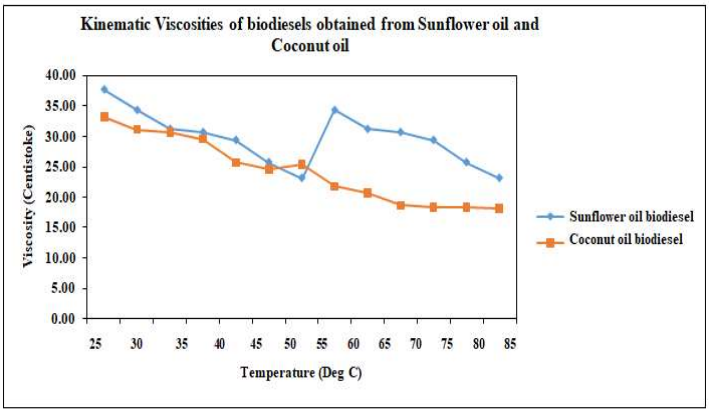

Figure 2. KinematicViscosities of biodiesels obtd. from Sunflower oil & Coconut oil

TABLE III. KINEMATIC VISCOSITIES OF BIODIESEL SAMPLES OBTAINED FROM COCONUT & SUNFLOWER OIL

Temperature (°C)	Flow-time (Sec)		Kinematic Viscosity $\eta = 0.260t - (0.0188/t)$	
	Sunflower oil - Biodiesel	Coconut oil - Biodiesel	Sunflower oil - Biodiesel	Coconut oil - Biodiesel
25	145	128	37.70	33.28
30	132	120	34.32	31.20
35	120	118	31.20	30.68
40	118	114	30.68	29.64
45	113	99	29.38	25.74
50	99	95	25.74	24.70
55	89	98	23.14	25.48
60	132	84	34.32	21.84
65	120	80	31.20	20.80
70	118	72	30.68	18.72
75	113	71	29.38	18.46
80	99	71	25.74	18.46
85	89	70	23.14	18.20

V. CONCLUSION

The trans – esterification reaction could be conducted successfully under similar experimental conditions temperature and time for the heating. Coconut based biodiesel possess high flash point and high boiling point as compared to the sunflower oil based product. The % yield is also better in the former. This may be due to the varying % composition of fatty acid present in them. While coconut oil is rich in saturated fatty acids, sunflower oil contains less % of saturated fatty acid. The flash points in both the products are higher than the working temperature of Diesel engine (84°C to 114°C), which indicates that it can be safely used without any fire hazard. Further study indicates that as the temperature increases, the kinematic viscosity decreases which is in accordance with the previous literature studies conducted on conventional oil samples. Use of biodiesel helps to adopt sustainable development practices [11] as prescribed under Environmental Management methodologies.

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