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Performance Evaluation And Emission Analysis Of Four Stroke Single Cylinder Diesel Engine Using Cotton Seed Bio Diesel As an Alternative Fuel With Additives

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Abstract - *The environment concerned with global warming has highly promoted the research of application of study of renewable fuel like bio-diesel and its blends to internal combustion engine. In this project we will practically investigate & compare the performance & emission of 4 stroke single cylinder diesel engine using fuel as diesel & diesel-cotton seed biodiesel blends with additives. In diesel, blends are 10%,20%,30%,40%,50%,60%,70%,80% of cotton seed biodiesel with each 10 ml of additives in each blends by volume basis . Out of them, we will find out which blend with additives is best for existing CI engine with improving brake specific fuel consumption, brake thermal efficiency and reducing emission of NOx, smoke without modification in engine. To carry the test we are using computerized 4 stroke single cylinder Kirlosker make CI engine & fuel efficiency monitor for emission analysis. Performance evaluation contains evaluation of brake power, friction power, brake specific fuel consumption, brake thermal efficiency. Emission analysis contain analysis of co%, no (ppm), no_2 (ppm), exhaust gas temp (^0c).*

Additives are used to improve brake specific fuel consumption (BSFC), combustion performance and reduce emission from diesel engine. Exhaust emission of compression ignition (CI) engine will evaluated experimentally for sole diesel and Blends-Diesel-cotton seed biodiesel fuel blends. The addition of additives to the standard diesel fuel caused brake thermal efficiency (BTE) increased. The smoke emission decreased at the maximum torque speed (1500 rpm) rather than at the rated power speed (2200 rpm).

Exhaust gases of an engine can have up to 2000 ppm of oxides of nitrogen. Most of this will be nitrogen oxide (NO), with a small amount of nitrogen dioxide (NO2). NOx is very undesirable. Released NOx reacts in the atmosphere to form ozone and is one of the major causes of photochemical smog. NOx is created mostly from nitrogen in the air. At high temperature and pressure higher levels of NOx is created and at low temperature lower level of NOx is produced. In addition to temperature, the formation of NOx depends on pressure and air-fuel ratio. Cetane improver additive is used 10 ml to the diesel-cotton seed biodiesel fuel. Addition of cetane improver additive to the diesel-cotton seed biodiesel is cost effective way to control NOx emission. Diesel-cotton seed biodiesel fuel with the 10 ml additive will have reduction in NOx and smoke.

Key Words: Cotton seed biodiesel, Diesel, fuel blends, additives, Diesel engine, Performance, Exhaust emission.

1. INTRODUCTION

1.1 General Introduction

Petroleum based fuels play a vital role in rapid depletion of conventional energy sources along with increasing demand and also major contributors of air pollutants. Major portion of today's energy demand in India is being met with fossil fuels. Hence it is high time that alternate fuels for engines should be derived from indigenous sources. As India is an agricultural country, there is a wide scope for the production of vegetable oils (both edible and non-edible) from different oil seeds. Though the concerned researchers recommended the use of vegetable oils in diesel engines, there was no evidence of any practical vegetable oil source engines. 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.

1.2 Problem Statement

The increasing use of diesel engines had led to considerable activity in methods for better performance and reduction in smoke and particle levels emitted in the exhaust. The required levels are difficult to achieve through engine design alone even with high grade fuels. But, blending different additives into diesel fuel is still today the best way to have results in matter of pollution. One group of fuel additives is oxygenated compounds. The main reason of using oxygen to produce a cleaner burning of diesel fuels is few decades old. The reduction of soot generation by the addition of oxygenated compounds depends on the

molecular structure and oxygen content of the fuel. This also depends on the oxygen concentration in the fuel plume. Change in the composition of diesel and the use of additives directly affect physical and chemical properties such as viscosity, density, volatility, and the cetane index .Meanwhile nitrogenated additives have high oxygen content therefore are considered as oxygenated additives also. The nitrogenated additives increase performance as predicted by considerations of product evolution and of thermal energy in the fuel-air mixture. The most important consideration in the application of fuel additives such as nitrogenated additives to engines is their mode of combustion and decomposition, and particularly the composition of the products. In this project nitrogenated additives are suggested as a class of chemical additives for blend in diesel fuel to increase the engine performance without an attendant penalty of increasing engine size or mechanical complexity.

It is evident that vegetable oil offer acceptable engine performance and the emissions for the short term operation while for the long term duration problems like filter clogging, carbon deposits on injecto exterior, compression ring, grooves, piston lands etc. have been take care. The high viscosity of vegetable oil is responsible for those problems. Therefore reduction in the viscosity of vegetable oils is of the prime importance to make them suitable for this task among them blending or dilution with other oils, preheating and transesterification predominant. Testing of diesel engines with preheating blending with diesel improves the performance and reduces the emissions compared with the vegetable oil. It is also reduces the filter clogging and ensures smooth flow of the oil.

2. Objectives

- In this project, nitrogenated additives used to improve brake specific fuel consumption (BSFC), combustion performance and reduce emission from diesel engine. The physico-chemical properties of the blended fuel and standard diesel were studied. Then exhaust emission of compression ignition (CI) engine have been evaluated experimentally for sole diesel, Additives-Diesel-Cotton Seed biodiesel blends.
- The addition of nitrogenated additives to the standard diesel fuel caused brake thermal efficiency (BTE) have to be increased. The smoke emission will decrease at the maximum torque speed rather than at the rated power speed.
- 10 ml Cetane improver additive will be used to the additives-diesel-cotton seed biodiesel fuel respectively. Addition of cetane improver additive to the additives-diesel- cotton seed biodiesel is cost effective way to control nox emission. Additives-diesel-cotton seed biodiesel with the 10ml additive of additives have to shows the significant reduction in nox and smoke .The sensitivity of NOx to change in cetane number is higher at low load than at high load. It is found that NOx emissions were reduced at low load than at high load.

3. Procedure

3.1 Production of Biodiesel

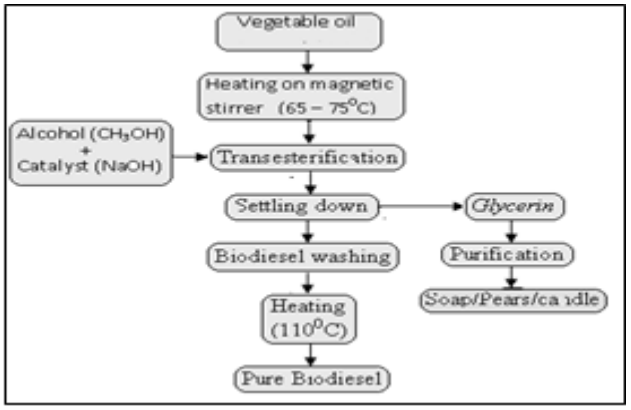

Fig -1: Flow chart of Biodiesel production

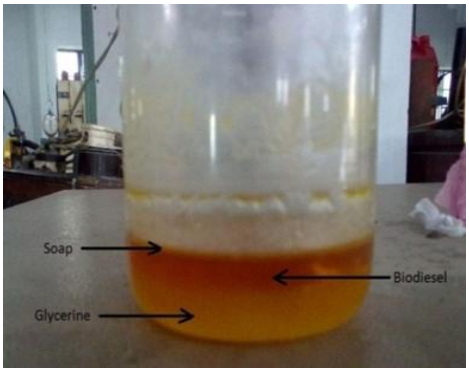

Fig -2: Various layers found while reaction

Fig -3: Fuel properties after transesterification reaction

3.2 Comparison of Properties

Table -1: Fuel properties after transesterification reaction

Properties	Cotton-seed oil	Bio-diesel	Diesel
Density (g/cc)	0.9	0.88	0.84
Boiling Point (° C)	319	262	248
Calorific Value(MJ/Kg)	41.95	38.51	45
Kinematic Viscosity at 34°C(mm2/s)	29.215	7.2	3.0

4. Additives and Pollutants

4.1 Additives

The consumption of fuel is increasing resulting in pollution of environment with smoke and NOx due to the development in automobile and power sector. These emission contents smoke and NOx can be reduced by adding additives with diesel fuel. As these additives are very costly and hence becomes unviable. These additives decrease the performance of combustion. Oxygenated compounds are most widely used among additives. The reason for this is the participation of their oxygen in reactions leading to better combustion and hence lowering the emission contents the molecular structure of the oxygen contents of additives directly influence on smoke reduction and the oxygen concentration of the fuel flame also effects the emission specially Nitro paraffin compound additives have high oxygen contents is then molecular structure. The development of engine design has also help in reducing emission level considerably. The other way to reduce emission is by blending the diesel with different additives has to prove very successful and hence become a point of research in this field from last two decades. We have so many additives available blended with diesel and used in CI engine. Those additives with oxygenated compounds are most widely used in Diesel, as the participation of their oxygen in reactions leads to a better combustion thus lowering emission. Their molecular structure and oxygen content have direct influence on soot reduction. In order to decrease soot formation, 11-21% volume of oxygenate chemicals should be blended with diesel fuel. When additives are added they alter the physical and chemical properties such as density, viscosity, volatility and cetane index significantly. Nitro paraffin is one additive which has high oxygen content in then molecular structure. By addition of additives, we can improve the performance via the increase of thermal energy output and combustion product alteration.

4.1.1 Merits of Additives

Following are the merits of additives:-

- Engine Performance It has been found out that some of additives improves thermal efficiency upto 19% without affecting the torque.
- Emissions Reduction:- Diesel additives can decreases pollutants and greenhouse gas emissions upto 55% or more.

4.4.2 Demerits of Additives

Following are the demerits of additives:-

- Fuel Cost: The high cost of additives increases the cost of fuel.
- Preparation of blend: Preparation of diesel additives blend are difficult in some cases.

4.2 Diesel Engine Pollutants

The pollutants from diesel fuel vehicles are Particulate Matter (PM), smoke, NOx, Sulphur di-oxide, CO and HC. Most pollutants are emitted from the exhaust. Because diesel engines operate at high air-fuel ratios, they tend to have low HC and CO emissions. They have considerably higher PM emissions than gasoline-fueled vehicles; however, for heavy-duty vehicles CO, HC and NOx emissions in the exhaust also vary with driving modes, engine speed and load.

5. Methodology

For test engine, windows based engine performance analysis software package “engine-soft” was taken for on line performance evaluation. The emissions of various gases were measured by fuel efficiency monitor. The tests were conducted at the rated speed of 1500 rpm at different loads. The engine was started with diesel fuel and warmed up. The warm up period ends when cooling water temperature is stabilized. Then fuel consumption, brake power, brake specific fuel consumption, brake thermal efficiency, exhaust gas temperature etc. were measured. Same procedure was repeated for additives-diesel -cotton seed biodiesel.

Fig -4: Experimental test set up

Fig -5: Fuel efficiency monitor

Table -2: Specification of Engine used

Particulars	Specifications
Product	VCR Engine test setup 1 cylinder, 4 stroke, Diesel (Computerized)
Engine	Make Kirloskar, Type 1 cylinder, 4 stroke Diesel, water cooled, power 3.5 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm. 661 cc, CR 17.5, Modified to VCR engine CR range 12 to 18
Dynamometer	Type eddy current, water cooled, with loading unit
Propeller Shafts	With universal joints
Fuel Tank	Capacity 15 lit with glass fuel metering column
Calorimeter & Pump	Pipe in pipe, Mono-block Pump
Crank angle	Resolution 1 Deg, Speed 5500 RPM
sensor	with TDC pulse
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load Sensor	Load cell, type strain gauge, range 0-50 Kg
Rota meter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Overall Dimensions	W 2000 x D 2500 x H 1500 mm

6. LITERATURE REVIEW

6.1 Advantages of biodiesel

- Biodiesel is Environmentally Friendly.
- Biodiesel has Economic Advantages.
- No Engine Modifications Necessary.
- Biodiesel can be made at Home.
- Biodiesel can be made from Waste Products.
- Biodiesel Byproducts.
- Biodiesel prolongs Engine Life.

6.2 Disadvantages of biodiesel

- Biodiesel Gels in Cold Weather.
- Biodiesel Grows Mold.
- Biodiesel Fuel versus Food.
- Biodiesel has Higher NOx Emissions.
- Biodiesel decreases Horsepower.

7. CONCLUDING REMARK AND SCOPE FOR THE FUTURE WORK

7.1 CONCLUSION

Cotton seed oil is renewable, clean burning fuel. Cotton seed Biodiesel blends can show performance characteristics close to diesel (Brake power, mechanical efficiency, and brake specific fuel consumption) hence can be used in compression ignition engine to reduce use of diesel. And in this work we will try to improve brake thermal efficiency and reduce emission by adding additives.

Although calorific value of Cotton seed Biodiesel is lower than that of diesel, but by using some additives it may be improved. Emission of blended fuel more (CO, NO) but it can be reduced by supercharging, exhaust gas recirculation & catalytic converter. It is observed that the exhaust emission reduced by Cotton seed Biodiesel .Also we will try to reduce emission (NO) by adding additives.

If Cotton seed Biodiesel production is done in mass basis, the use of diesel may be reduced significantly also cost will reduce drastically.

7.2Scope for the Future Work

In future we can establish cotton seed biodiesel fuel station so that we will independent on fossil fuel. Simultaneously we have to design vehicle engine which run by cotton seed biodiesel. We have to provide Supercharger, Turbocharger and Exhaust Gas Recirculation for better performance and lower emission of engine.

In this way we can achieve goal of green revolution and sustainable development in science and technology.

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