Performance and Emission Analysis of Single Cylinder Diesel Engine Using Jatropha Oil with Supercharger

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Abstract— Transesterified vegetable oil, also called bio-diesel is becoming increasingly important as a fuel for diesel engine due to several reasons. Bio-diesel is a renewable, inexhaustible and a clean burning fuel. Many studies have shown that properties of bio-diesel are very close to petro diesel. Bio-diesel can be used in diesel engine without modification. Bio-diesel has no aromatic, no-sulfur and contains 10-12% oxygen by weight. These characteristics of bio-diesel reduce the harmful emissions of unburned hydrocarbons and CO, research has shown that NOx, emission is higher in case of bio-diesel fueled engine. . The aim of present research work is to use B10, B20, B30, blend of jatropha methyl ester. The effect of super charging also studied and the performance of the engine are evaluated in terms of BSFC, TFC, SEC, brake thermal efficiency and volumetric efficiency. The investigation result shows that the brake thermal efficiency and volumetric efficiency of the engine with super charger was improved in comparison with naturally aspirated engine. HC and Smoke opacity emissions are dceresed with supercharging condition.
Keywords: Jatropha, Super Charger, Engine

I. INTRODUCTION

Vegetable oils present very promising alternate to Diesel oil since they are renewable and have similar properties. Several research and project in the field of Internal combustion Engine are being focused on reduced Emission, which not only makes commercial sense but also helps benefit the environment reducing harmful emission from diesel vehicles helps improve local air quality which is no becoming increasingly important towards corporate social responsibility. The use of vegetable oils as fuels for diesel engines is not a new concept. It is known that when Sir. Rudolph Diesel invented diesel engine he used Peanut oil in his engine. Jatropha an alternate fuel could be attributed to some important facts. Indian climate condition is suitable for Jatropha cultivation. Has no insects, pets and not browsed by animals, can survive long periods of drought. It can grow in saline and alkaline soils, arid and semi-arid condition. Its properties match with that of petroleum diesel.

Engine performance can be improved with supercharging. Supercharging improves the combustion process in Diesel engine. An increase in air pressure of the engine intake reduces ignition delay, resulting in a better combustion and smooth operation with lower rate of the pressure rise (1-2). A reciprocating air compressor has been used for supercharging. An inlet pressure of 4kg/cm2 is maintained for supercharging condition.

Present work aims to show the significance of Jatropha oil utilization in Diesel engine with chosen parameter of supercharging with various blends.

II. CHARACTERIZATION OF JATROPHA OIL

Jatropha curcas is a large plant and belongs to the family of Euphorbiacea occurring almost throught India. It has a long productive period of around 40-50 years. It grows as a tree up to the height of 3-5 mt. it is a good plantation for Eco-restoration in all types wasteland

A. *Properties of Jatropha oil*

The properties of the methyl ester of jatropha oil summarized in table.

Property	Diesel	Jatropha Methyl Ester
Density (kg/m$^{3)}$	840	870
Sp.gravity	0.840	0.870
Kinematic Viscosity (c St) at 40^{0}C	3.5	5.65
Flash point (^{0} C)	56	170
Calorific value (kj/kg)	42926	35717

Table 1: Properties Of Diesel And Jatropha Methyl Ester

B. *Availability of Jatropha oil*

India has rich and abundant resources of both edible and nonedible oil seeds. Jatropha curcus is a large shrub or tree commonly found through most of the tropical and sub-tropical regins of the world. Jatropha curcus plant is a drought-resistant, perennial plant living up to40- 50 years it can grow in saline and alkaline soils, arid and semi-arid condition. The production of Jatropha seeds are about 0.8 kg/m2 per year. The oil content of Jatropha seeds 40% by weight (3-6).

Fig.1: Process flow chart

Fresh Jatropha is a slow drying, odorless and colorless0 oil, and turns yellow after aging. Jatropha an alternate fuel could be attributed to some important facts, Indian climate condition are suitable for Jatropha cultivation. Has no insect, pets and not browsed by animals, can survive long periods of drought.

III. EXPERIMENTAL SET UP

The experimental investigation carried out in a single cylinder 4-stroke water cooled diesel engine developing 3.68 kW at 1500 RPM was used. The engine details are given in table 1. The schematic of the experimental set up is shown in fig 2. An eddy current dynamometer was used for loading the engine. The supercharging operation is carried out in a reciprocating single cylinder air compressor at working 4kg /cm2.

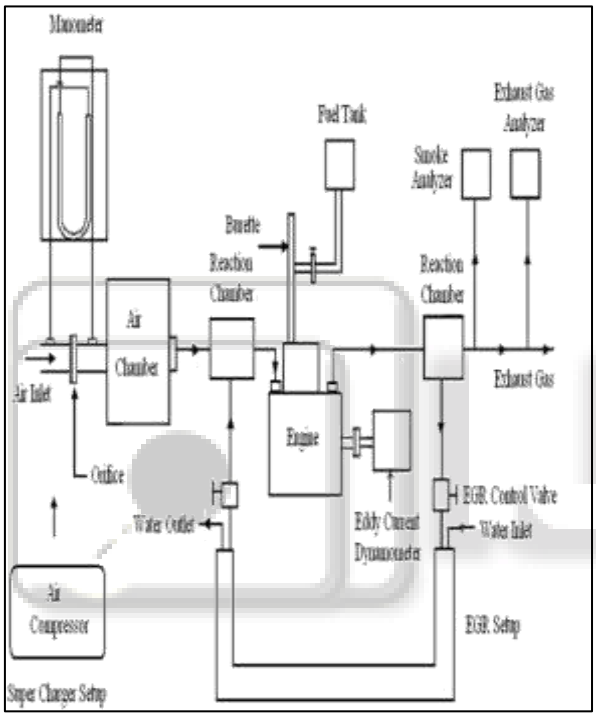

Fig.2: Schematic diagram of the experimental setup

Make	Kirloskar
Stroke	4
No. of cylinder	1
Rated Speed (RPM)	1500
Bore (mm)	80
Stroke (mm)	110
Compression Ratio	17.5:1
Rated Power (kW)	3.68

Table 2: Experimental Setup

Make	Metro Air Compressor
No of cylinder	1
Motor (H.P)	5
Speed (RPM)	700
Working Pressure (kg/cm^2)	4

Table 3: Air Compressor Specification

IV. EXPERIMENTAL PROCEDURE

The engine was coupled to an eddy current dynamometer to measure the output, fuel flow rates were timed with calibrated burette. Exhaust gas analysis was performed using exhaust gas analyzer. The blends of B10, B20, and B30 of Methyl Ester of Jatropha Diesel was prepared by volume basis and used for experimental purpose. The test was carried out without super charger and with super charger in addition of air supply of 5, 10 percent compared to naturally aspirated engine. During the experiments engine speed, fuel consumption air consumption was recorded with super charger and without super charger. The effect of air enrichment on various parameters such as Brake Thermal Efficiency, TFC, BSFC.SEC, Volumetric efficiency and emissions CO, HC, NOX, and smoke was determined with various blends of Jatropha oil.

V. RESULTS AND DISCUSSION

Based on the experimental data the graphs were drawn. These graphs show the variation in brake thermal efficiency, BSFC, and emissions. The variation of brake thermal efficiency with brake power at various blends of Jatropha oil of the base engine is compared with additional air flow rates in fig.3.

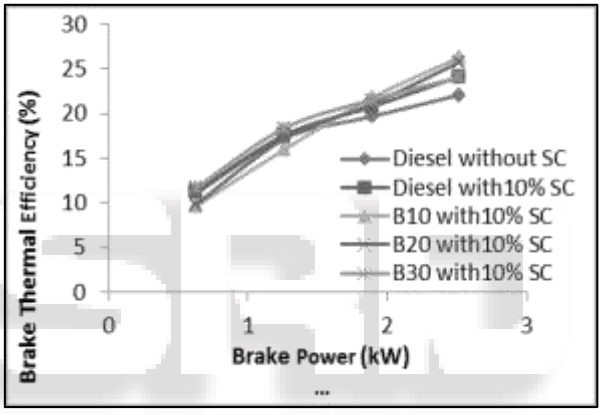

Fig. 3

The condition where atmospheric air was used is designated as normal diesel operation or base engine operation. There is an improvement in the brake thermal efficiency of B10, B20 and B30 blends where the additional air is enhanced. This improvement is may be due to better combustion with additional air supply to the engine.

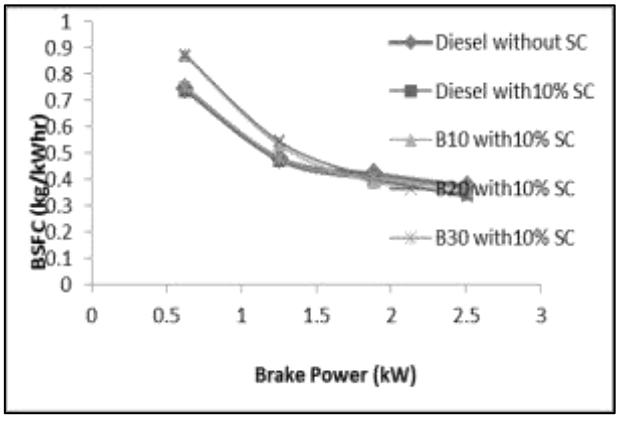

Fig. 4

In fig.4.the variation of brake specific fuel consumption with brake power at various blends of Jatropha oil of the base engine is compared with super charged engine. It is observed that B10 and B20 values are close to diesel fuel engine.

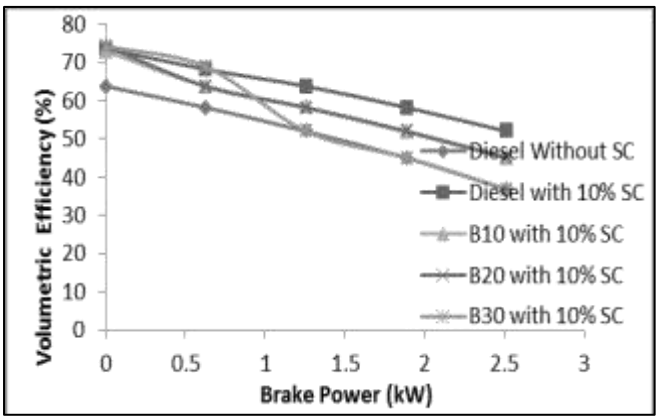

Fig. 5

In fig.5, the variation of volumetric efficiency with brake power at various blends of Jatropha oil of the base engine is compared with super charged engine. There is an improvement in the volumetric efficiency in all Jatropha blends where the additional air is enhanced.

The variation of CO emission with brake power at various blends of Jatropha oil is shown in fig.6 CO emission in the exhaust is the indication of an extent of incomplete combustion. With super charging CO emission is slightly increased with B10, B20 and B30 when compared with diesel.

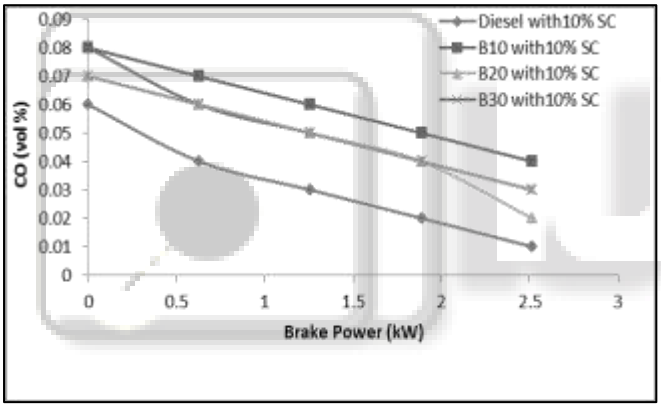

Fig. 6

The variation of HC emission with brake power at various blends of Jatropha oil is shown in fig.7 with super charging the HC emission decreases because of improved combustion quality and improved homogeneity of the mixture.

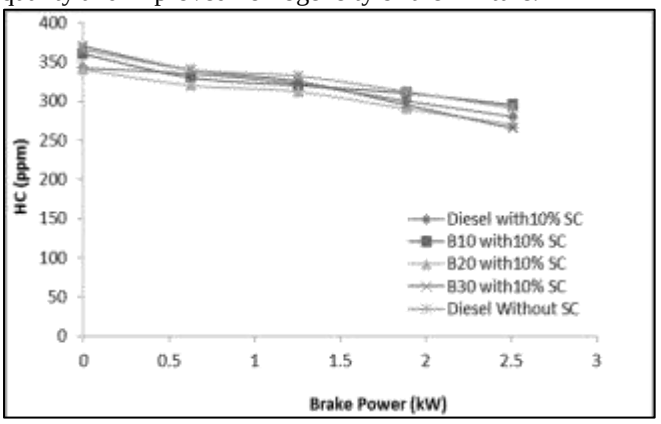

Fig. 7

The variation of NOx emission with brake power at various blends of Jatropha oil is shown in fig.8, NOx emission significantly increases with increase in air supply.

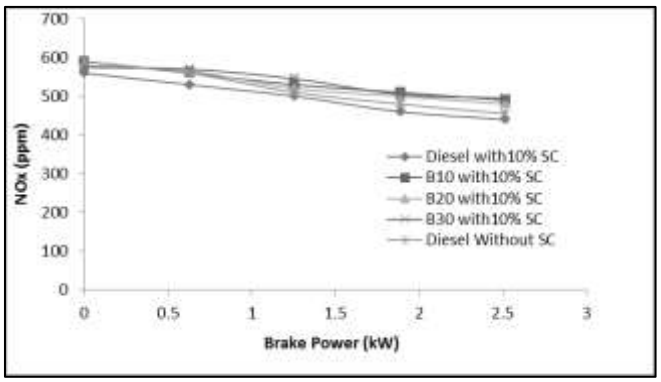

Fig. 8

The variation of smoke emission with brake power at various blends of Jatropha oil is shown in fig.9 smoke density drastically decrease with increase air supply to the engine at all loads due to better oxidation of soot .The additional air flow rate improves the combustion process which results in less smoke.

VI. CONCLUSIONS

An experimental investigation was conducted to test the performance and emission characteristics of Jatropha oil and its fuel blends with diesel in single cylinder diesel engine with super charger, the results obtained suggest the following conclusion.

1) Petro diesel and blends of jatropha oil exhibited similar performance and similar emission characteristics under various operating condition.
2) With super charging brake thermal efficiency is increases with B10, B20 and B30 when compared to naturally aspirated diesel engine.
3) With no super charging B10, B20 and B30 blends, volumetric efficiency is low compared to super charged engine.
4) NOx emission increased with super charging. CO and HC emissions are decreased with super charging in all blends. Smoke opacity is significantly reduced.

VII. B20 is the best blend with diesel showed better results with brake thermal efficiency. Brake specific fuel consumption, volumetric efficiency and less emission formation.

VII. NOMENCLATURE

1) BSFC - Brake Specific Fuel Consumption (kg/Kw. hr)
2) B10 - Blend of 10% Jatropha oil, 90% Diesel by volume
3) B20 - Blend of 20% Jatropha oil, 80% Diesel by volume
4) B30 - Blend of 30% Jatropha oil, 70% Diesel by volume
5) S.C - Super Charger
6) EGR - Exhaust Gas Recirculation
7) H.S.U - Hartridge Smoke Units
8) CO - Carbon monoxide
9) NOX - Oxides of nitrogen
10) PPM - Parts per million
11) kW - kilowatt

12) HC - Unburned hydrocarbon

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