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Research Article

Emission Characteristics of Compression Ignition Engine by using Palm Bio-Diesel

P.Arumugam†*, K.Patterson†, R.Saravanan † and G. Harish †

†Department of Mechanical Engineering, Christ college of Engineering Technology, Puducherry-605 010, India

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Abstract

Environmental concerns and energy crisis of the world has led to the search of alternate to the fossil fuel. FAME (Fatty Acid Methyl Ester) is environment friendly, alternative, and non-toxic, safe; biodegradable has a high flash point and is also termed as Bio-Diesel. The growing economic risk of relying primarily on fossil fuels with limited reserves and Increasing prices has increased the interest on alternative energy sources. Clean and renewable biofuels have been touted as the answer to the issue of diminishing fossil fuels. INDIA the largest producer of palm oil has committed to focus interest on biofuels, namely palm biodiesel. Since palm oil has a high fossil energy balance, it is a key source of raw material for biodiesel production. This paper presents palm biodiesel as an alternative source of green renewable energy through a survey conducted from previously researched findings. In this experimental study testing of emission characteristics and performances test of palm Bio-diesel at various ratios form (B25%, B 50%, B75%, B100%) of Bio-diesel. As we compared with fossil fuel (diesel) and palm bio-diesel on base of various emission elements (CO, CO_2, NO_x, O_2, and HC).

Keywords: *Emission Characteristics, Compression Ignition Engine, Bio-Diesel etc.*

1. Introduction

The world consumption of petroleum fuels has hence increased enormously in the past few decades. Petroleum fuels, for all their advantages, also present serious problems. They are fossil fuels which are bound to be ultimately depleted. Petroleum deposits are very unevenly distributed in the world. For India, the only viable long-term solution to this problem is to develop alternative sources of energy, preferably renewable, which are located in our territory. In this regard, non-edible vegetable oils can be a partial replacement for diesel oil, which forms such an important input for our transportation and agriculture operations. Vegetable oils have the following advantages as a substitute for diesel oil: They are easily handled liquid fuel with properties close to those of diesel oil in many respects.

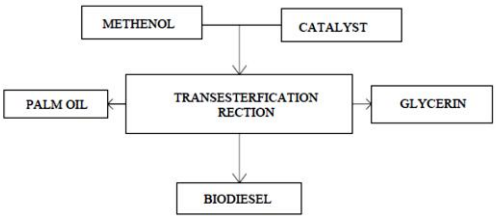
1) They are a renewable source of energy.
2) They mix easily with diesel oil. Hence they can be used in the blended form also.
3) They can be produced in rural areas by well-known agriculture practices. The extraction of the oil from the plants seeds is a relatively simple process which can also be carried out in rural areas.

*Corresponding author: **P.Arumugam**

Biodiesel production is the process of synthesizing biodiesel. Biodiesel is a Liquid fuel source largely compatible with petroleum based diesel fuel. The most Common method for its manufacture is synthesis by reacting glyceride-containing plant Oil with a short chain alcohol such as methanol or ethanol in a step known as Transesterification. The price of fossil diesel is soaring in these two years and it will be exhausted someday. Biodiesel is becoming a developing area of high concern. We are currently in the midst of a rapid evolution in the transportation sector. Over the next 10 to 20 years, the efforts to improve efficiency, fuel economy and reduce emissions will be the dominant factors driving change in engine and fuel technology. Over time, the most effective means of meeting the efficiency and emission goals will become clear, however, the direction for change is apparent and some of the first steps required for engines and fuel technology are well known.

A key factor that is enabling the evolution in both the engine and the fuel is the development of effective fuel additive technology that allows for the production and safe distribution of quality transportation fuel and ensures optimal engine performance.Rudolph Diesel, a German engineer, introduced the diesel engine over a century Ago (Nitske and Wilson, 1965). He tested vegetable oil as the fuel for his engine (Shay, 1993). Many researchers have concluded that vegetable oils and their derivatives hold Promises as alternative fuels for diesel engines rather than spark-ignited engines due to their low volatility and high cetane number (Wagner *et al*., 1984, Scholl and Sorenson,1993; Bagby *et al*., 1987).

2. Methodology



Transesterification of natural glycerides with methanol to methyl esters is a technically important reaction that has been used extensively in the soap and detergent manufacturing industry worldwide for many years. Almost all biodiesel is produced in a similar chemical process using base catalysed Transesterification as it is the most economical process, requiring only low temperatures and pressures while producing a 98% conversion yield.

The Transesterification process is the reaction of a triglyceride (fat/oil) with an alcohol to form esters and glycerol. A triglyceride has a glycerine molecule as its base with three long chain fatty acids attached. The characteristics of the fat are determined by the nature of the fatty acids attached to the glycerine.

During the esterification process, the triglyceride is reacted with alcohol in the presence of a catalyst, usually a strong alkaline like Potassium hydroxide. The alcohol reacts with the fatty acids to form the mono-alkyl ester, biodiesel, and crude glycerol. In most production, methanol is alcohol used (methanol produces methyl esters) and is base catalysed by either potassium. Potassium hydroxide has been found more suitable for the ethyl ester biodiesel production.

Preparation of Palm Bio-Diesel

The step by step process for preparation of bio diesel,

Step 1
Heating of Oil

Step 2
Mixing of methanol and catalyst (meth oxide)

Step 3
Heating and mixing (preparation of methyl ester)

Step 4
Settling and separation

Step 5
Draining of Glycerol
Step 6
Washing of Biodiesel

3. Experimental set up and test procedure

The experimental set up consists of a single cylinder four-stroke, water-cooled and constant-speed (1500 rpm) compression ignition engine. The detailed specification of the engine is given below;

Make	:	Kirloskar
Type	:	Four Stroke
Number of Cylinder	:	Single Cylinder
Type of Cooling	:	Water Cooled
Rated Power	:	5.4 kW
Rated Speed	:	1500 rpm
Loading Device	:	Eddy Current Dynamometer
Bore x Stroke	:	87.5 mm x 110 mm
Injection Pressure	:	220 kgf/cm^2
Ignition timing	:	23° beforeTDC (rated)
Ignition system	:	Compression Ignition

Experiments were initially carried out on the engine using diesel as a fuel to provide base line data. Under steady state conditions, the fuel consumption rate, air consumption rate, speed, exhaust gas temperature were recorded at various loads. The engine speed was held at 1500 rpm and the power output was varied. The engine was next run with various blends and the performance tests were carried out as before. Emissions like HC, NO_x, etc., and cylinder pressure, heat release rate, and smoke density were measured. The different parameters like specific energy consumption, power, efficiencies, Heat release rate, NO_x concentration, HC concentration are determined at various load conditions. The results obtained are weighed with those under pure diesel mode of operation. The Eddy current dynamometer was used for loading the engine.

Fuel consumption was measured on a volumetric basis using a burette and a stopwatch. Air flow was measured using an orifice flow meter. A series of experiments were carried out using diesel and the various blends. All the blends were tested under varying load conditions at the rated speed. During each trial, the engine was started and after it attains stable condition, important parameters related to thermal performance of the engine such as the time taken for 10 cc of fuel consumption, applied load, etc., the emission data were measured and recorded.

4. Results and discussions

4.1 Emission Analysis

Carbon Monoxide Emission

The carbon monoxide emissions were due to the incomplete combustion. Insufficient oxygen in the air/fuel mixture resulted in incomplete combustion. Fig2. Shows that in the B25 blend, there was less oxygen for the carbon atoms to bond and form CO_2. The carbon atoms bond with only one oxygen atom and carbon monoxide (CO) was formed. Other causes of CO emission include leakage injector, high fuel pressure, Improper closed loop control etc.

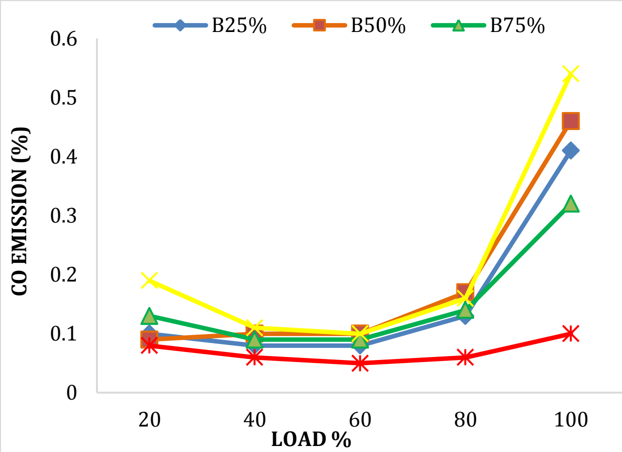


Fig 1 Variation of co emission with load for different blends

Hydro Carbon Emission

The HC emission variations were found to be lower than diesel fuel. The higher cetane number of the mustard biodiesel resulted in the less HC emission due to reduced ignition delay. Fig 3 reveal that the higher temperature of the burnt fuel will prevent the condensation of the hydrocarbon, reducing the emission of unburned hydrocarbon.

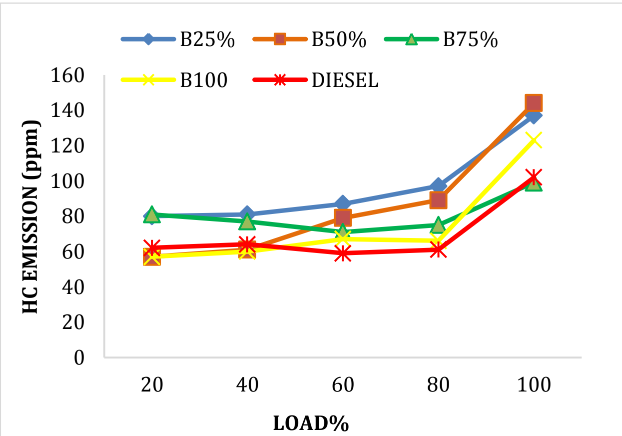


Fig 2 Variation of HC emission with load for different blends

Carbon Dioxide Emission

The CO_2 emission of the mustard biodiesel blends from the CI engine was found to be lesser than the diesel emission. The less CO_2 emission of the biodiesel indicated the incomplete fuel combustion. This was due to the oxygen content of mustard biodiesel, which is disimproved the fuel combustion. When the blend ratio was increased the CO_2 emission was reduced because of higher viscosity. Oxygen should not be either too high or too less which will lead to less combustion whenever there is too lean or too rich mixture of air and fuel incomplete combustion occurs.

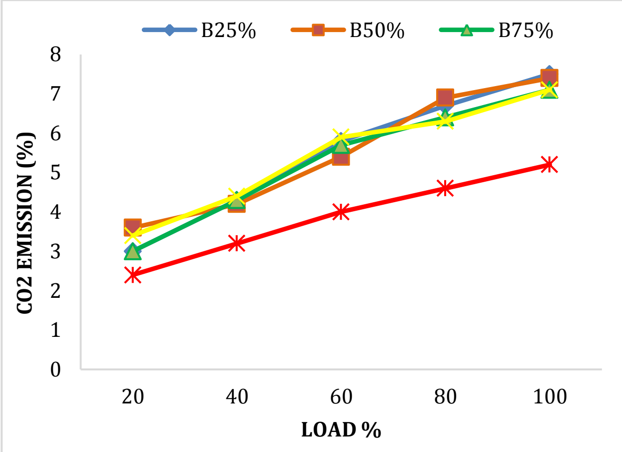


Fig 3 Variation of CO_2 emission with load for different blends

Oxides of Nitrogen Emission

The NO_x emission of mustard biodiesel was lesser than the diesel which was due to the oxygen content in the fuel blends which disenables NO_x formation fuel injection timing also plays a role in the NO_x emission. The high cylinder temperature and pressure which occurs during combustion process can cause nitrogen to react with oxygen to form (NO_x). Usually NO_x is emitted during heating load condition at their highest proper exhaust air recirculation operation, rich fuel mixture, less temperature intake air, less heated engine etc.,. It's some of the gases at which NO_x is lessly emitted. Blend biodiesel B75 and B100 has shown decreased NO_x emission respectively due to oxygen content and rich fuel mixture.

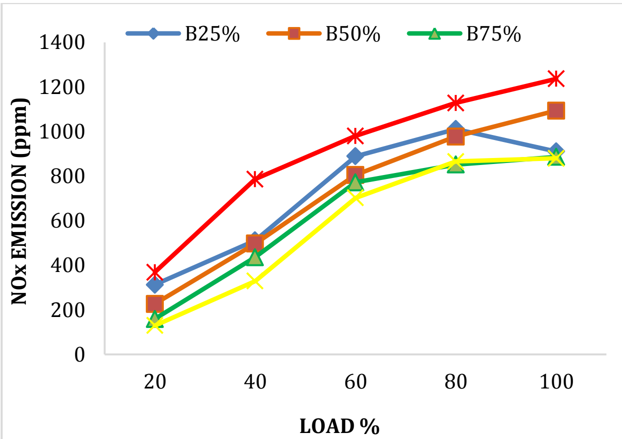
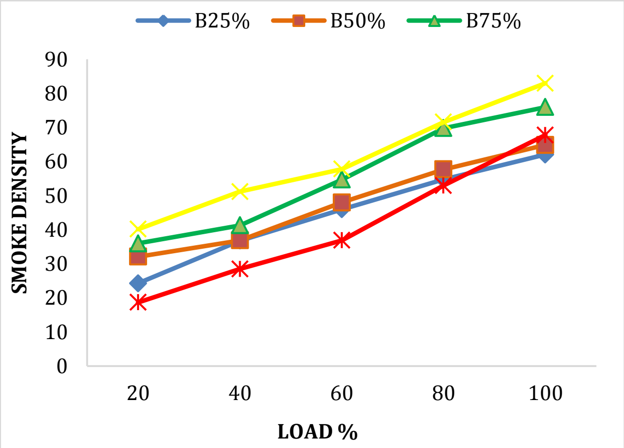


Fig 4 Variation of NO_x emission with load for different blends

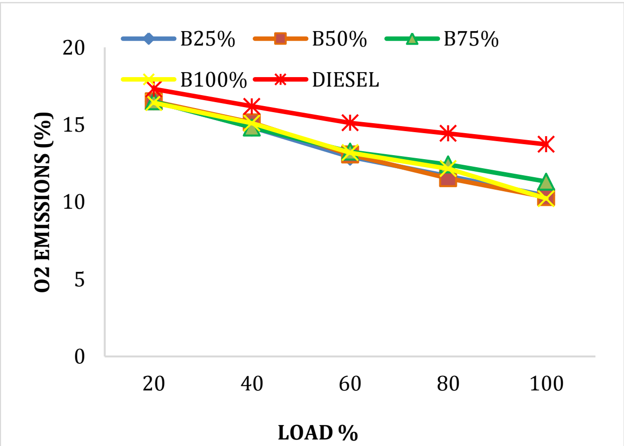
Smoke Density Emission

Smoke emission from diesel engine may be due to poor injector maintenance, excessive fuel delivery rates etc., Smoke emission is a result of wastage of fuel by the engine. It also results from incomplete combustion and engine ware. Fig5.1(e) shows that lean and rich mixture of fuel will lead to incomplete combustion those results in increased smoke emission. The fuel and air ratio affects the smoke formation. Smoke emission varies within the cylinder of a diesel engine. Smoke primarily occurs in the fuel rich zone of the cylinder at high temperature and pressure.



Oxygen Emission

The O_2 of B50, B75, B100 blends higher than the diesel fuel which was indicate the incomplete combustion occurred of the blends fuel.



Conclusion

The Palm biodiesel was created exploitation vegetable oil by the Transesterification method. The emission characteristics were investigated on IC engine, smoke instrument and emission instrument. The results of the experimental study were complete as follows.

a. The CO emission of the blends was accrued than the diesel.

b. The carbon dioxide emission was found to be higher than the fuel.

c. When compared to diesel, Nox emissions of all the blends of palm biodiesel were found to be reduced. Because the mix magnitude relation decreases the Emissions conjointly decrease severally.

d. HC emission reduced considerably thanks to the upper cetane variety of the Biodiesel

e. The EGT was accrued in B75, B100. Scrutiny to fuel.

f. The smoke emission was found to be slightly above fuel.

g. The O_2 emission was found to be lesser than fuel.

h. The BSFC of blends were determined to be appropriate at middle load for the CI Engine Compared to fuel, somewhat quantity of power loss happens for biodiesel blends. Thus exploitation biodiesel doesn't cut back the potency of the engine that a lot of. However, slight design of internal-combustion engine for biodiesel fuel might overcome this drawback.

The use of biodiesel has sure benefits over the fossil diesel. It's emission of carbon dioxide, HC, Nox are less compared to traditional diesel. Thence reduces heating and enhances rural development. Disbursal of internal-combustion engine with biodiesel continues to be pricey. However but, industrial production of biodiesel in bio refineries might drastically cut back its cost. Finally it will be complete that, within the way future once there would be shortage in fuel reserve, palm oil will be an acceptable renewable substitute to fossil diesel.

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