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NANOMATERIAL A FUEL ADDITIVE FOR BIODIESEL

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ABSTRACT:

Increasing concerns about depleting fossil fuels have caused an intensified search for lternative sources of energy. The search for alternatives to petroleum-based fuels has led to The development of fuels from various sources, including renewable feed stocks such as fats and oils. Several types of fuels can be derived from these triacylglycerol-containing feed stocks. One of them is biodiesel, which is an alternative diesel fuel and can be obtained from the transesterification of vegetable oils with simple alcohols. This process decreases the viscosity, density and flash point of the raw material. In this investigation castor oil methyl ester tested in four stroke single cylinder diesel engine. The test was carried out for performance and emission at an average constant speed of 1500 rpm at different loads for castor Biodiesel with cerium oxide as additive.

KEY WORDS: castor biodiesel, transesterification, Cerium oxide etc.

1. INTRODUCTION

The resources of petroleum as fuel are dwindling day by day and increasing demand of fuels, as well as increasingly stringent regulations, pose a challenge to science and technology. With the commercialization of bioenergy, it has provided an effective way to fight against the problem of petroleum scarce and the influence on environment. It is important for an alternative diesel fuels to be technically acceptable, economically competitive, environmentally acceptable and easily available. Among these alternative fuels, biodiesel and its derivatives, have received much attention in recent years for diesel engines [3]. Biodiesel is an oxygenated diesel engine fuel that can be obtained from vegetable oils or animal fats by conversion of the triglycerides to esters via transesterification. It has similar properties to those of fossil diesel. Therefore, researches on biodiesel derived from vegetable oils and animal fats lead the studies that of aimed to alternate petroleum based diesel fuels. It has been reported by the results of many studies that biodiesel can be used in diesel engines with little or no modifications, and with almost the same performance. Besides it reduces carbon monoxide (CO), unburned hydrocarbons (HC), and smoke emissions. However, a majority of results stated an increase in nitrogen oxides (NOx). The results vary according to the base vegetable oil or animal fats, the process of biodiesel production as well as biodiesel fuel properties. Therefore different based biodiesels and their blends with various fuels were tested in diesel engines with different engines as well as test conditions[1,2,8].

On the other hand, biodiesel has high viscosity, high density, lower calorific value and poor non-volatility, which leads in pumping problem, atomization problem and poor combustion inside the combustion chamber of a diesel engine. In case of long-term use of vegetable oils in diesel engines, problems such as gumming, injector fouling, piston ring sticking and contamination of lubricating oils are bound to occur. All these problems are due to the high viscosity of vegetable oils. Hence, it is necessary to reduce the viscosity of vegetable oil to a more approximate value of diesel. The solution to the problems has been approached in several ways, such as preheating the oils, blending them with diesel, thermal cracking and transesterification [6-7].

In present study the biodiesel derived from castor seed oil has been used. It is a triglyceride derived from ricinoleic acid, which constitutes 90% of fatty acids present in the molecule and 10% of non-hydroxylated fatty acid, mainly by oleic and linoleum acids. Due to this particular chemical composition castor oil becomes highly valuable for industrial purposes. The demand of renewable combustible fuel derived from vegetable oils has increased in the last years and has led to the development of a number of processes for transesterification of oils with methanol or ethanol, involving acidic or basic catalysis. To find out the performance of biodiesel prepared from castor seed oil, testing was undertaken with single cylinder compression ignition engine at an average constant speed of 1500 rpm at different loads [4-5].

2. CERIUM OXIDE NANOMATERIAL

Cerium oxide has the ability to catalyze combustion reactions, by donating oxygen atoms from it's lattice structure. This catalytic activity is dependent on surface area, amongst other things, so using nanoparticles can offer distinct advantages over bulk material or larger particles. Adding cerium oxide nanoparticles to fuel can help decomposition of unburnt hydrocarbons and soot, reducing the amount of these pollutants emitted in the exhaust and reducing the amount of fuel used. It has also been shown that cerium oxide decreases the pressure in the combustion chamber, which reduces the production of NO_x and makes combustion reactions more efficient. Cerium oxide nanoparticles can also be used as a short-term treatment for particulate filters in diesel engines. The nanoparticles help to clear away soot which clogs up the filters, which can drastically improve the performance of the filters and the cleanliness of the exhaust emissions [11].

3. PROPERTIES OF CASTOR OIL BIODIESEL

Castor oil is extracted from the seeds of Palma Christi. Seeds are approximately 46% oil. This oil is highly viscous, its coloration ranges from a pale yellow to colorless, and it has a soft and faint odor and a highly unpleasant taste. Castor oil dissolves easily in alcohol, ether, glacial acetic acid, chloroform, carbon sulfide, and benzene. It's made up of triglycerides: 89-94% ricinoleic acid, 4-5% linoleic acid, and 1-2% palmitic and stearic acids. Besides being used as a laxative, castor oil is widely used in the industrial field because of its many properties. In the textile industry, castor oil is used for moisturizing and removal of grease in fabrics, and for the manufacturing of waterproof fabrics. In the steel industry, it is used in cutting oils and lubricants for steel lamination at high temperatures and it is also used in other liquids that are necessary for steel work. The automotive industry uses castor oil for the production of high performance motor oil and braking fluids. Moreover, it is also employed as a softener in the tanning industry and *in* the production of fluids for hydraulic devices, artificial leather, varnish, paint, linoleum, insulators, powder, fatty acids, enzymes, as a moisturizer for stationary and insecticides [4];

Additionally it can be used as a raw material for the fabrication of plastics. The properties of Castor oil biodiesel are given in Table 1.[9].

Table 1. Properties of Castor oil biodiesel

Viscosity at 40°C	15.98 mm^2/s
Density @ 15^0C	0.9268 g/cm^3
Calorific Value	37908 kJ/kg
Cetane number	50
Ash content	0.02 %
Pour Point	-45°C
Visual appearance	Viscous pale yellow
Flash Point	190.7°C

4. EXPERIMENTAL APPROACH

The experiments were carried out on a single cylinder, vertical, 4-stroke cycle, single acting, totally enclosed, water-cooled, high speed compression ignition engine. The engine specifications have been mentioned in table no.2.

Engine was coupled to an Eddy Current Dynamometer through Universal coupling. The engine and the dynamometer were mounted on a common bed made from Iron C-Channel which was bolted to the cement foundation. One of the basic operations in testing of any engine is loading the engine by means of dynamometer. In case of eddy current dynamometer, the loading is electrical i.e., by means of excitation current to the dynamometer coil. Therefore basic but important factors involved in engine loading is complete reliability and stable operation of engine at different loads and speed points on torque / speed characteristics.

Table 2. Specifications of engine used

Make	Kirloskar
Type	Single-cylinder, four-stroke, compression ignition diesel engine
Stroke	110 mm
Bore	80 mm
Compression ratio	16.5:1
BMEP at 1500 rpm	5.42 bar
Rated speed	1500 rpm
Rated output	3.7 Kw
Dynamometer	Eddy current,water-cooled with loading unit

5. EXPERIMENTAL METHOD AND OBSERVATIONS

The present study was carried out to investigate the performance and emission characteristics of castor oil biodiesel. Bio-diesel (B100) were used to test the engine of the specifications mentioned in Table no.2. The performance characteristics of the engine were studied at different engine loads (25%, 50%, 75% and 100% of the load corresponding to the load at maximum power at an average engine speed of 1500 rpm). At each load, the engine was stabilized for 20 minutes and then measurement parameters were recorded. The exhaust of the engine was tested using a Hartridge smoke-meter of Netel make.

The engine was loaded using the Brake drum dynamometer. The exhaust gas temperature, water jacket inlet temperature and water jacket outlet temperature were recorded and monitored using thermocouples. The fuel consumption was measured by burette method for 15 cc or 10cc fuel consumption using a stop-watch. The water jacket outlet temperature was maintained in the range of 60-70°C and corresponding cooling water flow-rate was recorded using measuring flask and stop-watch. The observations taken on castor biodiesel and Biodiesel with additive

6. RESULT AND DISCUSSION

From experimentation the graph between Brake thermal efficiency (BTE) vs Brake mean effective pressure (BMEP) and Brake specific fuel consumption (BSFC) vs BMEP are plotted as shown in fig.no.1 and fig. no. 2.

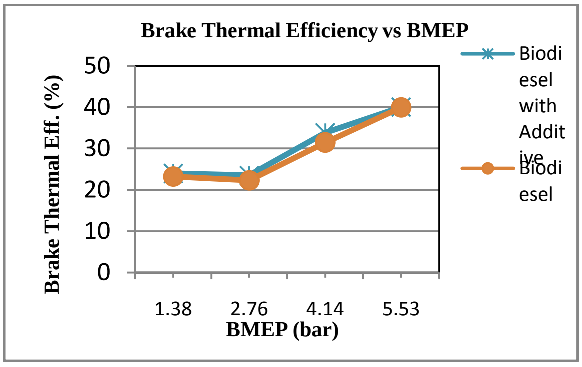

Fig. no.1. *Graph of BTE vs BMEP*

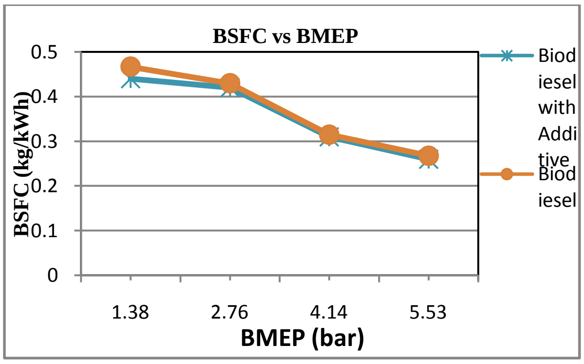

Fig. no. 2. *Graph of BSFC vs BMEP*

From fig.no.1 it shows that the variation of brake thermal efficiency with respect to different load for Biodiesel and biodiesel with additive. In all cases, brake thermal efficiency was having tendency to increase with increase in applied load. This was due to the reduction in heat loss and increase in power developed with increase in load. The trend of maximum brake thermal efficiency is observed with biodiesel with additive as compare to biodiesel.

Also, the variation of BSFC is shown in fig. no.2. BSFC decreases with increase in brake mean effective pressure. The trend of graph indicates that BSFC is less with additive as compared without additive.

7. CONCLUSION

From experimentation it can be concluded that testing of diesel engine using cerium oxide increases Brake thermal efficiency as well reduces the Brake specific fuel consumption.
Overall the performance of diesel engine using nanomaterial additive with biodiesel increases the performance of the engine. Also the use of castor bio-diesel increases the use of waste land and generates rural employment and increases the country's GDP. Local production of biodiesel will save a huge amount of foreign exchange. This capital when invested in country will improve its financial structure. Thus biodiesel with nanomaterial additive is a 'New Era Fuel' in the world of tomorrow and will reduce our dependence on diesel.

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