Biodiesel Production from Waste Cooking Oil and Performance Analysis by Using Biodiesel and Butanol Blends

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ABSTRACT

Biodiesel is receiving much attention these days as an alternative fuel to diesel which can be used without any modification to diesel engine. It can also work against the increasing environment degredation problems such as global warming and green house effect etc. The use of waste cooking oil (WCO) as biodiesel feedstock solves the problem of waste disposal in developing countries like India as well. It decreases the cost of biodiesel as expenses at biodiesel feedstock are reduced significantly. In this study, biodiesel was produced from waste cooking oil by trans-esterification reaction using molar ratio 6:1 of alcohol: WCO. Methanol was used as alcohol. A constant speed, stationary diesel engine was used to conduct performance analysis. The experiments were performed using 20, 40 and 60% biodiesel and diesel blends and were compared with diesel as basis. BHP inceased upto average 15% with the use of biodiesel. BTE increased upto 13%. Performance was checked also by adding oxygenated fuel butanol and it proved economic. Results indicated that 20% biodiesel blend and 10% butanol blends were optimum to use in diesel engine.

Keywords: Biodiesel, trans-esterification, waste cooking oil, performance.

1. INTRODUCTION

The new process technologies raised during last years made it possible to use used vegetable oil as biodiesel feedstock against edible raw oils with additional advantage of being lower in price. It is good from disposal management point of view as well as the problem of disposal of waste cooking oil is also solved with this. It provides a clean method to dispose used oil and biodiesel produced will cut exhaust emissions as well. There are some other alternative fuels to diesel also but biodiesel is being most attractive among them. Biodiesel consists of mono-alkyl esters of long chain fatty acids derived from vegetable oils and used potentially as alternative fuel to diesel.

There is limitation in biodiesel from some oils of getting freezed in winter season. So oxygentaed fuels program was started in 1990. It was mainly to combat caron mono oxide emissions from

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vehicles. n- Butanol among oxygenated fuels was used in this study. It has various advantages over other oxygenated fuels like ethanol. It is less hygroscopic and evaporative and can be used as transportation fuel more potentially. Oxygenated fuels contain oxygen component so that it's helpful to reduce PM emissions. There are no PM emissions from diesel engines when the mass of oxygen in the fuels is more than approximately 30% [2].

Blending oils with alcohols improves fuel properties [1]. This study indicates that biodiesel is more efficient as compared to diesel and its efficiency raised by 13% by adding n-butanol.

2. MATERIALS AND METHODOLOGY

Biodiesel was produced from waste cooking oil (WCO) by trans-esterification reaction (as shown in Figure 1) using 6:1 molar ratio. Trans-esterification is a reaction of forming esters by reacting oils and alcohols. Alkali catalyst was used as fatty acid content was lower than 5%. KOH was used at 1% weight. Methanol was prefered due to its less cost. Biodiesel production process is shown in figure 2.

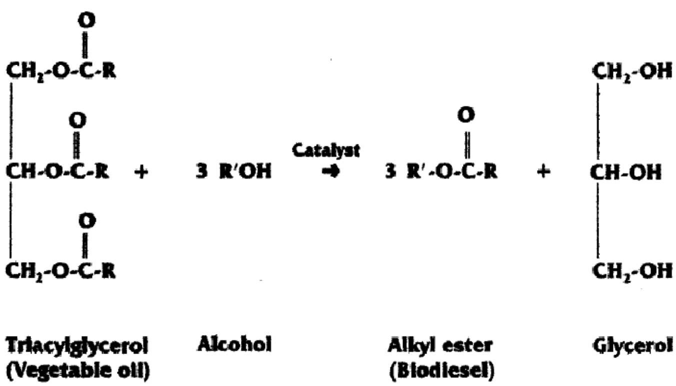
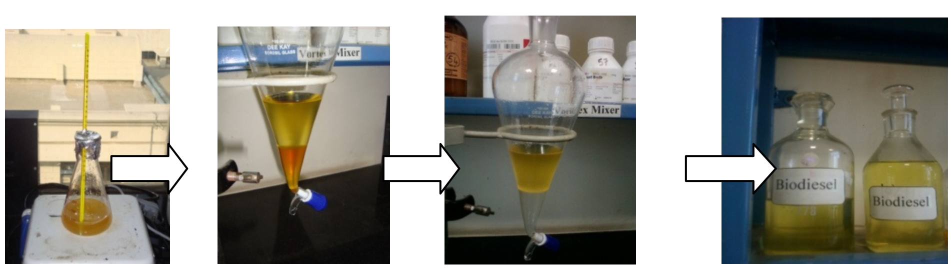


Figure 1 Trans-esterification reaction



Esterification | **separation in separatory Funnel** | **washing of biodiesel until lower layer gets crystal clear** | **Biodiesel produced**

Figure 2 Biodiesel obtained from waste cooking oil

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3. ENGINE ANALYSIS

An engine of 3.73 kW rated power, one cylindrical, 4-stroke engine at constant speed 1500 rpm was used for engine performance analysis with following specifications as mentioned in Table 1.

Table 1 Engine Specifications

Parameters	Details
Manufacturer	Kirloskar Oil Engines Limited India
Dynamometer	Eddy Current
Bore, mm	80
Stroke, mm	110
Displacement Volume, cc	252.9
Compression Ratio	16.5:1
Cooling System	Air Cooled
Horse Power	6.5
Injection Pressure	200 kg/cm^2
Voltage, V	240
Current, Ampere	17.5

4. ENGINE PERFORMANCE ANALYSIS

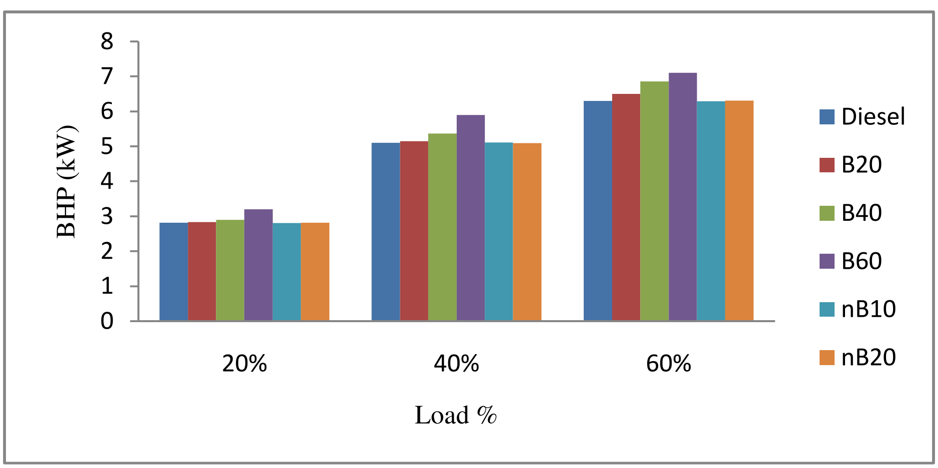

Figure 3 BHP Vs Load

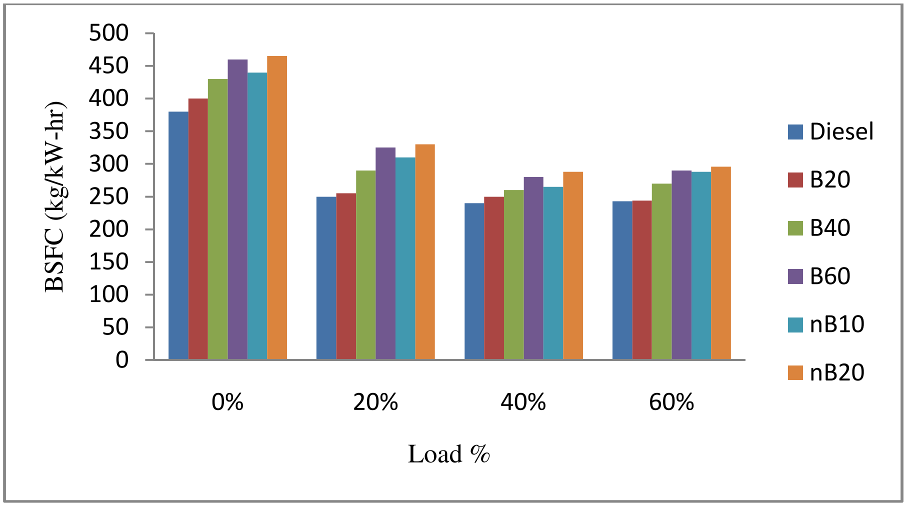

Figure 4 BSFC Vs Load

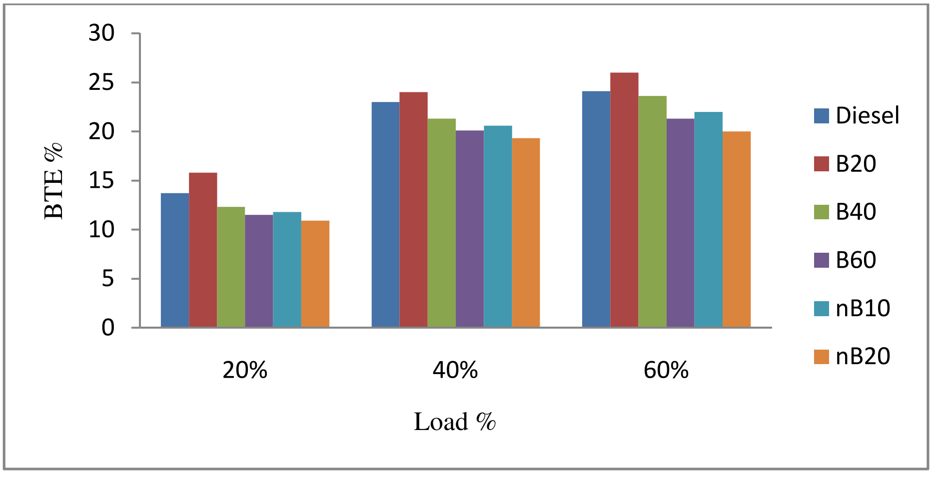

Figure 5 BTE Vs Load

5. OBSERVATIONS

1. Brake Horse Power (BHP) increases with load for every blend (Figure 3). BHP varies with current as voltage is almost constant. At no load, there is no current flow, so BHP is zero for every blend at no load. B60 showed higher increase level (15-20%) as compared to others where as B20 showed 8% increase. n-Butanol also had similar variations as B20.

2. Brake Fuel specific Consumption (BSFC) comes from brake power output and equivalent mass flow rate. It varied inversly to loads (Figure 4). At higher loads, BSFC decrease was

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more as compared to lower loads. B20 showed 5% difference at lower loads and of 2% at higher loads. Butanol addition can be of great advantage as the differnce grew more in butanol blends. It was about 25% at lower loads and 15% at higher loads.

3. Brake Thermal Efficiency (BTE) is realted with BHP directly and with mass flow rate & calorific value inversly. B20 showed higher efficiency as compared to diesel and other blends. B20 proved 13.2% more efficient as compared to diesel at lower loads and 7.3% more at higher loads. Other blends were less efficient though this differnce was very little of about 2-7%. So, B20 blend can be suggested as best blend for biodiesel preparation with WCO (Figure 5).

6. CONCLUSION

1. The lower blends of WCO methyl ester can be used in diesel engine without any engine modifications. The fuel filter needs to be changed after some interval of time.

2. Brake thermal efficiency of B20 is superior to diesel at all load conditions.

3. Bio-diesel from n-butanol biodiesel diesel blends resemble very much with the conventional diesel, in properties as well as in the performance on CI engines. The economical analysis suggests good scope for biodiesel in comparison to diesel.

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