

Study on Effect of Injection Pressure on Performance Characteristics of Diesel Engine Using Different Blends of Biodiesel

Suchith Kumar M T¹, Dhananjaya D A²

¹ Assistant Professor, Department of Mechanical Engineering, Adhichunchangiri Institute of Technology
Chikmagalur-577101, INDIA

² Vice Principal, Professor, Department of Mechanical Engineering, Rajeev Institute of Technology
Hassan-573201, INDIA

Abstract: In the modernized world energy used in the engines are limited and decreasing gradually. This leads to search of an alternate fuel for Diesel Engine. Biodiesel is a promising alternate fuel. The present work investigates the prospectus of making biodiesel from Calophyllum oil by transesterification process and conducting property test to the obtained biodiesel. Performance of Diesel engine using different biodiesel blends by varying Injection opening pressure. Parameters like Brake Specific fuel consumption, Brake Thermal Efficiency were measured at different loads at constant speed for pure diesel and blends of biodiesel.

Keywords: Transesterification, Injection opening pressure, Brake Thermal Efficiency

I. Introduction

Depletion of fossil fuels leads to search of an alternate fuel. Not only in Development towards Internal combustion Engine, discover of an opposite fuel is a must. Since Biodiesel is an alternate renewable fuel, it can bring revolutionary towards world energy crisis. The esters of vegetable oils and animal fats are known as biodiesel. The properties of Biodiesel are almost similar to that of Diesel. Biodiesel is easily available and causes less environmental damages than Diesel because it has low sulphur content. Biodiesel improves lubricity and raises the cetane number. Biodiesel extracted from a Calophyllum Inophyllum seed is a promising biodiesel. Calophyllum Inophyllum trees are grown near southern coastal region of India. It is a Medium sized tree averages 8-20 m in height with a broad spreading crown of irregular branches. An annual yield of seeds from this tree is 20-100 kg/tree. Injection Pressure plays a vital role in performance and emission characteristics of a diesel engine. As Injection Pressure is increased size of the fuel droplet will decrease resulting in proper mixing of fuel with air. Increase in Injection pressure will increase the fuel efficiency.

II. Transesterification

Transesterification is a process where fatty acids are converted to monoesters. The reaction is done, triglycerides in raw oil reacts with alcohol in presence of catalyst Sodium hydroxide or Potassium hydroxide to produce a monoester and Glycerol as a byproduct. Usually Methanol or Ethanol is used for their availability and better properties. Viscosity of the oil has been improved after transesterification. After the transesterification process the conducted biodiesel and glycerol is separated and the biodiesel is washed several times with hot water to remove the dissolved salts and acid content and later the washed biodiesel is heated up to 110⁰ C to remove the water content if present.

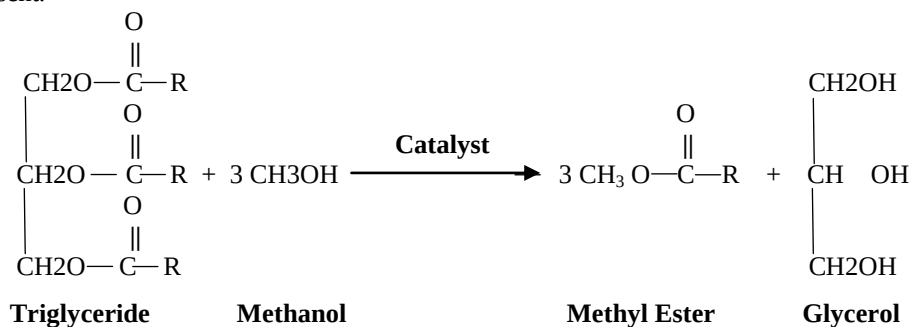


Figure 1: Transesterification Process

In this present work, Calophyllum Inophyllum oil (CIO) undergoes transesterification process reacting with Methanol and Sodium Hydroxide as a Catalyst to form Calophyllum Mono Methyl Ester (CIME) and Glycerol as a byproduct. Obtained CME properties are tested and compared with the diesel, show in Table 1

Property	Unit	Diesel	CIME
Density at 30 ⁰ c	Kg/m ³	812	900
Viscosity at 40 ⁰ c	cst	2	4.43
Flash point	⁰ C	58	173
Fire point	⁰ C	62	181
Calorific value	kJ/kg	43200	38799
Specific gravity	-	0.812	0.9

Table 1 : Properties of Diesel and Biodiesel

III. Experimental Setup

Engine used to performance test is Kirloskar make, single cylinder, four stroke, constant speed of 1500 RPM diesel engine. Engine is water cooled 3.5kW diesel engine. Load measurement is done by using Eddy current dynamometer. Specifications of the engine are shown in Table 2. Engine Model is shown in Figure 2. Experimentation is done by considering three different Injection Pressures. Injection pressure of the engine, 150 bar, set of the readings were taken at different loads by maintaining the constant speed. Later on it was increased by 20% i.e., 180 bar and the experiment is repeated. Then decreased by 20% i.e., 120 bar and readings were noted down.

Particulars	Specifications
Make	Kirloskar
General details	4- stroke, Direct injection, Compression ignition
Number of cylinders	One
Bore	80 mm
Stroke	100 mm
Cooling system	Water cooled
Output	3.5 kW at 1500 RPM
Dynamometer	Eddy Current Dynamometer
Injection Pressure	150 bar
Compression Ratio	17.5

Table 2: Engine Specifications



Figure 2: Engine Model

IV Results and Discussions

A. Brake Specific Fuel Consumption:

The variation of Brake Specific Fuel consumption (BSFC) for different loads is shown in Fig 3, Fig 4 and Fig 5 for IOP of 120 bar, 150 bar and 180 bar respectively. As shown in Fig3, Fig 4 and Fig 5, it is clearly observed that BSFC is decreasing as load is increased because Percentage of fuel required to operate the engine is less than the percentage increase in brake power due to relatively less portion of the heat losses at higher loads [4,5]. BSFC for Biodiesel Blends is lower than the Diesel for all the Injection Opening Pressure because fraction change in fuel rate which is very small compared to the corresponding change in brake power [1,2]. As observed in Fig 3, Fig 4, and Fig 5, BSFC values for different loads of B20 is nearer to diesel values. Also BSFC at IOP 150 bar is less compare to other IOP.

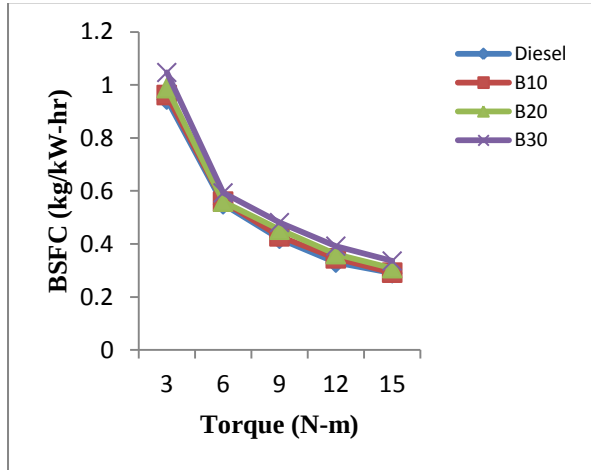


Figure 3: Variation of BSFC for IOP

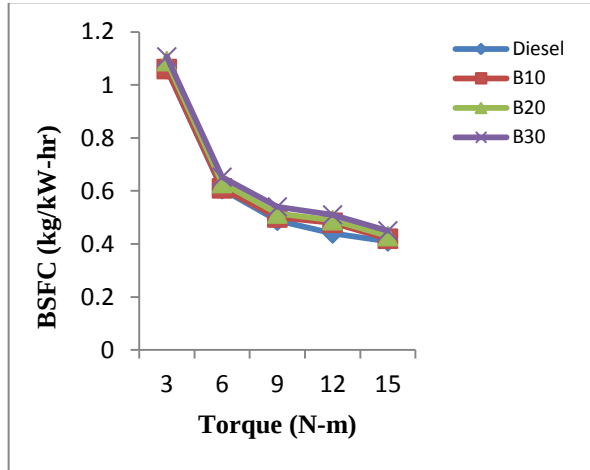


Figure 4: Variation of BSFC for IOP 150bar

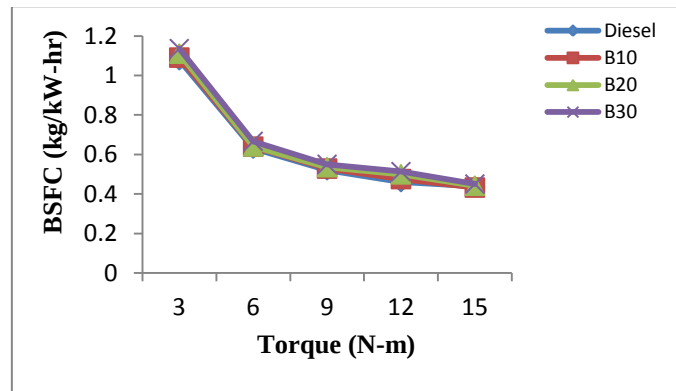


Figure 5: Variation of BSFC for IOP 180bar

B. Brake Thermal Efficiency

The variation of Brake Thermal Efficiency (BTE) for different loads is shown in Fig 3, Fig 4 and Fig 5 for IOP of 120 bar, 150 bar and 180 bar respectively. As shown in Fig3, Fig 4 and Fig 5, it is clearly observed that BTE is increases as the load increases. This was due to reduction in heat loss and increase in power with increase in load [3]. Blend B20 for IOP 150 bar is giving maximum BTE and nearer to Diesel.

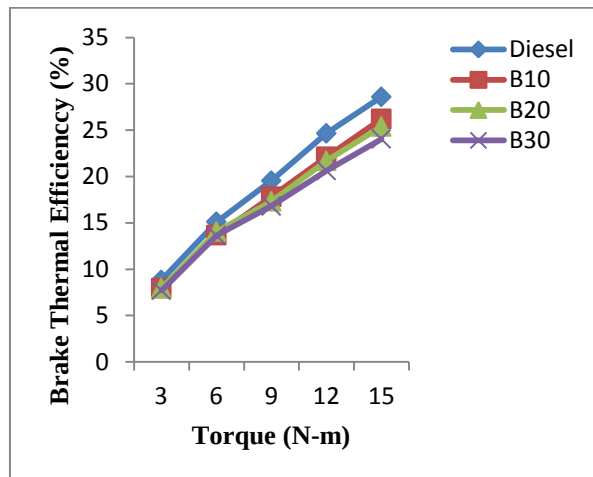


Figure 6: Variation of Brake Thermal Efficiency for IOP 120 bar

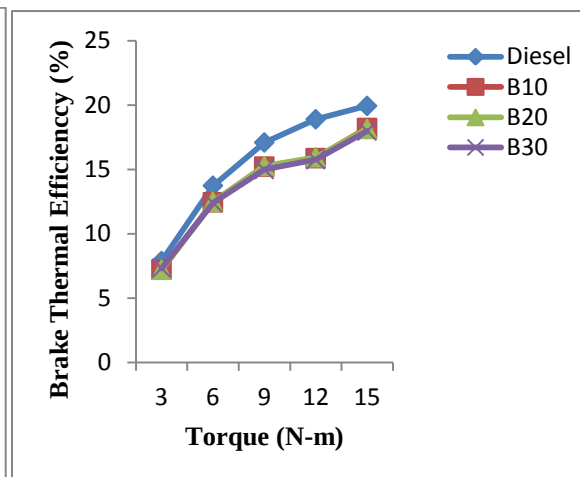


Figure 7: Variation of Brake Thermal Efficiency for IOP 150 bar

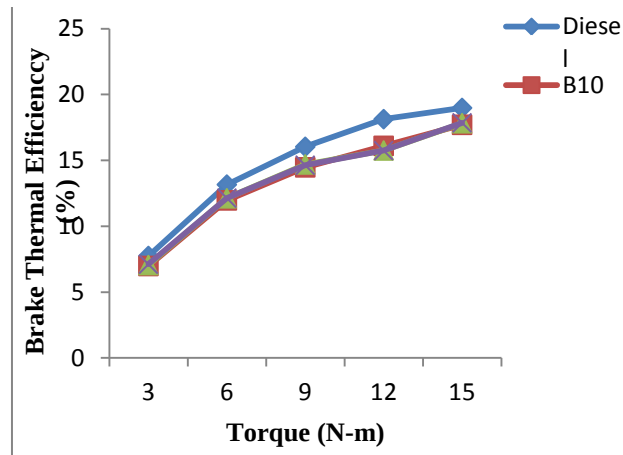


Figure 8: Variation of Brake Thermal Efficiency for IOP 180 bar

V Conclusions

Biodiesel obtained after transesterification has acceptable properties and conducted Performance Test for different IOP on a diesel Engine. Calophyllum Inophyllum is a better alternate fuel and can be used in Compression Ignition Engine. Minimum BSFC is obtained for blend B20 at 150 bar and Maximum BTE is obtained for blend B20 at 150 bar. This concludes that, an optimum pressure of 150 bar is fixed when Calophyllum Inophyllum is used as a fuel for present Compression Ignition Engine. To obtain performance of a Diesel Engine, Blend B20 operating at 150 bar is suggested.

References

- [1] Samaga.B.S Vegetable oil as alternative fuels for the CI engine pp. B-10to B-12, VIII NCICEC, 1983.
- [2] Senthil Kumar, Ramesh.A and Nagalingam.B Experi-mental investigation on a Jatropa oil-Methanol dual fuel engine pp. 1-7, SAE 2001-01-0153,. 2001
- [3] Nanundaiah1 ,Dr.D.K.Ramesha2. Dr. Ranapratap Reddy3 Effect of Injection Pressure on the Performance and Emission Characteristics of Diesel Engine Running on Methyl Esters of Jatropa oil and Diesel Blends
- [4] Agarawal.A.K. and Das.L.M. Biodiesel development and characterization for use as a fuel in compression ignition engines, pp. 440-447, Transactions of ASME, Vol.123, April
- [5] Ramesha D. K., B J Ranganath, N Ranapratapreddy. Characteristics of Ethanol Esterified Pongamia Pinnata and Madhuca Indica Oils for C.I. Engines application. Journal of Middle European Construction and Design of Cars, Nov 03 2007, vol. 5 pp 31-36.
- [6] V.V.Mahajani, "Sustainable development through bio diesel",Institute of chemical Technology, University of Mumbai.
- [7] A.S.Ramdas, S.Jayaraj, C. Muraleedharan, (2004), Use of vegetables oils as IC engine Fuels-A review, Renewable Energy, 29pp 727- 742.