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Performance and Emission Analysis of Palm Biodiesel Engine

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ABSTRACT

The Growing rate of population and increasing demand of resources in terms of fuel catches attention of researcher to search for a renewable alternative fuel. Therefore, in this research paper the prospects and opportunities of using palm biodiesel in an engine are studied. The experimentation was conducted on a four stroke, single cylinder, D.I. diesel engine with Diesel and various blends of Palm biodiesel. The analysis of performance and emission of various blends of palm biodiesel and neat diesel was carried out. The results reveal that at blend B20, the better performance and less emission are obtained as compared to other blends.

Keywords: BTE, BSFC, smoke density, NOx, Palm biodiesel etc.

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 trans esterification. 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.

The results vary according to the base vegetable oil or animal fats, the process of biodiesel production as well as biodiesel fuel properties [3][5].

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 [6][9][10]. Due to the high viscosity of vegetable oils all these problems occur. 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 trans esterification [7][8][11].

In the present research study the biodiesel derived from palm seed oil has been used in diesel engine to analyze the performance and engine characteristics. The properties of Palm biodiesel are given in Table 1. [4]

Table 1. Properties of palm biodiesel [4]

Calorific Value, kJ/kg	37254
Density @ 15^{0}C, kg/m^3	875.1
Calorific Value, kJ/kg	37254
Specific gravity @15^{o}C	0.8722
Pour Point	-12°C
Flash Point	175°C
Viscosity at 40°C, mm^2/s	4.1
Cetane number	52
Visual appearance	Dark Brown liquid

METHODOLOGY

The experimentation was carried out to analyze the performance and emission characteristics of palm oil biodiesel. Biodiesel (B100) and its blends B20, B40, B60, and 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. During experimentation palm biodiesel was preheated and maintained at 50^{0}C. 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

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

The constant engine load corresponding to various blends of biodiesel was maintained. At each blend, the engine was stabilized for 60 minutes and then performance and emission parameters were measured. The various graphs were plotted between Brake thermal efficiency and BMEP, BSFC and BMEP, Smoke density and BMEP and between NOx and BMEP as shown in figure 1, figure 2, figure 3 and, figure 4.

RESULTS AND DISCUSSION

Brake Thermal Efficiency:

The variation of Brake thermal efficiency with brake mean effective pressure for different blends are shown in figure 1 In all cases it increases with increase in brake mean effective pressure up to full load (BMEP 5.53 bar). This is due to a reduction in heat loss and increase in power with increase in load. The lower brake thermal efficiency obtained for B0, due to reduction in calorific value and increase in fuel consumption at full load. The maximum brake thermal efficiency is observed for blend B20 at full load.

Brake specific fuel consumption:

The variation of brake specific fuel consumption is shown in figure 2. For all blends tested, brake specific

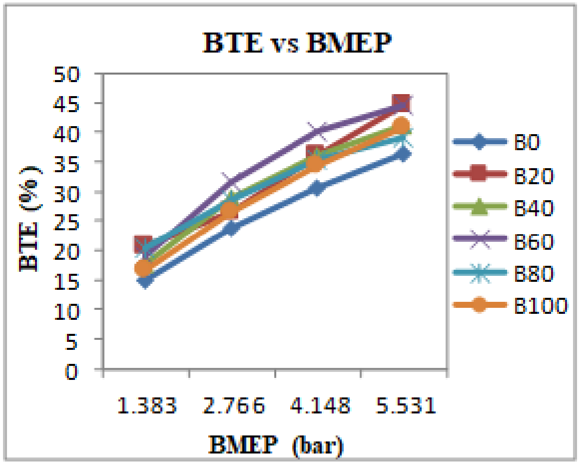

Fig.no. 1. BTE vs BMEP

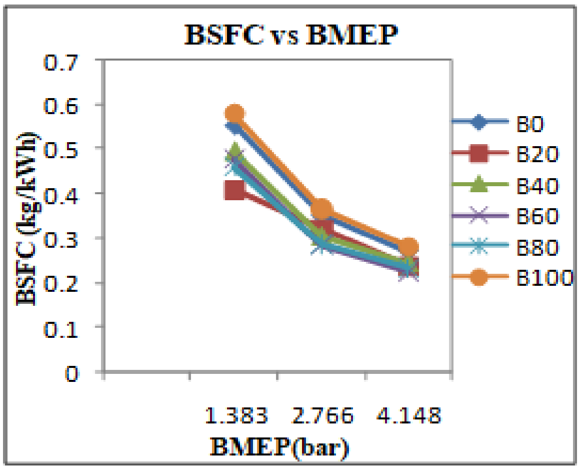

Fig. no. 2. BSFC vs BMEP

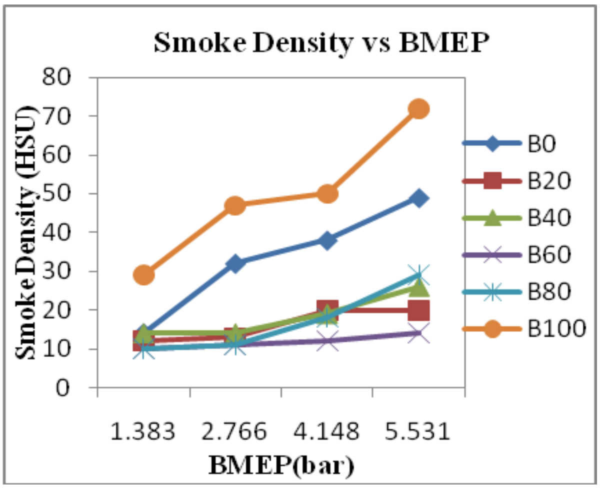

Fig. 3. Smoke Density vs BMEP

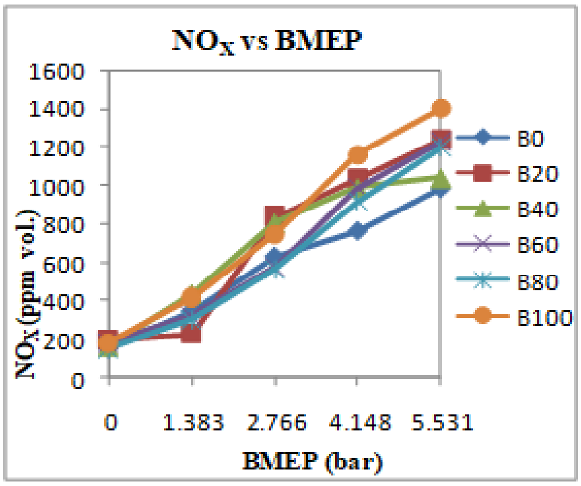

Fig. 4. NOx vs Biodiesel blend

fuel consumption decreases with increase in brake mean effective pressure up to full load (BMEP 5.53 bar). This reduction is due to the higher percentage of increase in brake power with load as compare to fuel consumption. The overall characteristics of palm biodiesel and diesel are similar. The lowest Brake specific fuel consumption is predicted for B20 at full load. Also, highest Brake specific fuel consumption is observed at B100. This is due to the combined effect of low heating value and high density of palm biodiesel.

Smoke density:

The variation of smoke density is shown in figure 3. For all blends tested, smoke density increases with increase in brake mean effective pressure. As blending proportion increases from 0 to 100 percents, smoke also increases. This increase in smoke is more at low loads as compared to high loads. The smoke is formed due to incomplete combustion of fuel. It is highest for B100 and lowest for B20 at full load. The reason for decreasing exhaust emissions with palm biodiesel blends is the presence of oxygen (O_2) in the biodiesel.

Nox:

The variation of NO_x is shown in figure 4. It is observed that as load increases the NOx formation increases and attains maximum at full load. At full load NOx is highest for B100 and lowest for B20. B80 shows sudden rise in NO_x at full load for preheating temperatures. This may be due to small amount of nitrogen contents present in Palm biodiesel, which contributes towards NOx production.

CONCLUSION

It can be concluded that, Due to preheating the viscosity of palm biodiesel blend decreases, which helps to improve the performance of engine. Also from overall observations it can be stated that B20 blend of palm biodiesel shows an optimized trend in almost all parameters at 50^{O}C preheating temperature and 16.5 compression ratio. The use of palm oil creates a need to increase palm oil sources. This in turn will increase the use of waste land productivity and generate rural employment and increase the countries' GDP. Local production of biodiesel will save a huge amount of foreign exchange. This capital when invested in country will improve its financial structure.

ABBREVIATION

B0 - Diesel 100%

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%

BSFC - Brake Specific Fuel Consumption (kg/kW h)

BTE – Brake Thermal Efficiency (%)

Nox – Nitrogen oxide (ppm)

Conflicts of interest: The authors stated that no conflicts of interest.

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