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PERFORMANCE AND EMISSION CHARACTERISTICS OF CITRONELLA OIL IN SINGLE CYLINDER DIESEL KIRLOSKAR ENGINE

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ABSTRACT

India imported about 2/3rd of its petroleum requirements which involved a cost of approximately Rs. 80, 000 crores in foreign exchange. Even 5% replacement of petroleum fuel by bio-fuel can help India save Rs. 4000 crores per year in foreign exchange. The country has been hit hard by the increased cost and uncertainty and so is exploring other energy sources occurring bio-diesel extracted from trees is one such alternative under consideration. Bio-diesel would be cheap to produce as it can be extracted from certain species of tree that are common in many parts of India. However, as the biodiesel is produced from vegetable oils and animal fats, there are concerns that biodiesel feedstock may compete with food supply in the long-term. Hence, the recent focus is to find oil bearing plants that produce non-edible oils as the feedstock for biodiesel production. Citronella oil is used as an input for biodiesel production via transesterification. Diesel fuel is much higher use than any other gasoline fuels because diesel engines have many adaptable domestic uses like small irrigation water pumbing systems, light weight four/two seated auto cab and car engine small electricity generators etc. Citronella biodiesel fuel properties are observed and tested in the fuel testing laboratory with standard procedure. Then an experimental set up is construct to study the performance of a small Kirloskar Diesel in the internal combustion engine by using different blends of Citronella Oil based biodiesel under different Operation Conditions. We have to determine the optimum performance of this citronella biodiesel. NOx emission from the test engine can be measured by chemical luminescent detector type NOx analyzer.

Keywords: citronella oil, transesterification, diesel.

INTRODUCTION

Biodiesel is the name of a clean burning alternative fuel that can be produced from algae, vegetable oils, animal fats or recycled restaurant greases, domestic, renewable resources. It contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend and can be used in compression ignition (diesel) engines with little or no modifications. Biodiesel is simple to use, environment friendly liquid fuel similar to petro-diesel in combustion properties biodegradable, nontoxic, and essentially free of sulfur and aromatics. It is a processed fuel consisting of short chain alkyl (methyl or ethyl) esters, made by transesterification of vegetable oils or animal fats, which can be used (alone, or blended with conventional diesel fuel) in unmodified diesel-engine vehicles.

Biodiesel is a liquid which varies in colour between golden and dark brown depending on the production feedstock. It is practically immiscible with water, has a high boiling point and low vapor pressure. Typical methyl ester biodiesel has a flash point of ~ 150 °C (300 °F). Biodiesel has a density of ~ 0.88 g/cm³, less than that of water. It has a viscosity similar to petrodiesel, the current industry term for diesel produced from petroleum. It can be used as an additive in formulations of diesel to increase the lubricity of pure Ultra-Low Sulfur Diesel (ULSD) fuel, which is advantageous because it has virtually no sulfur content. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix, in contrast to the "BA" or "E" system used for ethanol mixes. For example, fuel containing 20% biodiesel is labelled B20. Pure biodiesel is referred to as B100.

Figure-1. Citronella grass.

EXPERIMENTAL APPARATUS AND METHODS

Transesterification

In general, vegetable oil contains 97% of triglycerides and 3% di- and monoglycerides and fatty acids. The process of removal of all glycerol and the fatty acids from the vegetable oil in the presence of a catalyst is

called transesterification. The vegetable oil reacts with methanol and forms esterified vegetable oil in the presence of sodium/potassium hydroxide as catalyst. Transestrification is crucial for producing biodiesel from oils. The transesterification process is the reaction of a triglyceride (fat/oil) with a bioalcohol to form esters and glycerol. However; consecutive and reversible reactions are believed to occur.

These reactions are represented in Equations below:

Triglycerides + ROH= diglycerides + R1COOR
Diglycerides + ROH= monoglycerides + R2COOR
Monoglycerides + ROH= glycerol + R3COOR
Catalyst is usually a strong alkaline (NaOH, KOH or sodium silicate) medium.

The first step is the conversion of triglycerides to diglycerides followed by the conversion of diglycerides to monoglycerides and of monoglycerides to glycerol yielding one methyl ester molecule from each glycerides at each step. Meher *et al*. reported that the experimental study revealed that the optimum reaction condition for methanolysis of karanja oil was 1% KOH as catalyst. MeOH/oil of molar ratio 6:1, reaction temperature 65 °C, at the rate of mixing 360 rpm for a period of 3 h. The yield of methyl ester was >85% in 15 min and reaction was almost complete in 2 h with a yield of 97- 98% with 12:1 molar ratio of MeOH oil or higher, the reaction was completed within 1 h. The reaction was incomplete with a low rate of stirring, i.e. 180 rpm; whereas, stirring at high rpm was a time-efficient process.

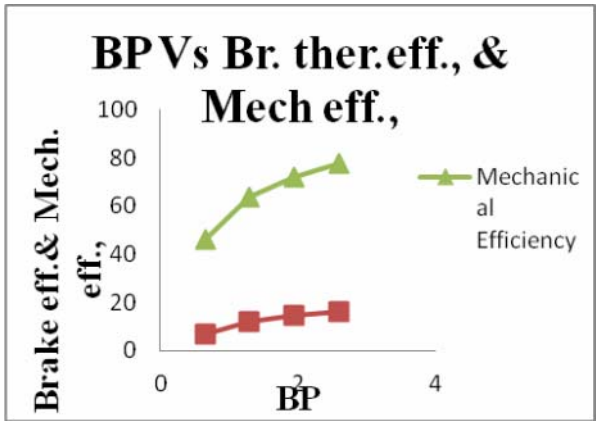
Figure-2. Apparatus for steam distillation.

Engine specification

Engine manufacturer	Kirloskar oil engines ltd
Bore and stroke	87.5 x 110 (mm)
Number of cylinders	2
Compression ratio	17.5: 1
Speed	1800 rpm
Cubic capacity	0.661 litres
Method of cooling	water cooled
Fuel timing	27º by spill (btdc)

Figure-3. CI engine setup.

RESULTS AND DISCUSSIONS



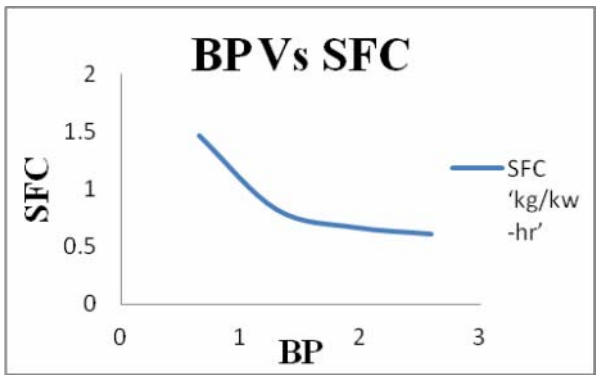


Figure-4. Performance test on single cylinder four stroke diesel engine – diesel.

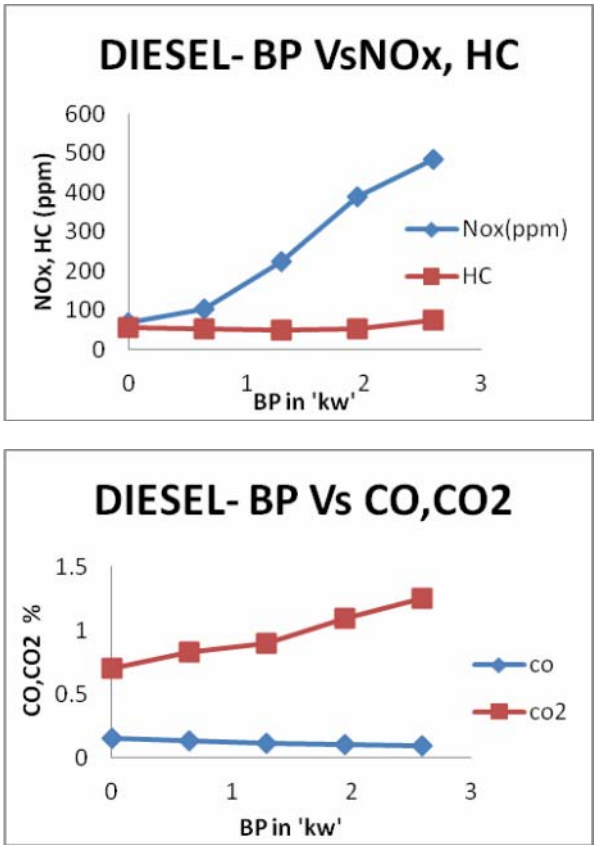


Figure-5. Emission test on single cylinder four stroke diesel engine - diesel.

CONCLUSIONS

From the results and discussions the blended Citronella oil has better brake thermal efficiency and values were very much closer to diesel. For high load, the specific fuel consumption is high compared to diesel. Thus Citronella oil based bio diesel which is important renewable and alternative fuel in future.

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