# Analysis On Internal Combustion Engine Using Biodiesel As Alter Native Fuel Compared To Conventional Diesel

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## *Abstract:*

*In this study, the technical specification of an internal combustion engine designed for diesel fuel was used for biodiesel. The changes in engine performance, and cycle by cycle (CBC) variations were observed, and their causes were studies. When biodiesel was used as the fuel, acceptable changes occurred in the performance values. The maximum brake mean effective pressure (BMEP) obtained with the biodiesel was slightly higher than that obtained with the diesel fuel, with the difference being just slight under maximum power. While biodiesel increase the maximum cylinder pressure have occurred at the same magnitude for both fuels for the same engine speeds. The best engine performance for biodiesel operates at the engine speed of 2000 rpm to 2500 rpm. The overall analysis has shown that biodiesel has potential as an alternative fuel in conventional internal combustion engines.*

**Keywords :** Break mean effective pressure, brake specific fuel consumption, performance

## 1. Introduction

The desire to have suitable replacement, alternative or an entirely different source of fuel from the presently existing fossil fuel has being very imperative. Till today researches are still being carried out all over the world on a suitable alternative [1,2]. The demand on fossil diesel is on the increase for home and industrial use. This has lead to the world fossil fuel reserve declining and environmental pollution problems arising from its use. The production of an alternative fuel which is imperative has made researchers to come out with various way of producing biodiesel from different sources, and because of its simplicity, today we have what is called "backyard" methods of producing biodiesel [2,3].

It is in line with these that the authenticity of biodiesel produced from any source need to checked by checking its performance from the various available model that determines the perfor stationary engines are being employed and to ensure that biodiesel they produce meet the required specification. The aims and objectives of this work are to ckeck the performance of biodiesel in a stationary internal combustion engine from developed models and to compare the performance of the biodiesel with conventional diesel fuel in a stationary diesel engine.

## 2. Materials and Methods

The analytical experimental procedure was carried out using a four stroke Kirloskar diesel engine; characterized biodiesel Pongamaoil, conventional diesel fuel.

The properties that determine the performance of biodiesel in a stationary diesel engine includes; mass flow rate, torque, input power, brake power, brake mean effective pressure, specific fuel consumption, break thermal efficiency and the relationship between pressure and time [4-6]. These were investigated. From theoretical models, the graphs of mass flow rate versus engine speed, specific fuel consumption versus engine speed, and torque versus engine speed, break thermal efficiency versus engine speed and pressure versus time for both the biodiesel and conventional diesel were obtained.

**Table 1: Kirloskar oil Engine Ltd. India**

| | Specification of the Engine |
|---|---|
| Model | TV-SR, Naturally as pirated |
| Type | Vertical in- line 4-stroke water- cooled swirl combustion chamber. |
| Number of cylinder | 2 |
| Bore/stroke | 100/115 mm |
| 1-hr rating output | 22kW/2000r/min |
| 12-hr rating Output | 20kW/2000r/min |
| Compression ratio | 20:1 |
| Advance angle of fuel delivery | $15^0$-$17^0$ |
| Total displacement | 1.806L |
| Mean effective pressure | 664KPa(12-hr rating output) |
| Specific fuel consumption | 263.8g/kW.h |
| Direction of rotation of crankshaft | Counter clockwise (view from flywheel end) |
| Cooling method | Closed type circulation |
| Lubricating method | Combination of pressure and splash |
| Starting method | Electric |
| Overall dimensions | 620 65Kg |
| Net weight | 220 65 Kg |
| Maximum rated speed | 2200rpm |
| Injection pressure | 13+1.0 Mpa |
| Piston/decompression | 1-1.5mm |

## 3. Engine Performance Equations

**Torque**

Engine torque is measured by the dynamometer. The engine is clamped on a test bed and the shaft is connected to the dynamometer rotor. The torque can be found as

Follow:

$$\tau = \frac{P}{\varpi} or\, \tau = \frac{60P}{2\pi N}$$

Where:

P=Power (kW)

N=Angular Speed (rpm)

τ=Torque (Nm)

**Input Power** is given by the

IP=m$Q_{net}$

Where:

IP=Input Power(kW)

$Q_{net}$=is the lower calorific value of the fuel.

The mass flow rate is calculated by multiplying the volumetric flow rate with density of the fuel

$$m = \frac{V}{t} \times 1 \times 10^{-3} \times \rho \times \mu$$

Where:

m=Mass Flow Rate of Fuel(kg/s)

V=Volume Flow Rate of Fuel($cm^3$/s)

ρ=Density of Water(kg/$cm^3$)

μ=Specific gravity(kg/$cm^3$)

**Break mean effective pressure**

Using the practical way to calculate BMEP (psi) since the torque and engine displacement are known then later converting to the unit back to "bar". The equation to use is given as;

$$\text{BMEP} = \frac{150.8 \times \text{torque (lbft)}}{Displacement(ci)}$$

**Brake specific fuel consumption(BSFC)**

$$\text{BSFC} = \frac{m}{\text{BP}}$$

Where mass flow rate=fuel consumption(L/s) x Specific gravity (Kg/L)

**Thermal efficiency**

With break power and input power, efficiency of the engine can be calculated using

$$\eta_{BT} = \frac{bp}{IP} \times 100$$

**4. Results and Discussion**

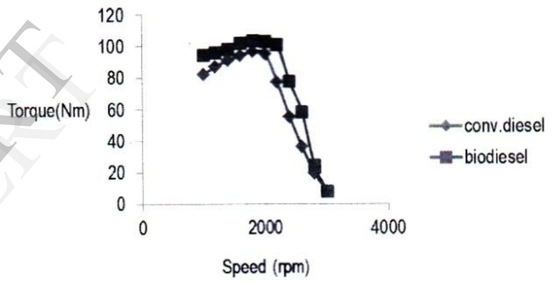


**Fig.1:Torque versus speed**

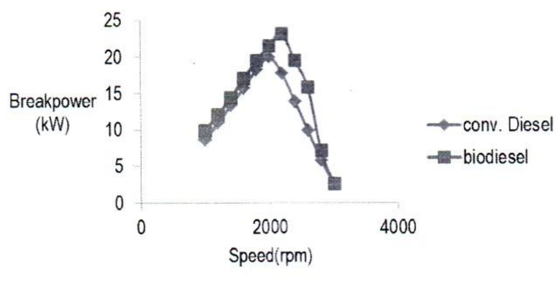


**Fig.2: Break Power versus speed**

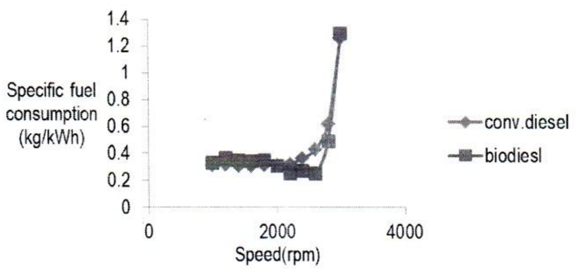

**Fig.3: Specific fuel consumption versus speed**

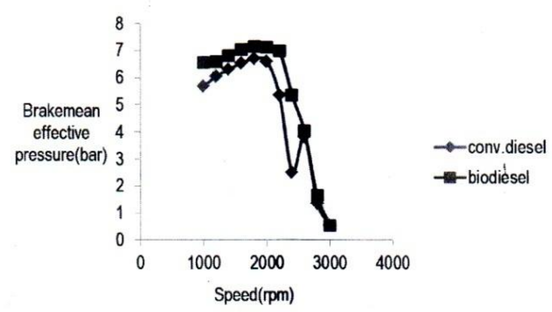


**Fig.4:Beak mean effective pressure versus speed**

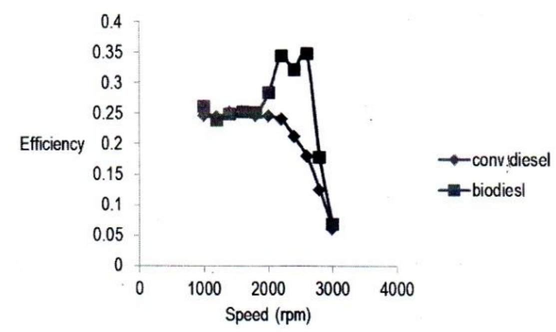


**Fig 5: Efficiency versus speed**

The result shows that there are two distinct trends for the engine when the speed is below or above 2000 rpm. In terms of efficiency, specific fuel consumption is one of the best indicators of engine performance. In theory, specific fuel consumption will be high because of the pumping work, increase friction and heat transfer. These will reduce the efficiency of fuel consumption [8].

Figure 1 shows the engine torque vs. speed for biodiesel and conventional diesel fuel. The torque decreases as the engine speed increased. As the engine speed increases, the high initial torque will decrease. The maximum torque is reached for both fuels for speeds ranging from 1800-2200 rpm.

However biodiesel produces a higher torque compared to conventional diesel fuel. Generally the torque reduces for every increase of speed. These apply to both fuels.

Brake power was calculated with the values of torque and engine speed. Figure 2 shows the brake power as a function of speed. From the figure, it shows that biodiesel required a higher amount of brake power. For conventional diesel fuel, the brake power reached the maximum value of speed from 1800 to 2200 rpm. The torque and brake power produced by both fuels are comparable to each other. The break specific fuel consumption for biodiesel compared to conventional diesel fuel is shown in Figure 3. There is a pattern showing that, between the range of 2000 and 2500 rpm, the fuel consumption is at its maximum; under that specific range, the fuel consumption of biodiesel is relatively higher than conventional diesel fuel. As the speeds goes higher than 2000 rpm, the flow rate decreased. The relationship of volumetric fuel injection system, fuel density, viscosity, and heating value caused the above effects.

Figure 3 shows the brake specific fuel consumption (BSFC) of biodiesel compare to conventional diesel fuel. At low speed, BSFC of biodiesel is greater than conventional diesel fuel. As the speed increases, BSFC of biodiesel becomes lower compare to convectional diesel fuel at 2200 to 2500 rpm. However, BSFC increased for both fuels at high speed. This indicates good combustion of biodiesel at the high-speed range.

Brake thermal efficiency is the percentage ratio of the output power and the input power. In the simulation performed, the input is calculated with the values of fuel consumed, lower calorific value and time taken. Figure 5 shows the efficiency against speed where, when input power decreases, the efficiency of the engine increases. The biodiesel graph illustrates that the efficiency varies and fluctuates between the speeds of 2000 to 2800 rpm. Biodiesel proves to be more efficient than conventional diesel fuel in this range. For conventional diesel fuel, the efficiency starts to drop when the speed decreases below 2000 rpm. We can also say that engine efficiency is proportional to combustion efficiency. To improve the thermal efficiency for braking, other factors such as input power, specific fuel consumption and exhaust temperatures need to be calibrated to their respective optimum values.

## 5. Current energy scenario, need for alternative Fuels and advantages of biodiesel

Rapid escalation of fuel prices, shortage of conventional petroleum-based fuels and depleting hydrocarbon reserve of the world have forced us to look for appropriate technology and alternative fuels to cater the ever increasing demands of energy. By now it has been realized that the internal combustion (IC) engines from an indispensable part for industrial growth. They also play a vital role in our modernized agricultural sector [9]. It is impossible to do away with IC engines at this juncture and alternative fuels must be sought to ensure safe survival of the existing engines.

As has been described earlier our energy needs are growing and individual energy consumption. The ever increasing expenditure on the fuel oil imports is causing economic imbalance, price hike and hardships for the people [10],[11],[12]. At the same time, emissions produced from the burning automobiles and for decentralized power production are contributing a lot to climatic changes and bringing about change in the atmosphere, even stringent conservation methods have not been able to eliminate our need for energy [12],[13]. Hence other viable options need to be explored. In this context alternative energy technologies offer a promising solution.

## Conclusion

The maximum brake mean effective pressure (BMEP) obtained with the biodiesel was slightly higher than that obtained with the diesel fuel, with the difference being just slight under maximum power. While biodiesel increase the maximum engine power, it reduces the brake specific fuel consumption. Changes of maximum cylinder pressure have occurred at the same magnitude for both fuels for the same engine speeds. The best engine performance for biodiesel operates at the engine speed of 2000 rpm to 2500 rpm. The overall analysis has shown that biodiesel has potential as an alternative fuel in conventional internal combustion engines.

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