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EXPERIMENTAL STUDY OF USING VEGETABLE OIL AS RENEWABLE FUEL IN DIESEL ENGINE

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ABSTRACT

This paper investigates the scope of utilizing biodiesel developed through the butyl ester from Pongamia oil and linseed oil as an alternative fuel source for a C.I engine. The common problem arises while using neat vegetable oils in C.I engine are due to its higher viscosity. To eradicate this problem, a process named transesterification is done. In this current investigation the performance characteristics of a 20% of methyl ester , 20% of ethyl ester & 20% of butyl ester of Pongamia pinatta (MEOP,EEOP,BEOP) and Linseed oil (MELO,EELO,BELO) with 80% of diesel is studied. Hence this investigation ensures the suitability of butyl ester blend as fuel for CI engines without any modification.

Keywords: Linseed oil, Pongamia pinnata, Transesterification

INTRODUCTION

The world today is plagued by a long list of environmental problems that threatens much of nature as well as the survival of the society. The need is to develop the eco friendly fuel as well as to meet the fossil fuel depletion. These compelling attentions towards vegetable oils as an alternate fuel source. Rudolf diesel tested peanut oil as fuel for his engine for the first time on august 10, 1893. Biodiesel is one of the most promising alternative fuels to meet these problems. It is renewable, biodegradable, non toxic and has almost very close property to that of diesel fuel. Biodiesel is defined by ASTM international as a fuel composed of monoalkyl esters of long-chain fatty acids derived from renewable vegetable oils or animal fats meeting the requirements of ASTM d6751 (ASTM 2008a).The term ''biodiesel' commonly refers to an oxygenated diesel fuel made from various feedstock by conversion of the triglyceride fats to methyl, ethyl, propyl and butyl esters via transesterification. This comes from the fact that in order to use vegetable oil in a diesel cycle engine without needing adaptations in the engine.

As edible oil consumption for fuel make its demand higher; it is not possible to use edible oils for fuel applications. India is rich in forest resources having a wide range of trees, which yield a significant quantity of oil yielding seeds. The ways in which oils and fats can be converted into biodiesel are namely, Transesterification, Blending, Micro-emulsions and Pyrolysis, transesterification being the most commonly used method. With abundance of forest and plant based non-edible oils being available in our country such as Pongamia (Karanja), Jatropha curcas (Jatropha), Madhuca indica (mahua), Shorea robusta (sal), Azadirachta indica A. Juss (neem), Linseed (ali) and Hevea brasiliensis (rubber), No much attempt has been made to use butyl esters of these non-edible oils as substitute for diesel except mahua. Few investigators have already obtained biodiesel from some of these oils.

TRANSESTERIFICATION

To reduce the viscosity of the vegetable oil, transesterification method is adopted for the preparation of biodiesel. The procedure involved in this method is as follows: 1000 ml of vegetable oil is taken in a three way flask. 12-15 grams of Potassium hydroxide (KOH) and 200 ml of corresponding alcohol (Ethanol, Methanol, Butanol) are taken in a beaker. The Potassium hydroxide and the alcohol are thoroughly mixed until it is properly dissolved. The solution obtained is mixed with vegetable oil in three way flask and it is stirred properly. The corresponding alcohols oxide solution with vegetable oil is heated to 78ºC, 65ºC, 117ºC respectively for ethanol, methanol and butanol and it is continuously stirred at constant rate for 90 minutes, 60 minutes,80 minutes by stirrer correspondingly for ethanol, methanol and butanol. The solution is poured down to the separating beaker and is allowed to settle for 4-6 hours. The glycerine settles at the bottom and the ester floats at the top. Corresponding alcohol ester is separated from the glycerine. Then it is heated above 1000ºC and maintained for 10-15 minutes to remove the untreated alcohol. Certain impurities like sodium hydroxide (KOH) etc are still dissolved in the obtained biodiesel. These impurities are cleaned up by washing with 350 ml of water for 1000 ml of coarse biodiesel. This cleaned biodiesel is the corresponding ester of Vegetable oil. This bio-diesel of Pongamia pinnata oil and Linseed oil is being used for the performance and emission analysis in a diesel engine.

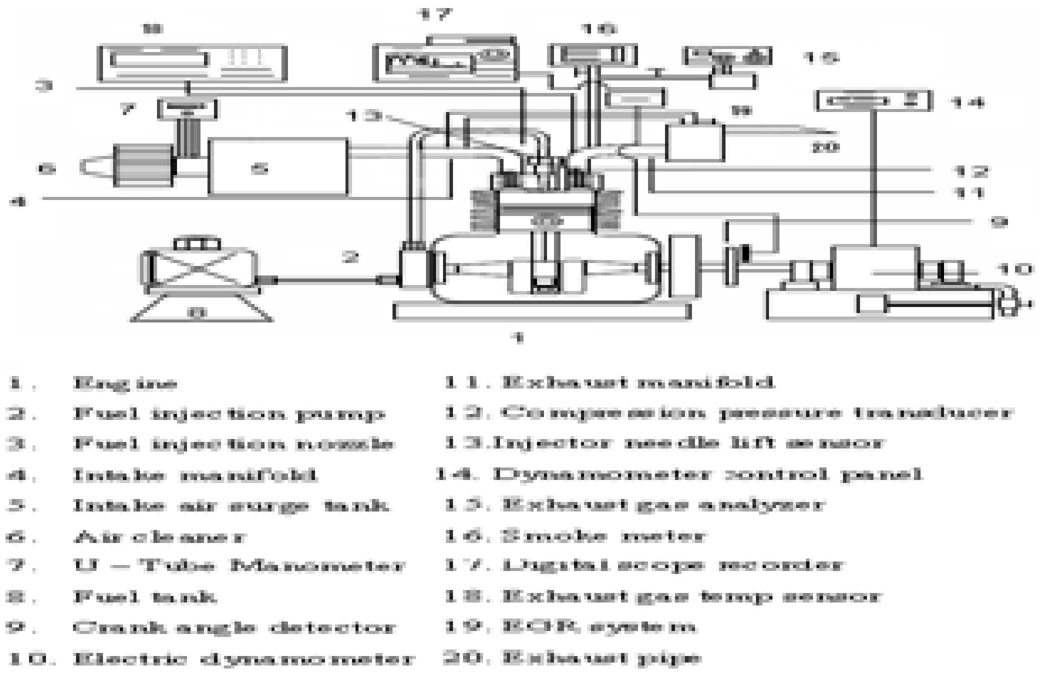
ENGINE SPECIFICATION

Engine manufacturer	-Kirloskar oil engines ltd
Bore& stroke	-87.5 x 110 (mm)
Number of cylinders	-1
Compression ratio	- 17.5: 1

Speed -1800 rpm
Cubic capacity -0.661 litres
Method of cooling -water cooled
Fuel timing -27º by spill (btdc)
Clearance volume -37.8 cc
Rated power -7 and 8 hp
Nozzle opening pressure -200 bars

EXPERIMENTAL SETUP

The engine used for the investigation is kirloskar SV1, single cylinder, four stroke, constant speed, vertical, water cooled, high speed compression ignition diesel engine. The kirloskar Engine is mounted on the ground. The test engine was directly coupled to an eddy current dynamometer with suitable switching and control facility for loading the engine. The liquid fuel flow rate was measured on the volumetric basis using a burette and a stopwatch. AVL smoke meter was used to measure the CO and HC emissions from the engine. The NOX emission from the test engine was measured by chemical luminescent detector type NOX analyser.The experimental setup is shown in the fig.1



TEST METHOD

The engine performance characteristics were taken with neat diesel and used as base reading. Then the engine performance and emission characteristics were taken for 20% blend of MEOP, 20% blend of EEOP, 20% blend of BEOP, 20% blend of MELO, 20% blend of EELO & 20% blend of BELO and with 80% of diesel is used as a fuel. The experiment aims at determining appropriate vegetable oil ester and diesel blend for which higher efficiency was obtainable. Hence experiments were conducted for different esters of biodiesel with diesel. The blend ratio was kept as 20% of ester and 80% of diesel.

PROPERTIES COMPARISON

The property of esters of Pongamia oil and Linseed oil are shown in the Table.1 and Table.2

Table.1 - Properties of esters of Pongamia oil

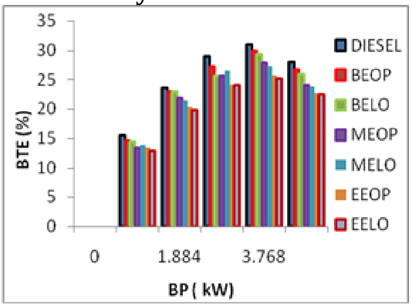
Property	Neat pongamia	Pongamia oil methyl	Pongamia oil ethyl	Pongamia oil butyl	Diesel
Viscosity (mm^2s^{-1})	37.32	4.72	5.10	4.22	2.60
Density (kgm^{-3}) at	915	885	879	862	830

Table.2 - Properties of esters of Linseed oil

Property	Neat linseed	Linseed oil methyl	Linseed oil ethyl	Linseed oil butyl	Diesel
Viscosity (mm^2s^{-1}) at	28.40	3.58	3.92	3.12	2.60
Density (kgm^{-3}) at 38 °	926.60	888.2	885.3	875.40	830

PERFORMANCE ANALYSIS

Brake thermal efficiency



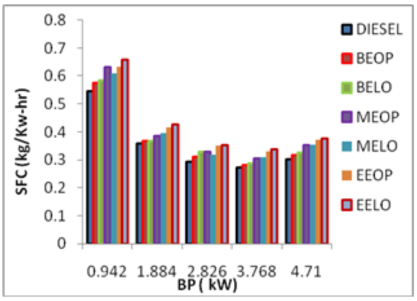


Fig. 2 Brake thermal efficiency for esters of Pongamia oil and Linseed oil with respect to brake power

Fig.3 Variation of SFC with BP for esters of Pongamia oil and Linseed oil

The variation of brake thermal efficiency with brake power is shown in Fig.2.Brake thermal efficiency is defined as the ratio of energy in brake power to the input fuel energy in appropriate units. Thermal efficiency of the engine depends on fuel properties, engine specification and area of application. Thermal efficiency of the esters are inferior to diesel, this is due to the lower heating value of the vegetable oil. However brake thermal efficiency of BEOP is higher than other esters, this is due to the promotion of combustion process due to its lowered specific gravity and viscosity.

Specific fuel consumption: Comparisons of the specific fuel consumption for the esters are shown in Fig.3.The amount of fuel consumed per brake power per hour of work is defined as specific fuel consumption. As the density of BEOP is lower than other esters, the SFC trend is very close to diesel. Among the other esters BEOP has higher SFC, thus gives good engine performance.

Total fuel consumption: Comparisons of the total fuel consumption for the esters are shown in Fig.4. Total fuel consumption of MEOP, EEOP, BEOP, MELO, EELO and BELO are higher than diesel due to their higher specific gravity. BEPO has lower specific gravity than other esters, thus the total fuel consumption is less and similar to diesel.

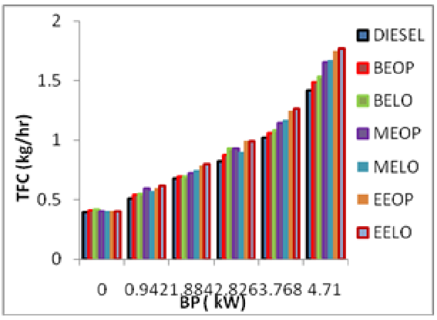


Fig. 4 Total fuel consumption for esters of Pongamia oil and Linseed oil with respect to brake power

CONCLUSION

The present research has confirmed that Pongamia oil and Linseed oil is used as a alternate source for diesel. The following conclusions were drawn from results

- Pongamia oil and Linseed oil are non-edible oils which can be used as diesel alternate.
- Transesterification of above oils with ethanol, methanol and butanol were made successfully and reduction of viscosity is achieved.
- Transesterification with butanol madden the property of the Pongamia oil and Linseed oil closer to diesel property than that of ethanol and methanol.
- It is concluded that 20% BEOP and 20% BELO with 80% of diesel blend can be used in existing diesel engines without modification in the engine.
- By comparing the performance characteristics of all the esters of Pongamia oil and Linseed oil, the butyl esters of Pongamia oil is more efficient.

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