PREDICTION OF PERFORMANCE AND EMISSION OF CASTOR OIL BIODIESEL IN DIESEL ENGINE

[1]SUMEDH S. INGLE, [2]VILAS M. NANDEDKAR, [3]MADHAV V.NAGARHALLI

[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
Email: sumedhi@rediffmail.com, vilas.nandedkar@gmail.com, nagarhalli@rediffmail.com

Abstract: The resources of petroleum as fuel are dwindling day by day and increasing demand of fuels, as well as increasingly stringent emission regulations, pose a challenge to science and technology. This aspect has drawn the attention to conserve and stretch the oil reserves by conducting research on alternative fuels. Therefore, in this paper the prospects and opportunities of using methyl esters of castor oil as fuel in an engine are studied. In the present work tests were conducted on a four stroke, single cylinder, D.I. diesel engine with Diesel and various blends of castor oil biodiesel. The results of performance and emission tests are compared for various blends of castor oil biodiesel with that of neat diesel. The results indicate that at blend B60, Brake Specific Energy Consumption (BSEC) is lowest with highest exhaust gas temperature and lowest smoke opacity as compared to other blends

Keywords-Brake specific energy consumption, smoke density, exhaust gas temperature.

I. INTRODUCTION

Current study focuses that biodiesel and its derivatives, have received much attention in recent years for diesel engines. Biodiesel is an oxygenated diesel engine fuel that can be obtained from vegetable oils or animal fats by conversion of the triglycerides to esters via transesterification. It has similar properties to those of fossil diesel. Therefore, research on biodiesel derived from vegetable oils and animal fats lead to the study of alternative to petroleum based diesel fuels [1][2]. It has been reported by the results of many studies that biodiesel can be used in diesel engines with little or no modifications, and with almost the same performance. Besides it reduces carbon monoxide (CO), unburned hydrocarbons (HC) and smoke emissions. However, a majority of results stated an increase in nitrogen oxides (NOx). The results vary according to the base vegetable oil or animal fats, the process of biodiesel production as well as biodiesel fuel properties. Therefore different blends of biodiesels and neat diesel were tested in diesel engines at different engine loads [3][4].

On the other hand, biodiesel has high viscosity, high density, lower calorific 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 [5][9]. All these problems are due to the high viscosity of vegetable oils. Hence, it is necessary to reduce the viscosity of vegetable oil to a more approximate value 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 [5][7].

Transesterification is a process of using an alcohol, viz. methanol, ethanol or butanol in presence of a catalyst, such as sodium hydroxide (Na OH) or potassium hydroxide (K OH), which chemically breaks the molecule of raw renewable oil into methyl or ethyl esters of the renewable oil with glycerol as a byproduct, reducing the viscosity of the oil. As the properties this oil are very much similar to that if petroleum diesel it is known as 'Biodiesel' [10].

In the present study the biodiesel derived from castor seed oil has been used. To find out the performance of biodiesel prepared from castor seed oil, testing was undertaken with single cylinder compression ignition engine at an average constant speed of 1500 rpm at different loads and for various blends of petroleum diesel and castor oil biodiesel.

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

Table 1. Properties of Castor oil biodiesel

Density @ 15^0C	0.9268 g/cm^3
Flash Point	190.7°C
Calorific Value	37908 kJ/kg
Ash content	0.02 %
Viscosity at 40°C	15.98 mm^2/s
Pour Point	-45°C
Visual appearance	Viscous pale yellow
Cetane number	50

II. EXPERIMENTS

Experiments were carried out on a single cylinder, vertical, 4-stroke cycle, single acting, totally enclosed, water-cooled, compression ignition engine.

Diesel, biodiesel (B100) and its blends B20, B40, B60, and B80 were used to test the engine of the specifications mentioned in Table.2. The performance and emission characteristics of the engine were studied at 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 20 minutes and then measurement parameters were recorded. The exhaust of the engine was tested using a Hartridge smoke-meter of Netel make. The engine was loaded using the eddy current dynamometer. According to the results obtained, the graphs between BSEC and BMEP, exhaust gas temperature and BMEP and Smoke opacity and BMEP are plotted.

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	5.42 bar
Rated output	3.7 Kw
Rated speed	1500 rpm
Dynamometer	Eddy current,water-cooled with loading unit

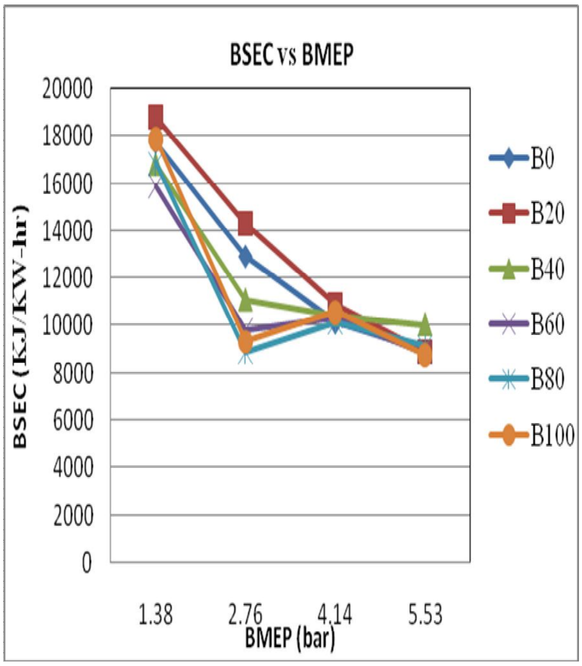

Figure 1. Graph of BSEC vs BMEP.

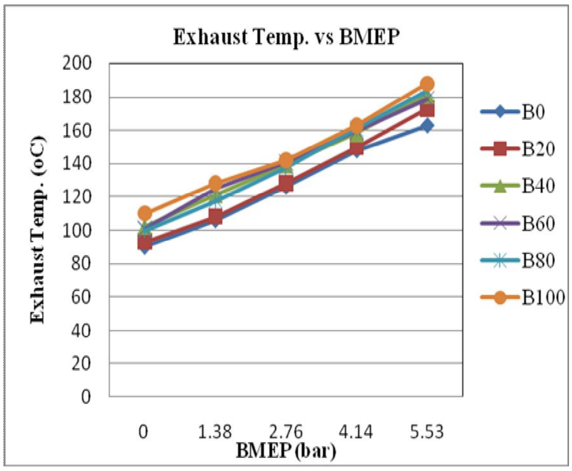

Figure 2. Graph of Exhaust gas temperature vs BMEP.

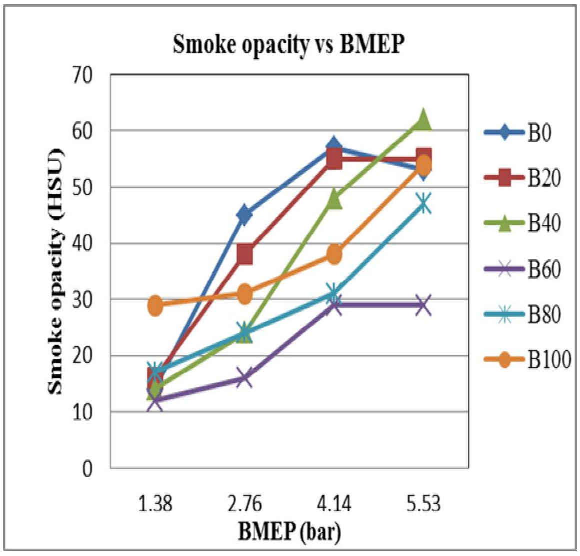

Figure 3. Graph of Smoke opacity vs BMEP.

III. RESULTS AND DISCUSSION

BSEC with respect to load for different blends as shown is Fig.1 brake specific energy consumption decreases with increase in brake mean effective pressure up to full load. At atmospheric temperature B60 shows lowest BSEC. It was observed that as biodiesel percentage increases BSEC decreases.

The variation of exhaust gas temperature with respect to applied loads for different blends as shown in Fig. 2. It is observed that with increase in load exhaust gas temperature also increases. This reveals that the effective combustion is taking place in the early stage of strokes and there is reduction in the loss of exhaust gas energy. When biodiesel concentration is increased, the exhaust gas temperature increases by same value, but for blend B80 shows low exhaust gas temperature at all loads. The highest exhaust gas temperature is observed at B60 blend at full load. The higher exhaust gas temperature may be because of better consumption of the castor methyl ester as it contains oxygen molecule which helps in proper consumption.

The variation of smoke opacity with respect to BMEP as shown in Fig. 3. Smoke opacity increases with increase in brake mean effective pressure. At atmospheric temperature, B60 shows less smoke opacity as compared to other blends.

CONCLUSION

The research aims to study the performance and emission of castor biodiesel and its different blends with diesel and find the optimum blend to be used in diesel engine. At atmospheric temperature B60 shows optimum performance for use in compression ignition engines. The overall characteristics of castor oil biodiesel and diesel are similar. Hence biodiesel is a 'New Era Fuel' of tomorrow and which will reduce our dependence on oil producing countries. These plants do not require more water and can be grown on barren land. A large part of barren Government land can be leased to the unemployed youth and the yield can be sold at lower price to produce a large quantity of biodiesel. This will make country self sufficient and less dependent of imported fuel apart from savings in valuable foreign exchange.

Abbreviation (for figures)

B0 - Diesel
B20 - castor Biodiesel 20% + Diesel 80%
B40 - castor Biodiesel 40% +Diesel 60%
B60 - castor Biodiesel 60% +Diesel 40%
B80 - castor Biodiesel 80%+Diesel 20%
B100- castor Biodiesel 100%
BSEC - Brake Specific Energy Consumption (kJ/kW h)
BMEP – Brake Mean Effective Pressure (bar)

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