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Research Paper

EXPERIMENTAL INVESTIGATION OF PONGAMIA AND NEEM METHYL ESTERS AS BIODIESEL ON COMPRESSION IGNITION ENGINE

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Biodiesel is a fuel comprised of mono alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. Biodiesel is reliable, renewable, biodegradable and regarded as a clean alternative fuel to reduce exhaust emissions. Vegetable oils have become more attractive for the production of biodiesel in the recent past owing to its environmental benefits and the fact that it is made from renewable resources. Nowadays, most biodiesel is produced by the transesterification of triglycerides of edible/non edible oils, and waste vegetable oils using methanol with alkaline catalyst NaOH/KOH. In this research, methyl esters of pongamia and neem are produced through transesterification. The objective of this paper is to investigate the mechanical properties and performance characteristics of biodiesel extracted from Pongamia and Neem oil. The objective is achieved by transesterifing the pongamia and neem oil using lab setup developed inhouse. The viscosity of pongamia and neem oil is reduced first by blending with diesel in 10%, 20%, 30%, 40% and 50% on the volume basis, then analyzed and compared with diesel. In the present experimental investigation Single Cylinder water cooled diesel engine was tested for blends of diesel with Pongamia and Neem Biodiesel.

Keywords: Biodiesel, Pongamia oil, Neem oil, Transesterification, Engine performance

INTRODUCTION

India is one of the fastest developing countries with a stable economic growth, which multiplies the demand for transportation in many folds. Fuel consumption is directly proportionate to this demand. India depends mainly on imported fuels due to lack of fossil fuel reserves and it has a great impact on economy. India has to look for an alternative to sustain the growth rate. Fossil fuels are finite energy resources, and as the amount of new supplies found is decreasing, the resources will eventually be exhausted. Furthermore, the use of fossil fuels has a severe impact on

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climate change. Increased fossil fuel use thus conflicts with the increasing global pressure to reduce environmental impact and mitigate climate change (Planning Commission of India, 2003).

Biodiesel refers to a vegetable oil or animal fat-based diesel fuel consisting of long-chain alkyl esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat) with an alcohol producing esters. Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel modified diesel engines. Biodiesel can be used alone or blended with petro diesel. Biofuels have become a matter of global importance because of the need for an alternative energy at a cheaper price and with less pollution (Mishra *et al.*, 2012). Therefore, it is focused on performance and characteristic study of biodiesel.

Vegetable oils have become more attractive for the production of biodiesel in the recent past owing to its environmental benefits and the fact that it is made from renewable resources (National oilseeds and Vegetable Oils Development Board Government of India). Vegetable oils are a renewable and potentially inexhaustible source of energy with an energetic content close to diesel fuel. Oils derived from vegetable and microbial sources may in course of time become as important as petroleum and the coal tar products of present time. Recent increases in petroleum prices and due to uncertainties concerning petroleum availability, there is renewed interest in vegetable oil fuels for diesel engines.

Biodiesel has a potential not only to reduce the fuel demand in the country significantly which reduces foreign exchange but also helps in developing agriculture and thereby increasing employment opportunity for rural population. Change over to biodiesel may also reduce air pollution and greenhouse gas emissions in urban areas. The semiarid regions are suitable for growing oil bearing trees, there is a potential to rehabilitate degraded lands which are abundantly available in India.

A number of methods are currently available and have been adopted for the production of biodiesel fuel. There are four primary ways to produce biodiesel: pyrolysis, micro-emulsification, dilution and Transesterification. The most commonly used method for converting oils to biodiesel is through Transesterification process using sodium hydroxide or potassium hydroxide catalyst (Mishra *et al.*, 2012). When sodium hydroxide is used as a catalyst, side reactions forming sodium soaps generally occur. This type of reaction is also observed when sodium methylate is used and a trace of water is present.

METHODOLOGY

Experimental Setup

The experiments were conducted on a kirloskar made four stroke single cylinder water cooled direct inject compression ignition engine without any hardware modifications. Pongamia and Neem biodiesel blends (B10, B20, B30, B40, and B50) and diesel was used to test a conventional engine. The engine was coupled with an eddy current dynamometer to apply different loads. Performance parameters like brake power, brake specific fuel consumption and brake thermal efficiency were evaluated. The technical specification of diesel engine is given in the Table 1.

Table 1: Engine Specifications

Type	Kirloskar
Details	Single cylinder, four stroke, water cooled
Bore and Stroke	80×110 mm
Rated Power	3.75 KW at 1500 RPM
Compression Ratio	16:1to 25:1

RESULTS AND DISCUSSION

Table 2 shows the fuel properties of diesel, pongamia biodiesel and its blends. Table 3 shows the fuel properties of diesel, neem biodiesel and its blends Biodiesel blends of pongamia and neem methyl esters with diesel on 10, 20, 30, 40 and 50% volume basis was prepared and fuel properties are measured following standard procedure.

Table 2: Properties of Diesel, Pongamia Biodiesel and its Blends

Properties	Units	Diesel	B10	B20	B30	B40	B50	B100
Viscosity	Cst	3.02	3.290	3.73	4.05	4.25	4.51	5.18
Density	Kg/m^3	816	818.7	821	836	841	847	892.9
Flash Point	°C	52	55	57	63	65	72	169
Fire Point	°C	61	62	67	70	72	84	181
Calorific Value	KJ/Kg	43796	42701	41606	40511	39416	38321	37226

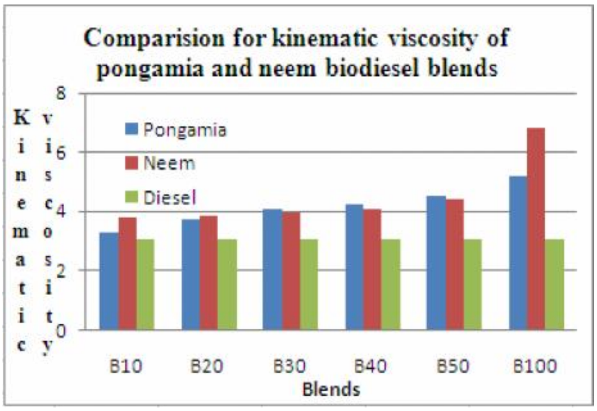
Table 3: Properties of Diesel, Neem Biodiesel and its Blends

Properties	Units	Diesel	B10	B20	B30	B40	B50	B100
Viscosity	Cst	3.02	3.78	3.855	3.92	4.074	4.38	6.81
Density	Kg/m3	816	820.1	825.9	831.4	839.6	843.8	873.2
Flash point	oC	52	57	62	68	70	74	168
Fire point	oC	61	67	74	75	77	85	184
Calorific value	KJ/Kg	43796	42111	41863	40780	39460	38643	36496

The pongamia and neem biodiesel is produced through two stage process, i.e., esterification and transesterification process. The experimental investigation was carried out for different blends of pongamia and neem biodiesel and the performance was evaluated and compared with the diesel.

In Figure 1, the kinematic viscosity of different blends of pongamia and neem biodiesel blends B10, B20, B30, B40 and B50 are higher than the viscosity of diesel. But up

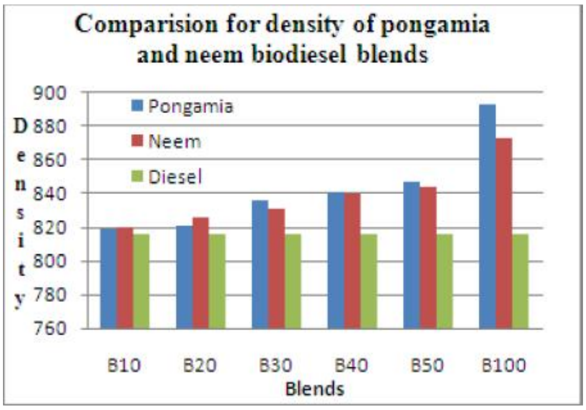
Figure 1: Kinematic Viscosity vs Blends



to blend B10 the viscosity of biodiesel is close to the viscosity of diesel.

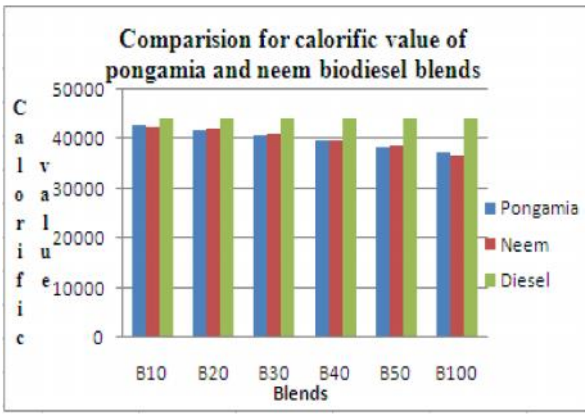
The density of different blends of pongamia and neem biodiesel is increased with the increase in blend percentage as shown in Figure 2. The blends of B10 and B20 of pongamia and neem biodiesel are closer to the density of diesel. The high density of biodiesel can be reduced by heating.

Figure 2: Density vs Blends



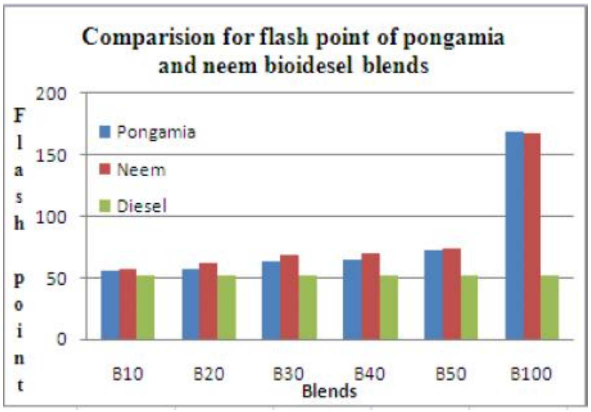
The calorific values of different blends of pongamia and neem biodiesel are lesser than the calorific value of diesel as shown in Figure 3. The biodiesel blends B10 and B20 have calorific values closer to diesel.

Figure 3: Calorific Value vs Blends



The flash points of different blends of methyl esters are increased with the increase in methyl ester percentage as shown in Figure 4. It is also observed that the flash points of blends B10 and B20 are close to diesel.

Figure 4: Flash Point vs Blends



The Figures 5 to 9 represents the variation of specific fuel consumption with brake power for various blends of biodiesel and diesel. It can be observed that the specific fuel consumption of different blends of pongamia and neem biodiesel is found to be slightly higher than the diesel at full load. It is also observed that specific fuel consumption of

Figure 5: Variation of Specific Fuel Consumption with Brake Power for B10 Blends

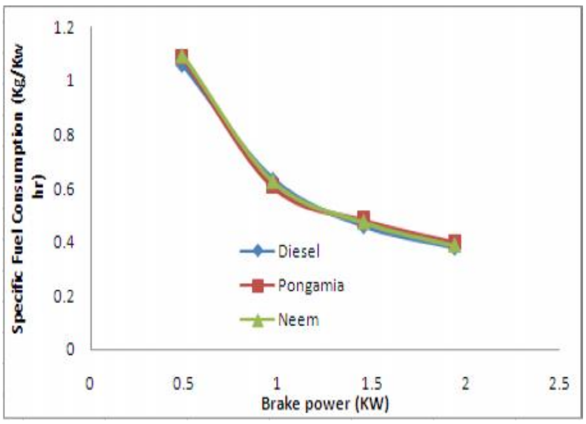


Figure 6: Variation of Specific Fuel Consumption with Brake Power for B20 Blends

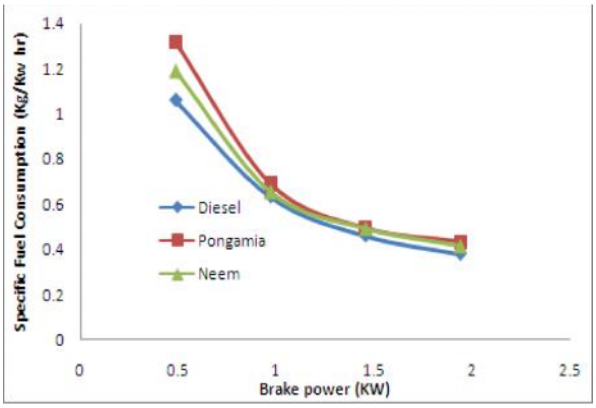


Figure 7: Variation of Specific Fuel Consumption with Brake Power for B30 Blends

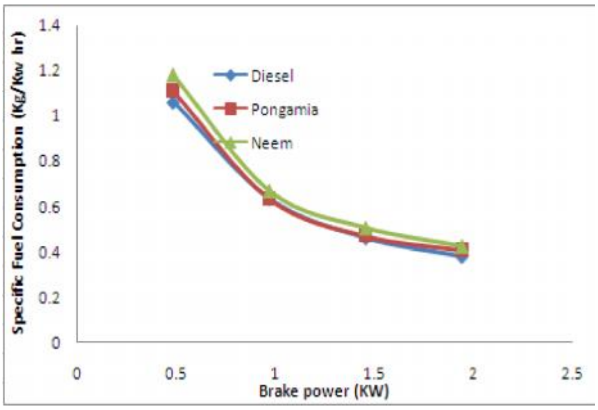


Figure 8: Variation of Specific Fuel Consumption with Brake Power for B40 Blends

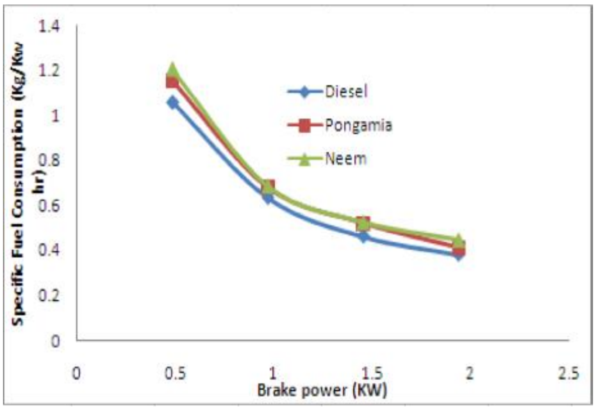
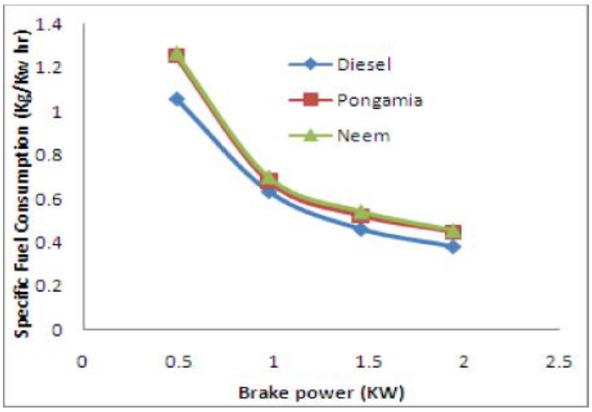


Figure 9: Variation of Specific Fuel Consumption with Brake Power for B50 Blends



B10 blend of pongamia and neem biodiesel is very close to specific fuel consumption of diesel at all loads. For blends B20 to B50 the specific fuel consumption is found to be higher than the diesel.

The Figures 10 to 14 represents the variation of brake thermal efficiency with brake power for various blends of biodiesel and diesel. A slight drop in brake thermal efficiency was found with the biodiesel blends when compared with diesel. This drop in thermal efficiency may be due to poor combustion

Figure 10: Variation of Brake Thermal Efficiency with Brake Power for B10 Blends

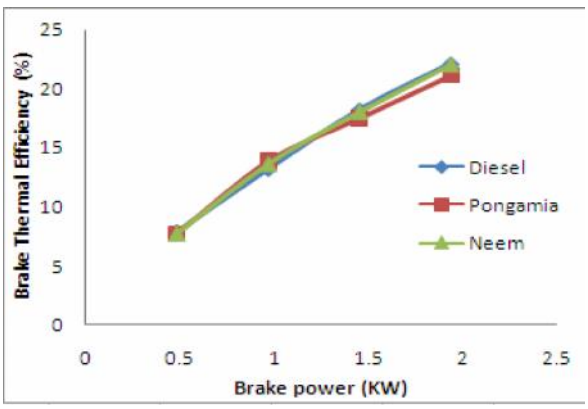


Figure 11: Variation of Brake Thermal Efficiency with Brake Power for B20 Blends

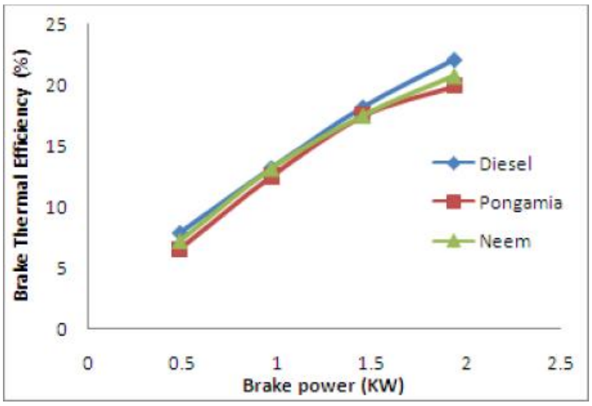


Figure 12: Variation of Brake Thermal Efficiency with Brake Power for B30 Blends

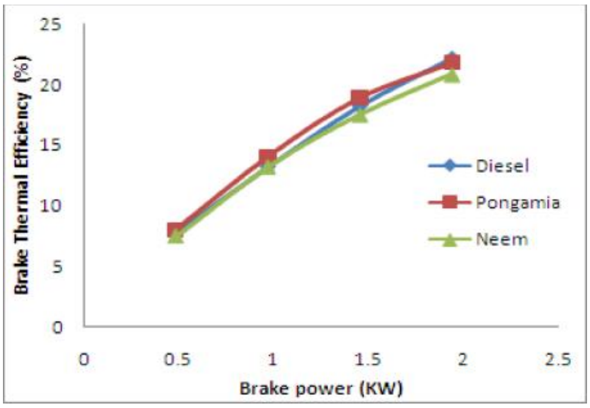


Figure 13: Variation of Brake Thermal Efficiency with Brake Power for B40 Blends

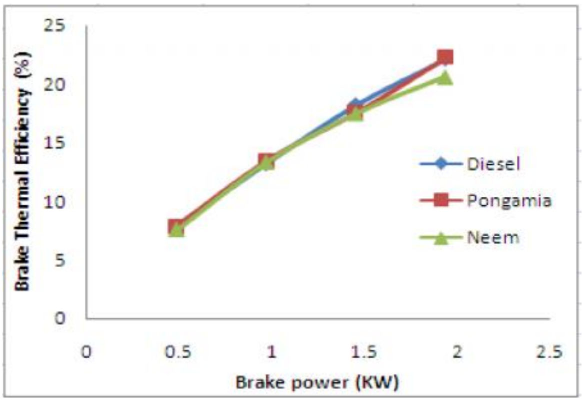
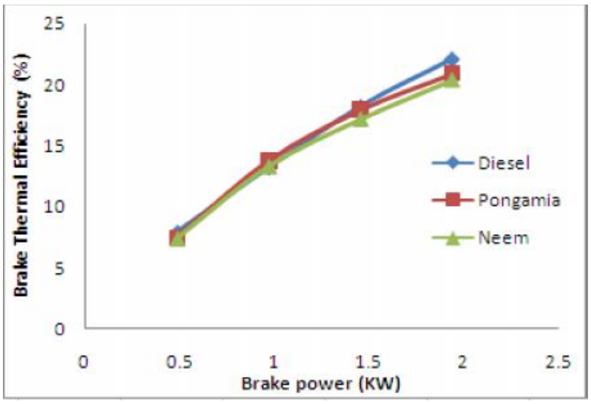


Figure 14: Variation of Brake Thermal Efficiency with Brake Power for B50 Blends



characteristics of biodiesel blends due to high viscosity. It can also be observed that the brake thermal efficiency of B10 and B20 neem biodiesel blends is slightly higher than the B10 and B20 pongamia biodiesel blends.

CONCLUSION

Based on the experimental investigation the following conclusions can be drawn.

- Pongamia and neem biodiesel blends can be directly used in diesel engines without any engine modifications.
- The fuel properties of different blends of biodiesel are nearer to the diesel and blends B10 and B20 is giving good results.
- The fuel properties of biodiesel B100 are not in good agreement with the diesel so it is advisable not to use B100 biodiesel in CI engines.
- The pongamia biodiesel shows better fuel properties than the neem biodiesel up to blend B20.
- The brake thermal efficiency of biodiesel blends is slightly lesser than the diesel. The

brake thermal efficiency of B10 and B20 neem biodiesel blends is slightly higher than the B10 and B20 pongamia biodiesel blends.

- Specific fuel consumption of B10 blend of pongamia and neem biodiesel is very close to specific fuel consumption of diesel at all loads. For blends B20 to B50 the specific fuel consumption is found to be higher than the diesel.

The engine performance is highly influenced by the factors like viscosity, density and volatility of fuel. For biodiesel, these factors are mainly decided by the effectiveness of the transesterification process. The pongamia and neem biodiesel can provide a useful substitute for diesel thereby reducing our dependency on foreign countries for oil and improving the economic scenario of our country.

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