IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
ISSN: 2278-1684, PP: 16-20
www.iosrjournals.org

Prediction of Performance and Emission of Palm oil Biodiesel in Diesel Engine

Sumedh Ingle[1],Vilas Nandedkar[2],Madhav Nagarhalli [3]
[1](*Associate Professor, Dept. of Mechanical Engg.,SRES's College of Engineering, Kopargaon 423603, India,)*
[2](*Professor,Dept. of Production Engg., SGGS Institute of Engg.& Technology, Nanded 431606, India)*
[3](*Professor, Navsahyadri Education Society's Group of Institutes,Faculty of Engg.,Naigaon, Pune, India)*

ABSTRACT: *Recent studies reveal that increasing fuel prices and scarcity of its supply have promoted interest in development of alternative sources for petroleum fuels. Biodiesel is receiving increasing attention each passing day because fuel of properties and compatibility with petroleum- based diesel fuel. Therefore, in this paper the prospects and opportunities of using methyl esters of palm oil as fuel in an engine is studied. In the present research work tests were conducted on a four stroke, single cylinder, D.I. diesel engine with Diesel and various blends of Biodiesel at various preheating temperature. The results of performance and emission tests are compared with various blends of palm oil biodiesel with that of neat diesel. The results indicate that at blend B20 with preheating temperature 60^{O}C, Brake Specific Energy Consumption (BSEC) is lowest and highest exhaust gas temperature as compare to other blends, while neat diesel gives lowest smoke density.*

Keywords*-Brake specific energy consumption, smoke density, eddy current dynamometer, exhaust gas temperature.*

I. Introduction

The present reservation of fuels used in internal combustion (IC) engines including diesel will deplete within 40 years if consumed at an increasing rate. This aspect has drawn the attention to conserve and stretch the oil reserves by conducting research on alternative fuels. In view of this, vegetable oil is a promising alternative because it has several advantages such as it is renewable, environment-friendly and its high yield crops available in rural areas. Therefore, in recent years, systemic efforts have been made by several researchers to use vegetable oils as fuel in engines. Obviously, the use of non-edible vegetable oils compared to edible oils is very significant because of the tremendous demand for edible oils as food and they are far too expensive to be used as fuel at present. Vegetable oil esters are receiving increasing attention as a non-toxic, biodegradable and renewable alternative diesel fuel. These esters have become known as biodiesel [1] [2].

Its use requires virtually no changes in the fuel distribution system and is technically competitive with petroleum-derived diesel fuel. Many studies have shown that the properties of biodiesel are very close to diesel fuel. Therefore, biodiesel can be used in diesel engines with few or no modifications[3][4]. Biodiesel has high viscosity, density, iodine value and poor non-volatility, which leads in pumping problem, atomization problem and poor combustion inside the combustion chamber of a diesel engine. In case of long-term use of vegetable oils in diesel engines, problems such as gumming, injector fouling, piston ring sticking and contamination of lubricating oils are bound to occur. All these problems are due to the high viscosity of vegetable oils. Hence, it is necessary to reduce the viscosity of vegetable oil to be near to that of diesel. The solution to the problems has been approached in several ways, such as preheating the oils, blending them with diesel, thermal cracking and transesterification. Transesterification, or alcoholysis, is the reaction of a fat or oil with an alcohol to form esters and glycerol [5][6]. The literature clearly shows that transesterification is the best way to use vegetable oil as a fuel in existing diesel engine[7]. The objective of this work is to preheat palm biodiesel at various temperature (50^{o} C, 55^{o} C, 60^{o} C) and test the biodiesel blends with petroleum diesel under different loading conditions to derive an optimum fuel-blend in terms of emission and performance.

The properties of Palm oil biodiesel are given in Table 1. [8]

Table 1. Properties of palm oil biodiesel

Density @ 15^0C, kg/m^3	875.1
Viscosity at 40°C, mm^2/s	4.1
Flash Point	175°C
Pour Point	-12°C
Cloud Point	Not Applicable
Specific gravity @15^oC	0.8722
Calorific Value, kJ/kg	37254
Visual appearance	Dark Brown liquid
Ash content	0.001%
Cetane number	52

II. Experiments

The experimentation was carried out to investigate the performance and emission characteristics of palm oil biodiesel. Diesel, Bio-diesel (B100) and its blends B20, B40, B60, B80 were used to test the engine of the specifications mentioned in Table.2. The experiments were conducted on a single cylinder, 4 stroke D.I. diesel engine. No engine modifications were done. The biodiesel is preheated using preheating setup, which is connected to fuel tank of engine. The engine was loaded using the Eddy current dynamometer .The engine speed in rpm was sensed using a sensor pre-installed in the dynamometer and was recorded from the display on the control panel of the dynamometer.

Table 2. Specifications of engine used

Make	Kirloskar
Type	Single-cylinder, four-stroke, compression ignition diesel engine
Stroke	110 mm
Bore	80 mm
Compression ratio	16.5:1
BMEP at 1500 rpm	5.42Bar
Rated output	3.7 kW
Rated speed	1500 rpm
Dynamometer	Eddy current, water-cooled with loading unit

The performance and emission characteristics of the engine were studied at different preheating temperature (50^o C, 55^o C, 60^o C) and different engine loads (25%, 50%, 75% and 100% of the load corresponding to the load at maximum power at an average engine speed of 1500 rpm). At each load, the engine was stabilized for

60 minutes and then performance parameters were measured. The various graphs were plotted between BSEC and Brake mean effective pressure (BMEP), smoke density and BMEP, and also between exhaust gas temperature and BMEP at different preheating temperatures.

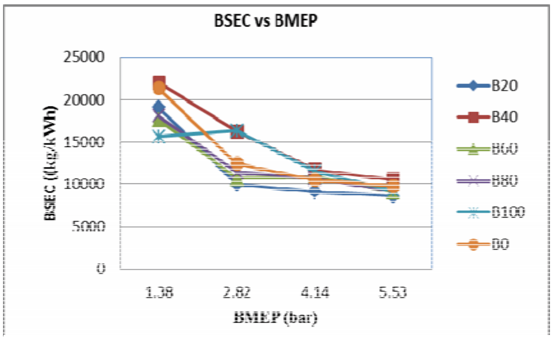

Fig.1.BSEC vs BMEP for 50^{o} C preheating temp.

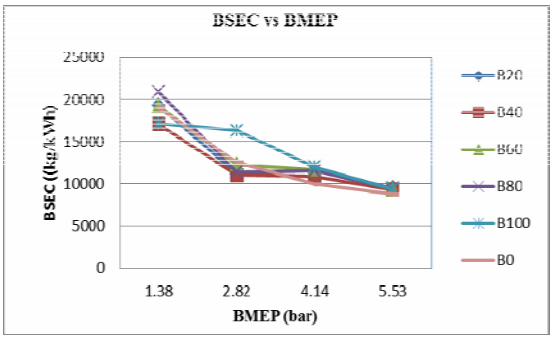

Fig. 2. BSEC vs BMEP for 55^{o} C preheating

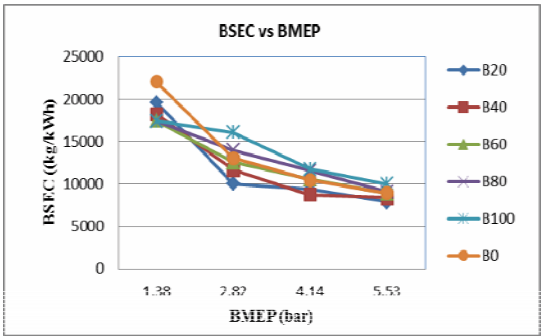

Fig. 3. BSEC vs BMEP for 60^{o} C preheating

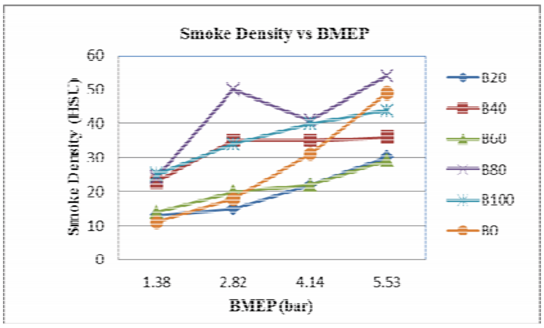

Fig. 4. Smoke density vs BMEP for 50^{o} C

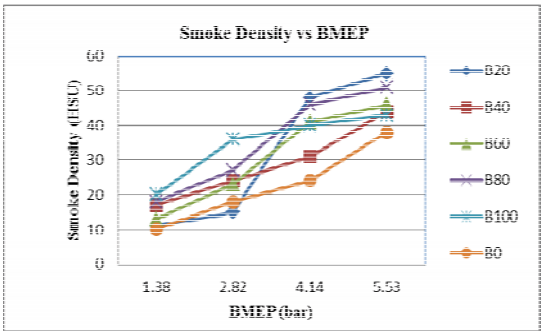

Fig. 5. Smoke density vs BMEP for 55^{o} C

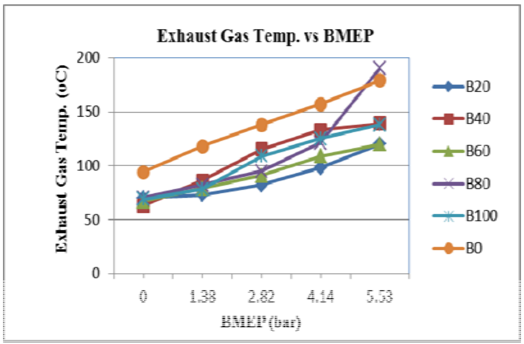

Fig. 6. Smoke density vs BMEP for 60^{o} C

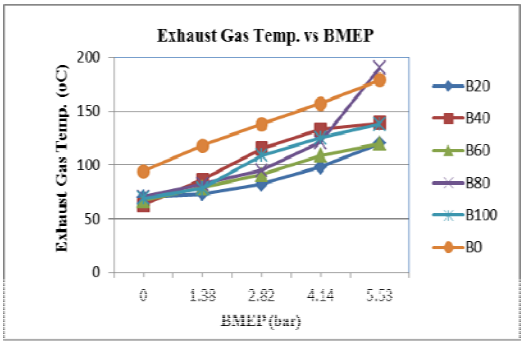

Fig. 7. Exhaust gas temp. vs BMEP for 50° C

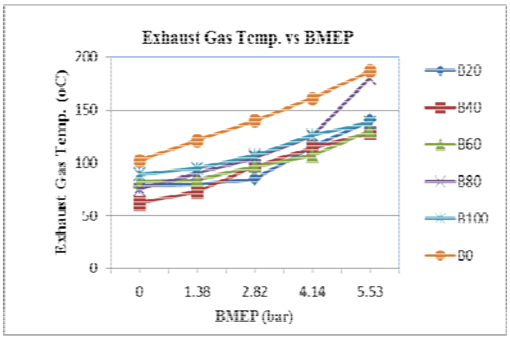

Fig. 8. Exhaust gas temp. vs BMEP for 55° C

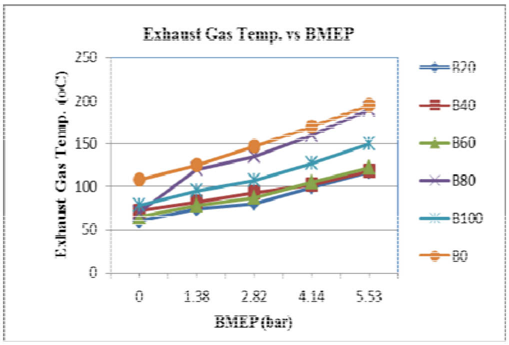

Fig. 9. Exhaust gas temp. vs BMEP for 60° C

III. Results and Discussions

The variation of brake specific energy consumption for all blends of biodiesel and diesel as shown in Fig.1, Fig.2 and Fig.3. The brake specific energy consumption decreases with increase in brake mean effective pressure up to full load (BMEP 5.53 bar).Brake specific energy consumption is lowest for B20 at 60°C with full load and highest for B80 at 55° C with no load.

The variation of smoke density for all blends of biodiesel and diesel as shown in Fig.4, Fig.5 and Fig.6. Smoke density increases with increase in brake mean effective pressure. It is highest for B80 at 60°C and lowest for B20 at 60°C at full load. B20 at 60°C and B40 at 50°C show very gradual increasing (almost flat). B20 at 55°C shows sudden rise in smoke density upto full load. The smoke is formed due to incomplete combustion of fuel.

Exhaust gas temperature indicates amount of waste heat going with exhaust**.** The variation of exhaust gas temperature with brake mean effective pressure is shown in Fig.7, Fig.8 and Fig.9. The exhaust gas temperature increases with increase in brake mean effective pressure up to full load (BMEP 5.53 bar). Neat diesel at 60°C shows the highest exhaust gas temperature at full load. This may be due to chemical composition of palm oil biodiesel, which promotes the combustion process.

IV. Conclusion

Biodiesel is a eco-friendly, bio-degradable, non-toxic, sulphur free & renewable alternative fuel. Palm methyl ester blends (PMEB) showed performance and emission characteristics close to diesel. Therefore PMEB can be used in CI engine for meeting energy demand. The present work concludes as follow:

i) At full load, B20 at 60°C, shows the lowest brake specific energy consumption of all the blends but is greater than that of diesel.

ii) Neat diesel (B 0) at 60°C shows the highest exhaust gas temperature at full load. iii) B20 at 60°C at full load shows lowest HSU reading.

In totality at preheating temperature 60° C, blend B20 and neat diesel shows an optimized trend for almost all parameters. The use of palm oil creates a need to increase palm oil sources. This in turn local production of biodiesel will save a huge amount of foreign exchange and increase the employment potential. This capital when invested in country will improve its financial structure.

Abbreviation (for figures)

B0 - Diesel

B20 - Palm Biodiesel 20% +Diesel 80% B40 - Palm Biodiesel 40% +Diesel 60% B60 - Palm Biodiesel 60% +Diesel 40% B80 - Palm Biodiesel 80%+Diesel 20% B100- Palm Biodiesel 100%
BSEC - Brake Specific Energy Consumption (kJ/kW h) PMEB - Palm Methyl Ester Blends
BMEP – Brake Mean Effective Pressure (bar)

References

[1]. Roila Awang, Choo Yuen May, "Effect of hydroxylated Compounds on properties and Emission of Palm Oil Biodiesel", *American Journal of Applied Sciences, vol no-4*, 2007, 99-101, ISSN 1546-9239.

[2]. A.K.Babu, G. Devarao. : Vegetable Oils and Their Derivatives as Fuels for CI Engine: An Overview: *SAE 2003-01-0767*.

[3]. M.V.Nagarhalli, V.M.Nandedkar, K.C.Mohite.: Emission and Performance characteristics of Karanja Biodiesel and its blends in CI engine and its economics" *ARPN journal of Engineering and Applied science,5(2),* Feb. 2010,52-56.

[4]. A.K. Agarwal, L.M. Das, "Biodiesel Development and Characterization for Use as a Fuel in Compression Ignition Engines." *Alternative Fuels and Emission Control, vol. no.123,* April-2001, 440-447.

[5]. Mohammed Harun Chakrabarti, Mehmood Ali, "Performance of Compression ignition engine with indigenous castor oil Biodiesel in Pakistan", *NED University Journal of research, 4(1),* (2009), 10-19.

[6]. Ingle S, Nandedkar V.M, "Indigenous Castor oil Biodiesel an alternative fuel for Diesel Engine" *International journal of Mechanical and Industrial Engineering, ISSN no. 2231-6477, 2(2)*, 2012, 62-64.

[7]. Yusuf Ali, M.A. Hanna.: Alternative Diesel Fuels From Vegetable Oils", *Bioresource Technology, paper no- 0960-8524(94)00072-7 50 (1994), 153-163.*

[8]. M.A. Kalam, H.H. Masjuki,.: Biodiesel from Palm Oil- an analysis of its properties and potential", *Biomass and Bioenergy, vol. no.23,* 2002 ,471- 479.