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Experimental Analysis of Biodiesel Produced From WCO with the Help of 4-Stroke Single Cylinder Diesel Engine Assisted With Engine soft Software

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Abstract: In this research work focus is on the biodiesel produced from misuse soybean oil by means of Na-OH catalyzed transesterification feedback. Bio-diesel, a combination of full of fat acid (methyl) esters (FAME), is a non conventional fuel produced from the catalytic transesterification of vegetable oils using Na-OH as catalysts.Un use soybean cooking oils (WSCO), which havegreatquantity of free full of fat acids formed in restaurants. Due to the high cost of the fresh vegetable oil, un use soybean cooking oil attracted researcher to produce bio-diesel from un use soybean cooking oil because it is accessible with comparatively cheap price. The transesterification of UN use soybean cooking oil with methanol as well as the main uses of the full of fat acid methyl esters is reviewed. The cooking oil was transesterified with methanol using Na-OH as catalyst to obtain bio-diesel by Mechanical Stirrer production technique was carried out. Results which obtained are significantly comparable to pure diesel and gives better performance than conventional diesel fuel. This biodiesel fuel was performed on 4-stroke single cylinder, kirloskar Diesel Engine with variable loads, Assisted with enginesoft software. During this act graphs were plot and reading were note down at uneven loads, with the help of these readings various engine parameters are calculated and compare with pure diesel parameters. The result shows that the calculate results are near to that of pure diesel.
Keywords: WSCO (soybean), Biodiesel, transesterification, Mechanical stirrer, Diesel engine, Engine-soft software.

I. INTRODUCTION

The relic fuel assets are decrease day by day. Their utilization has been continuously increased, which accelerates the depletion of limited petroleum reserve and unavoidably increases petroleum prices. There is a need for alternative energy sources to petroleum-based fuels due to the depletion of the world's petroleum reserves, global warming and environmental concerns. Biodiesel is a clean and renewable fuel which is considered to be the best substitution for diesel fuel (1). Biodiesel releases less harmful emissions to the environment than petro diesel.

The problems associated with the direct use of vegetable oils in diesel engines can be solved through various methods such as dilution, catalytic cracking and transesterification. Presently, transesterification is often considered to be the best method for utilizing vegetable oils in diesel engines (2-4). Biodiesel is generally more expensive to than petro diesel. However, the cost of biodiesel is expected to drop due to technological advancement, economies of scale, rising cost of crude oil, etc. Biodiesel can be used in pure form or blended with petro-diesel in order to enhance the properties of the latter. Every day, a large amount of waste vegetable oil is produced in food factories and restaurants. Waste vegetable oils are readily available raw materials for the production of biodiesel (5-7).

II. TRANSESTERIFICATION REACTION

Transesterificationresponse was occur using different types of alcohol perform at volumetric ratio 1:7 of oil to methanol, oil to ethanol and oil to 1-butanol using Na-OH catalyst. Transesterificationresponsetake place using methanol and ethanol and butanol at unlike volumetric ratio of oil to methanol, ranging from 4:1, 3:1, 1:3, 1:4 and 1:6 at 40º C and 320 rpm. The response time was maintained 3 hours always for all experiments. Two types of catalysts, Na-OH and KOH have been used to come about the transesterificationresponse at 1.0% (w/v) absorption having volumetric ratio 1:6 of oil to methanol. The Na-OH has been used at a concentration of 0.5, 1.0, 1.5, and 2.0 % (w/v) of oil having volumetric ratio 1:6 of oil to methanol. After transesterificationresponse the bio-diesel was divided from glycerol using separating funnel and finally washed with 5% water follow by magnesium sulfate anhydrous to take away the water. Catalyst type and concentration, methanol to oil ratio and reaction temperature of transesterification were investigated as they played a significantly difference in biodiesel produced.

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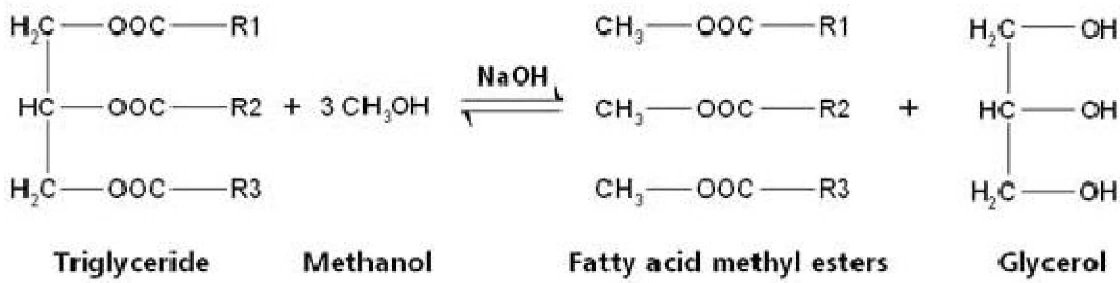
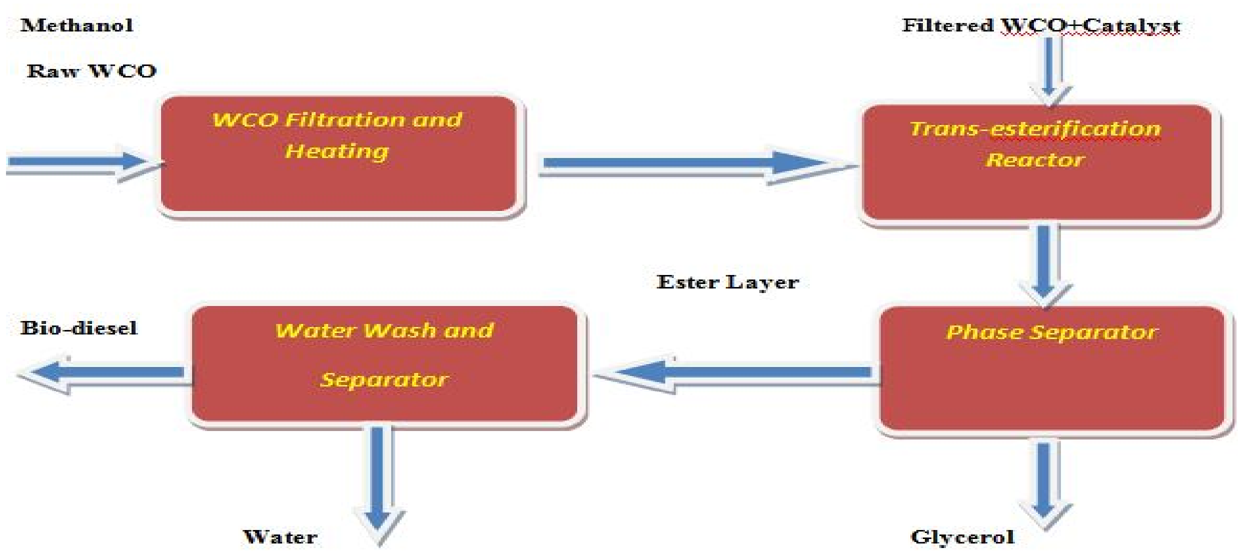


A. Experimental Work for Bio-diesel Production Materials

WSCO containing 2.10 wt% FFA was collected from local restaurant. Methanol (CH_3OH) and Na-OH were used as reacting agent and catalyst respectively during the transesterification process.

B. Bio-diesel Processes Process Flow Chart



C. Filtration and Heating of Raw WSCO

Non-oil components of the WSCO were removed by separation using filter and moisture was disinterested by heating the oil at about 12^0C for 30 to 45 minutes. Heating with electric heater is usually the easiest way to bring the oil up to required temperature.

D. Determination of FFA

In order to determine the percent of FFA in the oil, a process called titration is used. The vegetable oil is first mixed with methanol. Next, a mixture of Sodium Hydroxide (Na-OH) and water is added until all of the FFA has been reacted. This is confirmed by checking the pH of the mixture. A pH of about 9 signifies all of the FFA has been reacted.

E. Titration

One gram of Na-OH was dissolved in 1 liter of distilled water (0.1%Na-OH) solution. Phenolphthalein solution was used to get the end point. In a smaller beaker, 1ml of WSCO oil is dissolved in 10ml of methanol. The mixture was stirred gently until all the oil dissolves in the alcohol and the mixture turns clear. Two to three drops of phenolphthalein solution was added. Using a burette, 0.1% Na-OH solution was added drop by drop to the oil alcohol phenolphthalein solution, stirring all the time, until the solution stays pink. The number of ml of 0.1% Na-OH solution gives the amount of Na-OH to be used per liter of oil and FFA percentage.

F. Mixing of Methanol and Catalyst

The purpose of mixing methanol and the catalyst (Na-OH) is to react the two substances to form Meth oxide. The amount of Methanol used should be 20% of the volume of the oil. Methanol and NaOH are dangerous chemicals by themselves, with Methoxide even more so. None of these substances should ever touch skin. Vapors should not be inhaled. Gloves and ventilation are required at all times when working with these substances.

G. Transesterification (bio-diesel reaction)

The methanol in excess is added to the oil in a beaker serving as a batch reactor. The mixture is then agitated for about 60 to 90 minutes and then left overnight for phase separation to take place due to gravity.

H. Washing of Bio-diesel

The purpose of washing is to wash out the remnants of the catalyst and other impurities. Generally water washing is preferred in which lukewarm water (about one third of raw bio-diesel) is added to raw bio-diesel, stirred for a short duration and then impurities are allowed to settle down at bottom with water.

I. Production Technology

This section contains the details of bio-diesel production methodology which is used in the present work like mechanical stirring.

J. Mechanical Stirring

In this method, mixing of WSCO and methanol is done in a tank equipped with mechanical stirrer as shown in fig 1. An electric motor is used to rotate the shaft around which blades are provided to stir the mixture of immiscible liquids (oil and alcohol are not miscible with each other), as shaft starts rotating a turbulence is created which disrupt the phase boundary between two immiscible liquid and thus resulted in proper mixing. Temperature is measured with the help of a thermometer and kept in the range of the 60-65 °C.

Figure 1.Experimental set-up of bio-diesel reactor with magnetic stirrer with WSO

K. Experimental Results

The experiments are performed with alcohol to oil molar ratio as 6:1 and 4.5:1. The amount of oil, alcohol and catalyst taken is shown in Table 2.

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Molar ratio (methanol/oil)	Quantity of waste cooking oil (g)	Quantity of methanol (g)	Catalyst consumed NaOH	
			0.75 % (Wt %)	1.0 % (Wt %)
6:1	8000	1765	60g	80g
4.5:1	8000	1324	60g	80g

Table 1.WCO, methanol and catalyst during the experiment

L. Calculation data

1) For calculation of molar ratio following data are used

a) Molecular weight of triglycerides from waste soybean cooking oil = 870 g/mole

b) Molecular weight of methanol = 32

c) Hence, 1 gm mole of waste cooking oil = 870 g

d) And 1 gm mole of methanol = 32 g

e) Catalyst (NaOH) = 0.75% and 1% by weight of oil

2) Amount of methanol for 8000g of WCO

a) For 1:6 molar ratio = (32 / 870) ×8000 × 6 = 1765.51 g

b) 1:4.5 molar ratio = (32 / 870) ×8000 × 4.5 = 1324.13 g

3) Sample Calculation for yield

a) Quantity of WCO taken = 100 g

b) Quantity of bio-diesel produced = 90 g (say)

c) Yield % = (Quantity of bio-diesel produced/Quantity of oil taken)*100

= (90/100)*100= 90%

L. Experimental Data from Mechanical Stirring Method

Time and yield of bio-diesel from waste cooking oil for corresponding molar ratio and catalyst (%) are shown in the table 2.

Percentage of catalyst	Molar ratio 6:1		Molar ratio 4.5:1	
	Time (min)	Yield %	Time (min)	Yield %
0.75	35	76.80	35	72.35
	50	81.00	50	77.65
	65	88.20	65	86.00
	80	90.30	80	86.65
	95	91.30	95	87.40
1.0	35	81.85	35	74.90
	50	86.05	50	80.20
	65	91.70	65	87.85
	80	92.55	80	89.20
	95	93.10	95	89.50

Table 2 Time and yield of bio-diesel from waste cooking oil for corresponding molar ratio

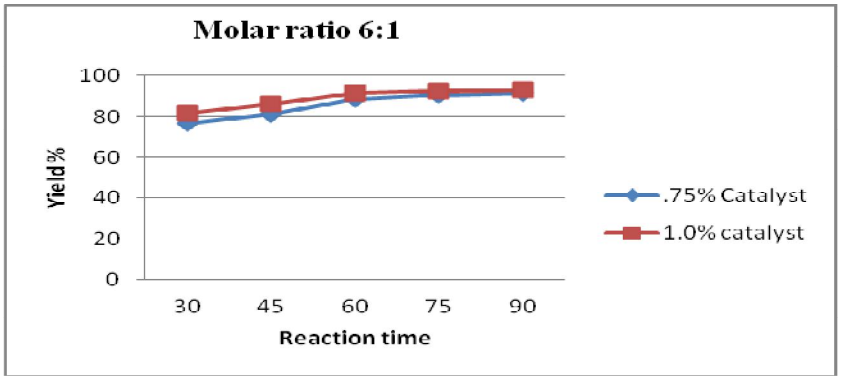

Figure 2.Time v/s Yield (%) for molar ratio 6:1 and different catalyst percentage

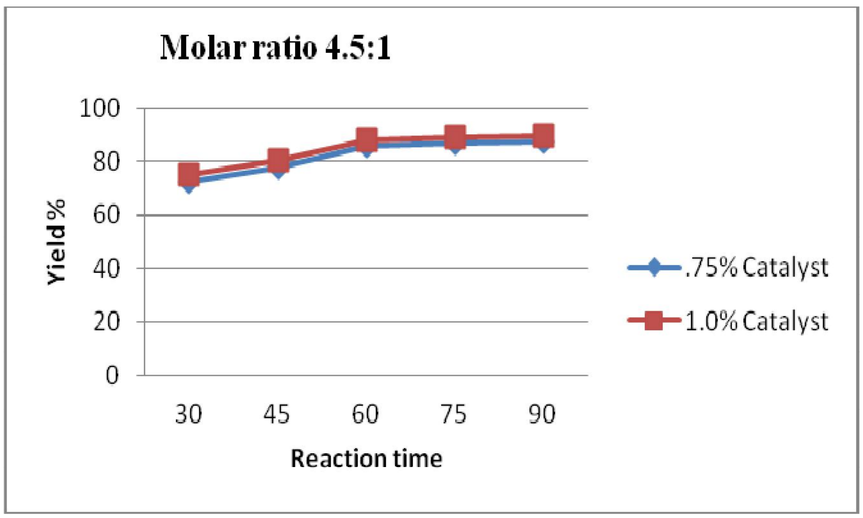

Figure 3.Time v/s Yield (%) for molar ratio 4.5:1 and different catalyst percentage

M. Engine Performance

Engine performance parameter is various but we discus only some few parameters, these parameter result from engine are shown in figures through the graphs.

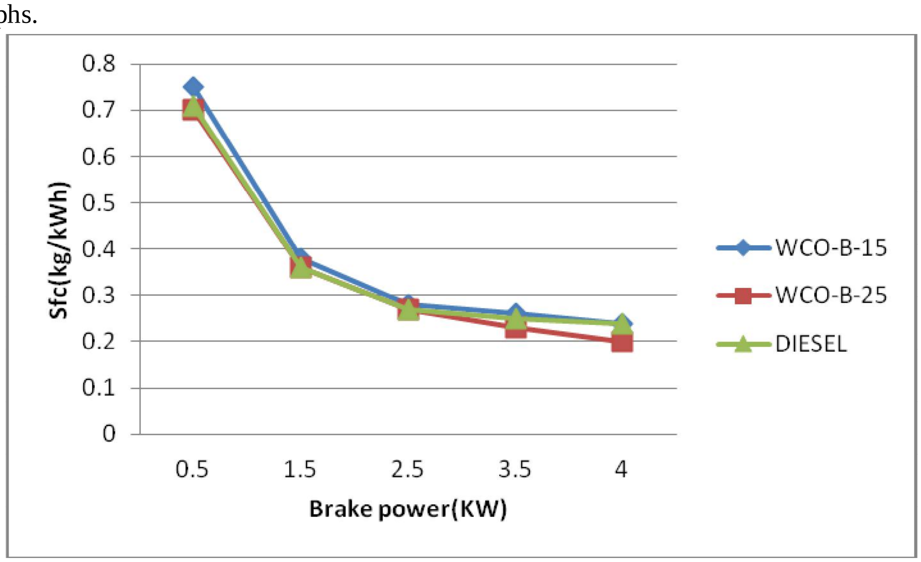

Figure 4. Comparison of specific fuel consumption v/s brake power

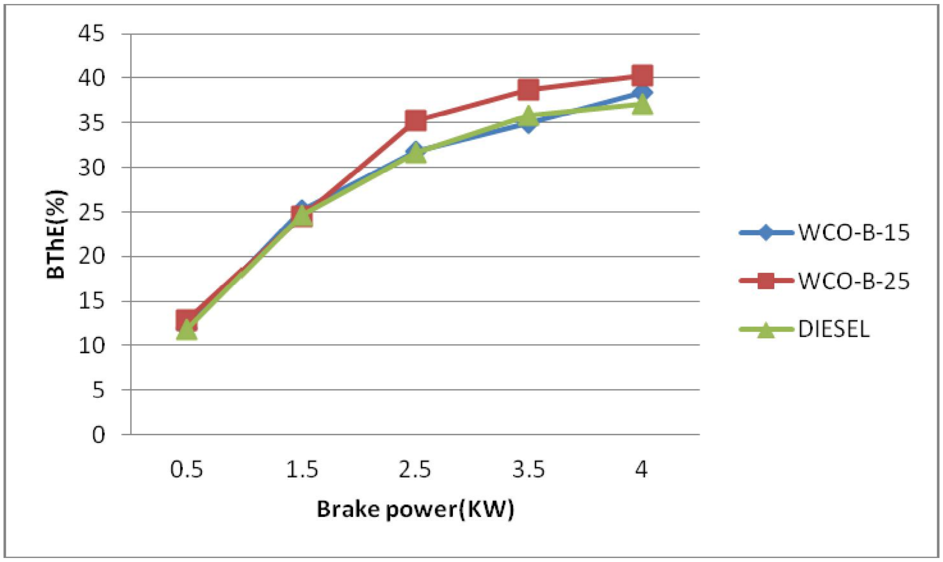

Figure 5.Comparison of brake thermal efficiency v/s brake power

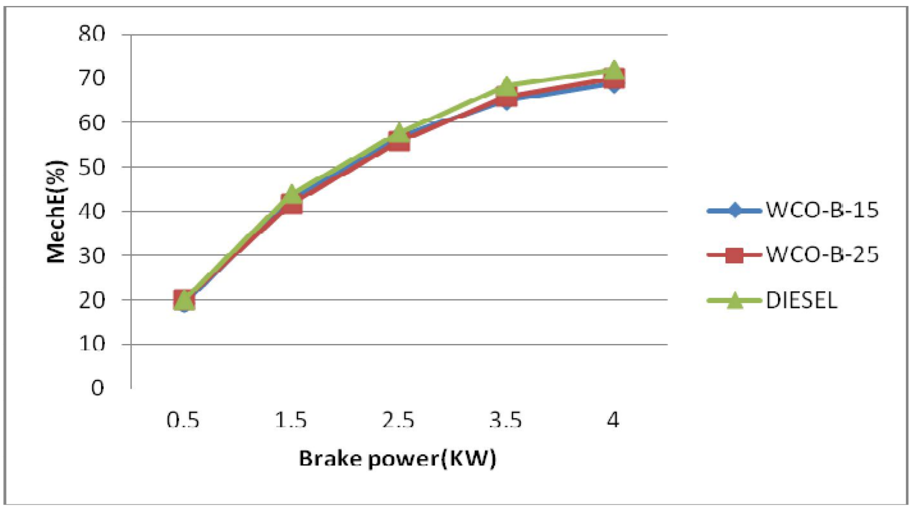

Figure 6.Comparison of mechanical efficiency v/s brake power

III. CONCLUSION

The important conclusions are as follows: As shown in figures.
It is found that in mechanical stirring the yield obtained at 1% NaOH is higher as compare to 0.75% NaOH.
Bio-diesel yield increases as reaction time increases and eventually it becomes slight constant after 65 min of reaction time.
The yield is more for molar ratio 6:1 and 1 % catalyst (max value is 93.10%) as compared to molar ratio 4.5:1 and 1% catalyst (max value is 91.30%).
Figure 4 show the efficiency of the biodiesel is near about the pure biodiesel.
Figure 5 show the SFC of biodiesel is also near about the pure diesel engine.

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