STUDIES ON PERFORMANCE AND EMISSION CHARACTERISTICS OF NON-EDIBLE OIL (HONGE OIL) AS ALTERNATE FUEL IN CI ENGINE

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Abstract

Energy conservation is important for most of the developing countries, including rest of the world. The rapid depletion in world petroleum reserves and uncertainty in petroleum supply due to political and economical reasons, as well as the sharp escalations in the petroleum prices have stimulated the search for alternatives to petroleum fuels. The situation is very grave in developing countries like India which imports 70% of the required fuel, spending 30% of her total foreign exchange earnings on oil imports. Petroleum fuels are being consumed by agriculture and transport sector for which diesel engine happens to be the prime mover.. For the developing countries of the world, fuels of bio-origin can provide a feasible solution of the crises. The fuels of bio-origin may be alcohol, vegetable oils, biomass and biogas. Some of these fuels can be used directly while others need to be formulated to bring the relevant properties close to conventional fuels. The power used in the agricultural and transportation sector is essentially based on diesel fuels and it is therefore, essential that alternatives to diesel fuels be developed. Non-edible oils have capability to solve this problem because they are renewable and lead to reduction in environmental pollution. The direct use of non-edible oils as a diesel engine fuel is possible but not preferable because of their extremely higher viscosity. Transesterified non-edible oils (bio diesel) are promising alternative fuel for diesel engines. Studies has been carried out on the performance & emission characteristics of Honge oil Methyl Ester (HOME) and its blends with diesel oil are analyzed in a direct injection C.I.Engine. The properties of HOME thus obtained are comparable with ASTM bio diesel standards.

Keywords- Biodiesel, Non-edible oils, Transesterfication, Honge oil Methyl ester.

1.0 INTRODUCTION

Diesel engine is a popular prime mover for transportation, agricultural machinery and industries. Diesel fuel is largely consumed by the transportation and agricultural sectors. Import of petroleum products is a major drain on our foreign exchange sources and with growing demand in future years the situation is likely become even worse. Diesel and petrol engines are the main sources of carbon dioxide, carbon monoxide and un-burnt hydrocarbon emissions and increase in carbon dioxide, carbon monoxide levels in the atmosphere leads to global warming and green house effect. The world is on the brink of an energy crises. Efficient use of natural resources is one of the fundamental requirements for any country to become self sustainable with the fossil fuel depleting very fast, researchers have concentrated on developing new agro based alternative fuels, which will provide sustainable solution to the energy crises. There are more than 300 different species of trees in India, which produces oil. Most of these trees are wild and therefore once established will look after themselves.[1,4] Since India is net importer of vegetable oils, edible oils cannot be used for production of bio diesel. India has the potential to be a leading world producer of bio diesel, as bio diesel can be harvested and sourced from non edible oils like Jatropha curcus, Pongamia pinnata, Neem, Mahua, caster, linseed, Kusum, etc. Some of these oils produced even now are not being properly utilized. Out of these plants , India is focusing on Pongamia pinnata , which can grow in arid and wastelands. Oil content in the Pongamia seed is around 30-40%. India has about 80-100 million hectares of wasteland, which can be used for Pongamia and other non edible plants.[2,3] Implementation of bio diesel in India will lead to many advantages like green cover to wasteland, support to agriculture and rural economy and reduction in dependence on imported crude oil and reduction in air pollution.[3]

Of the various alternative fuels under consideration, bio diesel derived from non-edible oils is the most promising alternative fuel to diesel due to the following reasons. [1]-[3].

- Biodiesel can be used in the existing engine with out any modification.
- The use of biodiesel in conventional diesel engines results in substantial reduction of un burnt hydro carbon, carbon monoxide and particulate matters (but NO_X about 2% higher).
- Biodiesel has almost no sulphur (0.05%), no aromatics and has about 10% built in oxygen which helps in better combustion.
- Its higher flash point (>100 as against 35 in diesel) is good from safety point of view.
- Unlike fossil fuels the use of biodiesel does not contribute to global warming as CO_2 emitted is once again absorbed by the plants grown for non-edible oil production. Thus CO_2 balance is maintained.
- Biodiesel is produced from renewable non-edible oil and hence improves the fuel or energy security and economy independence.

A lot of research work has been carried out to use vegetable oil both in its neat form and modified form. Studies have revealed that the usage of non-edible oil in neat form is possible but not preferable [3]. The high viscosity of non-edible oils and low volatility affects the atomization and spry patterns of fuel, leading to incomplete combustion and severe carbon deposits, injector choking and piston ring sticking. The methods used to reduced the viscosity are.

- Emulsification.
- Pyrolysis.
- Dilution.
- Transestrification.

Among these, the transestrification is commonly used commercial process to produced clean and environment friendly fuel [4], methyl esters of used cooking oil [5], sunflower oil [6], rice bran oil [7], palm oil [8], soybean oil [9], mahua oil [10], jatropha oil [11], have been successfully tested on C.I. engines. The sunflower oil, palm oil, rice bran oil, soybean oil are edible oils and also are expensive. Hence there are not suitable for use as feed stock for biodiesel production in economical way.

In the present investigation, the oil obtained from the seeds of Pongamia pinnata has been considered as a potential alternative fuel for C.I. Engines. Iman K. Reksowardojo et.al. [12] reported that the biodiesel fuel from Pongamia oil and its blend with petro-diesel can comparable engine performance parameters such as Torque(T) Fuel Volumetric Consumption (FVC), Break Specific Energy Consumption (BSEC), engine exhaust gas emissions of total hydro carbon (THC), carbon monoxide (CO) & smoke emissions reduce significantly when engine run with biodiesel fuel. Breuer [13] studied the effect of fuel properties on heat release through experiments conducted with rapeseed oil and its methyl ester.

In this work the performance & emission characteristics of HOME is studied & reported. More over this paper presents comprehensive analysis of HOME and its blends with diesel.

2.0 EXPERIMENTAL PROCEDURE

2.1 Preparation of Honge oil Methyl Ester (HOME)

As a diesel fuel substitute, Honge falls under the category of bio-diesel. Extraction requires passing the seeds through a screw crusher, generally called expellers. The oil is then filtered to make it clean enough for processing. The filtered oil is treated with alcohol, i.e ethanol or methanol using KOH or NAOH as catalyst in a process known as transestrification.[14]. Figure 1 shows the process of Honge oil Methyl Ester (HOME).

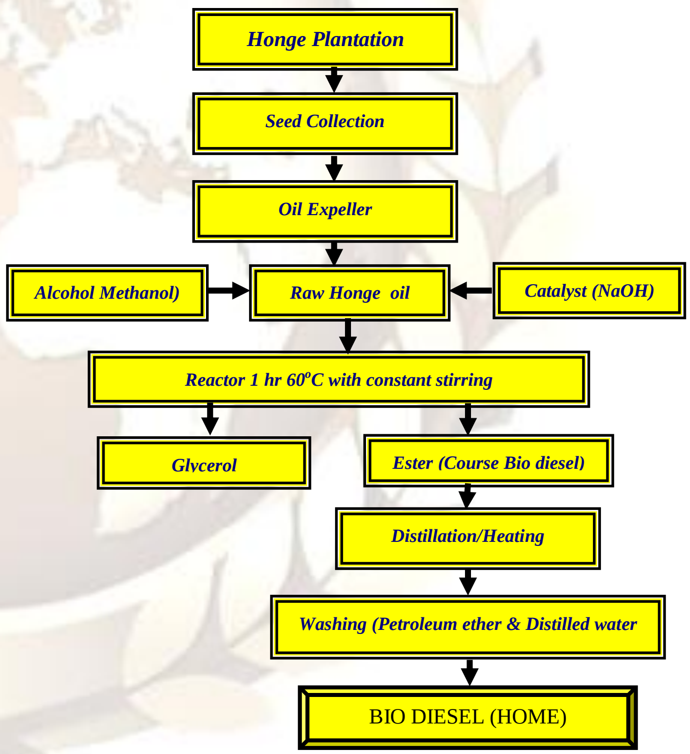

Figure - 1 Process of Honge oil Methyl Ester (HOME).

Table 1. Properties of Diesel & HOME

Properties	B 10	B 20	B 30	B 40	B 50	B 100	Diesel
Density (kg/m3)at 40° C	832	839	840	844	848	875	829
K.V(cst) at 40°C	3.99	4.24	4.27	4.29	4.52	5.52	3.8
Calorific value(kJ/kg)	42542	42240	41700	41370	41114	38996	42990
Flash Point (°C)	102	102	106	108	111	172	58

2.2 Engine Tests

The engine used for this experimental investigation was a single cylinder 4 stroke naturally aspirated water cooled diesel engine having 5 BHP as rated power at 1500 rev/min. The engine was coupled to a brake drum dynamometer to measure the output. Fuel flow rates were timed with calibrated burette. Exhaust gas analysis was performed using a multi gas exhaust analyzer. Figure 2 shows schematic diagram of the experimental setup.

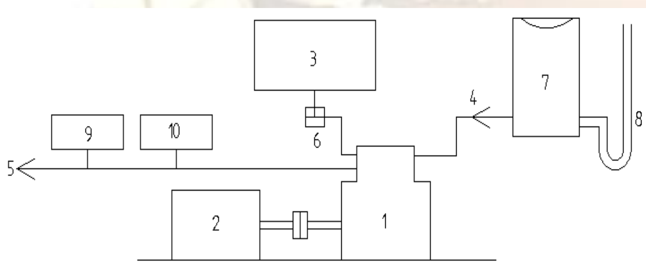

Figure 2: Schematic Diagram of the Experimental Setup

1. Engine
2. Eddy Current Dynamometer
3. Fuel Tank (Biodiesel)
4. Air Flow Direction.
5. Exhaust Flow
6. Three Way Valve
7. Air Box.
8. Manometer.
9. Smoke Meter.
10. Exhaust Gas Analyzer

3.0 RESULTS AND ANALYSIS

This paper compares specific fuel consumption, brake thermal efficiency and exhaust emissions of HOME and its blends with those of diesel.

3.1 Performance characteristics

Engine performance characteristics are the major criterion that governs the suitability of a fuel. This study is concerned with the evaluation of brake specific fuel consumption (BSFC) and brake Thermal efficiency (BTE) of the HOME diesel blends

3.1.1 Brake Specific Fuel Consumption (BSFC)

HOME has lower calorific value than that of diesel. Hence the specific fuel consumption is slightly higher than that of diesel for HOME and its blends. Fig.3 shows the BSFC of various blends of HOME –diesel

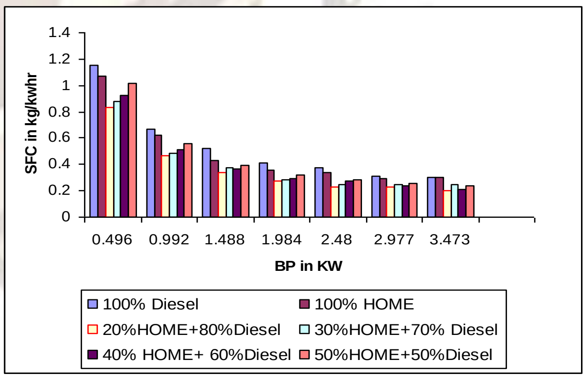

Figure 3: Variation of BSFC with BP

3.1.2 Brake Thermal Efficiency(BTE)

Fig 4 shows that brake thermal efficiency of HOME and its blends is slightly higher as compared to that of diesel.

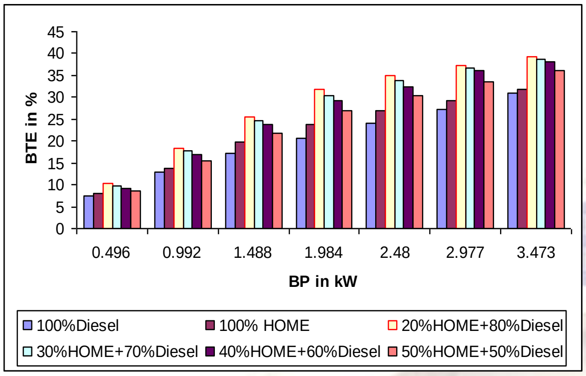

Figure 4: Variation of BTE with BP

3.2 Emission Characteristics

With problem like global warming ozone layer deletion and photochemical smog in addition to widespread air pollution automotive emission are placed under the microscope and every possible method is attempted to reduce emission. Hence this study compares the emission of pollutants nitrogen oxides, carbon monoxide, unburned hydrocarbon emissions and smoke of HOME and its blend with diesel.

3.2.1 Exhaust Gas Temperature (EGT)

Fig 5 shows the exhaust gas temperature variations for test fuels with load. It is observed that the exhaust gas temperature increases with load because more fuel is burnt at higher loads to meet the power requirement. It is also observed that the exhaust gas temperature increases with percentage of HOME in the test fuel for all the loads. This may be due to the oxygen content of the HOME, which improves combustion and thus may increase the exhaust gas temperature.

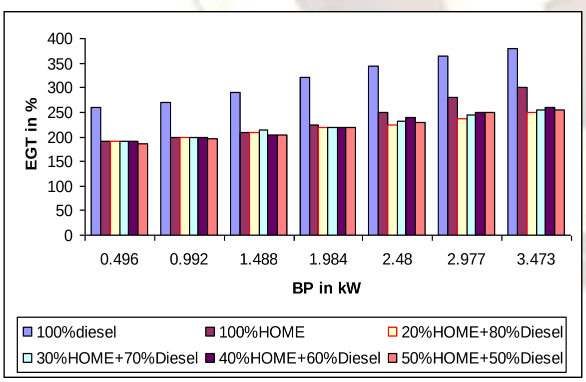

Figure 5: Variation of EGT with BP

3.2.2 Carbon dioxide emission (CO_2)

The carbon dioxide emission from diesel engine with different blends is shown in fig. 6. The CO_2 increased with increase in load conditions for diesel and for bio-diesel blended fuels. HOME followed the same trend of CO_2 emission, which was higher than in case of diesel. The CO_2 in the exhaust gas was same for HOME

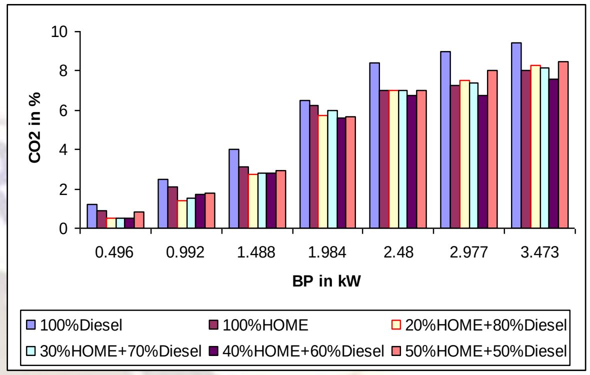

Figure 6: Variation of CO_2 with BP

3.2.3 Carbon monoxide emission (CO)

Fig 7shows that carbon monoxide emissions are almost same up to moderate load for HOME and diesel.CO is predominantly formed due to the lack of oxygen. Since HOME is an oxygenated fuel, it leads to better combustion of fuel resulting in the decrease in CO emission is a strong advantage in favor of HOME.

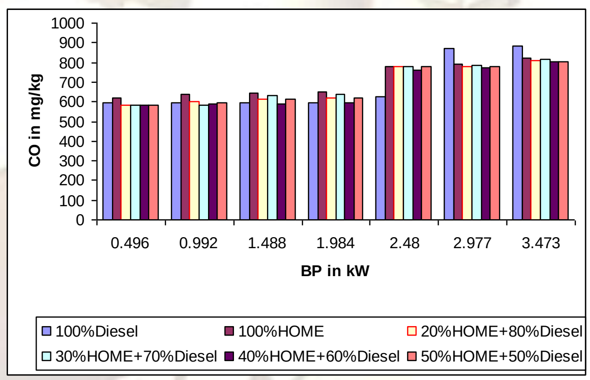

Figure 7: Variation of CO with BP

3.2.4 Nitrogen Oxides Emission (NO_X)

Fig. 8 shows gradual increase in the emission of nitrogen oxides (NO_X) with increase in percentage of HOME in the fuel. The NO_X increase for HOME may be associated with the oxygen content of HOME, since the oxygen present in the fuel may provide additional oxygen for NO_X formation.

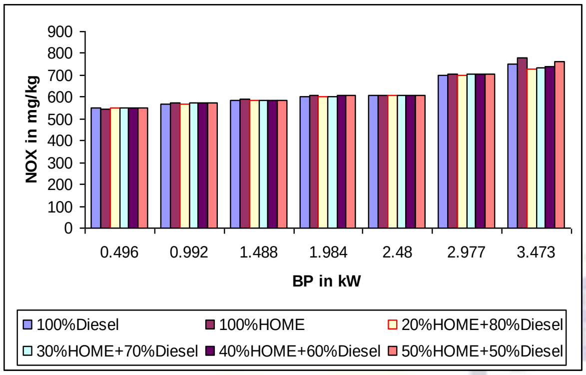

Figure 8: Variation of NOx with BP

3.2.5 Smoke Intensity

Smoke or soot primarily comprises of carbon particles. The improved combustion characteristics of HOME may led to fewer unburnt fuel particles impinging on cylinder walls. Fig. 9 presents the smoke intensity of diesel, HOME and its blends. A vast reduction in smoke intensity is observed with increase in percentage of HOME in the blend, especially at moderate loads.

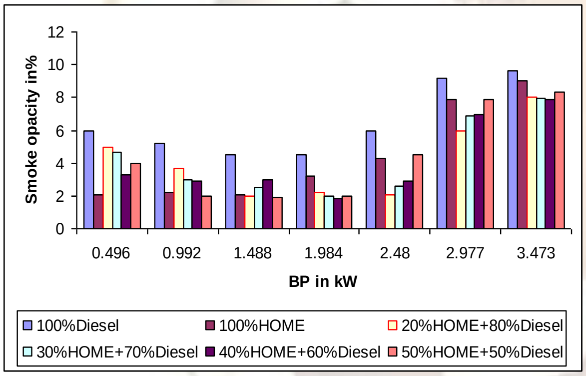

Figure 9: Variation of Smoke opacity with BP

4.0 CONCLUSION

The performance, emission characteristics of a single cylinder direct injection compression ignition engine fuelled with HOME and its blends have been analyzed and compared to the base line diesel fuel. The results of present work are summarized as follows.

- The specific fuel consumption increases with increase in percentage of HOME in the blend due to the lower calorific value of HOME.
- Methyl ester of Honge oil results in a slightly increased thermal efficiency as compared to the of diesel.
- It is also observed that the exhaust gas temperature increases with percentage of HOME in the test fuel for all the loads.
- CO_2 emissions are low with methyl ester of Honge oil.
- CO emission is low at higher loads for Methyl ester of Honge oil when compared with diesel .NOX emissions is slightly increased with Methyl ester of Honge oil compared to diesel.
- There is a significant difference in smoke emissions when HOME is used.
- HOME satisfies the important fuel properties as per ASTM specification of Biodiesel and improves the performance and emission characteristics of engine significantly.

ACKNOWLEDGEMENT

Authors thank the Management and Principal of Sri Siddhartha Institute of Technology, Maralur, Tumkur-572105, India for providing necessary experimental setup to perform this research.

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