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Experimentally the performance and exhaust emission characteristics by adding additive as ethanol in methyl ester of rice bran oil in CI engine

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ABSTRACT

One of the methods to reduce the use of fossil fuel is blending ethanol with fossil diesel. However, an emulsifier or a co-solvent is needed to homogenize the diesel-ethanol blends. This project is aimed to investigate experimentally the performance and exhaust emission characteristics by adding additive as ethanol in methyl ester of rice bran oil in CI engine. The experimental results showed that the highest brake thermal efficiency was observed with 5% ethanol in the diesel-biodiesel-ethanol blend was lower than that of diesel fuel. The hydrocarbons and smoke were lower than that of diesel fuel, the rice bran oil biodiesel can be used as an additive to mix higher percentage of ethanol in diesel-ethanol blends to improve the performance and reduce the emissions of a diesel engine.

Keywords— *Biodiesel, Methanol, Kirloskar, Experimental, Ethanol, Bio fuel*

1. INTRODUCTION

Energy is very important for life quality and social development of people as well as economic growth. Industries are forced into looking for new products to meet new specifications. This can be achieved by a new formulation of existing fuels. Fossil fuels have been an important conventional energy source for years. The climate changes occurring due to increased carbon Dioxide (CO_2) emissions and global warming, increasing air pollution and depletion of fossil fuels are the major problems in the present century. The present researchers have focused on the biofuels to reduce dependence on fossil fuels and to reduce air pollution. The biofuels can play an important role towards the transition to a lower carbon economy and also combine the benefits of low greenhouse emissions with the reduction of oil import.

1.1 Biodiesel definition

Biodiesel is the first generation biofuel of biomass which derived from vegetable oils, animals' fats, or recycled restaurant grease for use in diesel vehicles. Biodiesel's physical properties are similar to those of petroleum diesel, but it is a cleaner-burning alternative. Using biodiesel in place petroleum diesel can reduce emissions.

Fuels are any materials that store potential energy in forms that can be practically released and used as heat energy. Combustion or burning is the sequence of exothermic chemical reactions between a fuel and an oxidant accompanied by the heat and conversion of chemical species. In a complete combustion reaction, a compound reacts with an oxidizing element, such as oxygen or fluorine, and the products are compounds of each element in the fuel with the oxidizing element. The combustion of methane as follows:

$$CH_4\ (g) + 2O_2\ (g) - CO_2\ (g)\ 2H_2O\ (g)$$

Liquid fuel, Solid fuel, and gaseous fuel are the major types of fuel. Biodiesel comes under the liquid non-conventional fuel.

1.2 Blend

A blend is a mixture of two or more different things or substances. Blends of biodiesel and conventional hydrocarbon-based diesel are products most commonly distributed for use in the retail diesel fuel marketplace. Much of the world uses a system known as the 'B' factor to the state the amount of biodiesel in any fuel mix.

100% Biodiesel referred to as B100.
20% Biodiesel, 80% Petrodiesel- B20 ROME
15% Biodiesel, 80% Petro diesel and Ethanol 5%– B20E5ROME
17% Biodiesel, 80% Petro diesel and Ethanol 3%– B20E3ROME
19% Biodiesel, 80% Petrodiesel and Ethanol 1%– B20E1ROME

1.3 Additives definition

Something that is added as one substance to another to alter or improve the general quality or to counteract undesirable properties.

1.4 Diesel fuel additive

It helps to maintain diesel engine performance by keeping fuel injectors clean and improving the lubricity of diesel fuel.

The additive can withstand the high temperature of the combustion chamber not only cleans the engines. But act as catalysts thereby reducing the consumption of diesel by 6 to 12% and harmful carbon and particles emissions substantially reduces around 50% in India.

- **Brake power of the engine:** Brake power is the power output of the drive shaft of an engine without the power loss caused by gears, transmission, and friction, etc. It's called also pure power, useful power, true power or wheel power as well as other terms.

- **Indicated power of the engine:** The indicated power is partially consumed in overcoming the frictional forces within the engine and setting the auxiliary mechanisms in motion. The indicated power may be defined as the sum of the power produced at the crankshaft (actual horsepower) and the power consumed by losses (friction horsepower).

- **Total fuel consumption:** It is the mass of fuel consumed at a particular load consumed at a particular load per hour. It is expressed in kg/hr.

- **Specific fuel consumption:** It is defined as the mass of fuel consumed per hour per brake power of the engine. Its unit is Kg/KW-hr.

- **Mechanical efficiency:** Mechanical efficiency measures the effectiveness of a machine in transforming the energy and power that is input to the device into an output force and movement.

- **Brake thermal efficiency:** Brake thermal efficiency is defined as the brake power of a heat engine as a function of the thermal input from the fuel. It is used to evaluate how well an engine converts the heat from a fuel to mechanical energy.

- **Indicated thermal efficiency:** Indicated thermal efficiency is the work done by fuel combustion inside a cylinder over a given time interval divided by the total heat content of the fuel supplied to the cylinder during that time.

- **Emissions test and characteristics:** The emissions test is a conducted engine to check for pollutant emissions produced. There are generally specific standards an engine must pass to be cleared from the emissions test. Emission test performed while using biodiesel on the engine. The devices such as Gas Analyzers, DLC scanner. Emission test identifies the hydrocarbons, nitrogen oxide, carbon monoxide, carbon dioxide content in the fuel by the equipment.

  EPA provides emission standards such as for vehicle as follows vehicles must stay under 4.2 g/millions of carbon monoxide, nitrogen oxide emissions for a duty vehicle is 0.6 g/millions transitional low emission vehicle (TLEV) passenger car is 0.156 g/millions of hydrocarbons.

2. OBJECTIVE

The main objective of the present work is to study the various parameters such as performance and emission characteristics for the biodiesel of proportions B0, B20, B20E1, B20E3, and B20E5 of the rice bran oil and to determine the suitable alternative to diesel.

3. PROBLEM SPECIFICATION

To achieve the objective have to new biodiesel from vegetable oil resources such as rice bran oil. And we made a load test on Kirloskar single cylinder four stroke diesel engine and Emission characteristics also noted.

4. METHODOLOGIES TO MEET OBJECTIVES

The methods have performed to meet the objective as follows:

4.1 Transesterification process

This is the process we have performed to make biodiesel from vegetable oil a resource reacts with alcohols and catalyst.

4.1.1 Requirements for biodiesel preparation

The requirements and process involve while making biodiesel as follows for our work discussed in this part.

1. **Vegetable Oil Resource:** From the literature review, we found the following vegetable oil used as a feedstock for biodiesel preparation. The rice bran oil is taken as feedstock for the present work.
2. **Chemical Components:** Chemical components needed to perform the transesterification process. The transesterification process discussed upcoming topics briefly. The chemical components used for our project as follows:
   - **(a) Methanol:** Methanol (CH_3OH) is used in our project to replace glycerol ($C_3H_5(OH)_3$) with the supporting of NaOH catalyst. Glycerol has three sites upon which fatty acids can be attached, while methanol has only one. About 150 ml of CH_3OH for making biodiesel from 750 ml of vegetable oil.
   - **(b) NaOH:** Sodium hydroxide is a chemical component normally of used as a catalyst for encouraging the reactions as possible lowest time. About 2.62 gms of NaOH for making biodiesel from 750 ml of vegetable oil.

4.1.2 Equipments and apparatus

The Equipment's used to make biodiesel from vegetable oil by transesterification process. The equipment's for our work used as follows:

a) Magnetic stirrer

A magnetic stirrer is an electrical device, used to rotate the chemicals while reaction carried out for better bonding by magnetic action. The Magnetic stirrer used for our work capable of rotating at 1600 rpm and it heated the fuel up to 80^0 C. The rotary action made by the magnetic pallet. The magnetic stirrer as shown in the following figure 1:

Fig. 1: Magnetic stirrer

b) Separation Funnel

Separating funnel is an equipment to separate biodiesel from the glycerine content after the transesterification process. After separation, the biodiesel consumes the top area and the glycerol consumes a bottom area of the separation funnel. Figure 2 shows the separation funnel as follows:

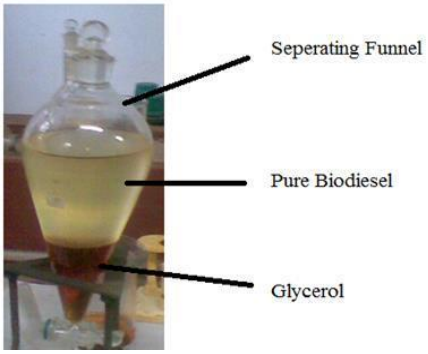
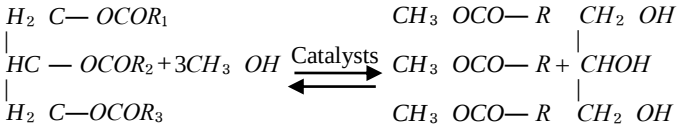


Fig. 2: Separation funnel

4.2 Transesterification Process

Transesterification is the chemical process which replaces one type of alcohol for another in an ester. An ester is made by combining an alcohol with an acid. The transesterification Process as follows in the chemical process:



Triglyceride (Parent oil) | Methanol (Alcohol) | Methyl esters (Biodiesels) | Glycerol

Equation: Transesterification process

From the chemical process found that vegetable oil is an ester of glycerol with long chain fatty acids. The formula for vegetable oil is C_3H_5 $(RCOOH)_3$, With the fatty acids represented by RCOOH attached to a glycerol ($C_3H_5(OH)_3$) molecule. Methanol (CH_3OH) is used to replace glycerol ($C_3H_5(OH)_3$).

The following parameters considered in the project as follows:

. Reaction temperature
. The ratio of alcohol to vegetable oil
. Amount of catalyst
. Mixing intensity (RPM)
. Raw oils used
. Catalyst

4.2.1 Experimental setup and experimentation

Experiments have been conducted to run with mechanical dynamometer using biodiesel of rice bran. The experimental setup used in this study is given below.

4.2.2 Experimental Setup

The experimental setup used for studying the Emission characteristics of biodiesel of rice bran is shown in figure 3.

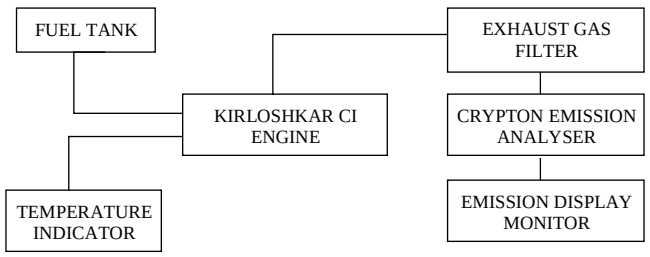


Fig. 3: Engine setup

The setup includes a CI engine, fuel supply system to feed biodiesel, gas analyzer, temperature indicator and emission display monitor. The details and specifications of the instruments are given below.

5. KIRLOSKAR ENGINE

The CI engine used in the experimental study is KIRLOSKAR model four-stroke single cylinder diesel engine and it is capable of producing 7HP. The specification of the engine as given below:

Model	: Kirloskar
Power	: 7 HP (5.2kw)
Speed	: 1500RPM
Stroke length	: 110mm
Bore diameter	: 875mm
Brake drum radius	: 0.175m

5.1 Crypton gas analyzer

The gas analyzer is capable of monitor the five gases that need to be monitored according to the EPA emissions standards. These gases are carbon monoxide (CO), hydrocarbons (HC), carbon dioxide (CO_2), and oxygen (O_2) and NO_x. The gas analyzer is inserted in the tailpipe of the filter which is connected to the exhaust gas pipe of the engine to measure the levels of emission of these gases. The gas analyzer uses a sampling probe that tests a tiny part of the exhaust gases. And the Crypton gas analyzer consists of different sensors for analyzing purpose.

5.2 Temperature sensor and indicator

The temperature sensor used to measure the temperature of inlet water temperature, exhaust gas temperature, outlet water temperature for different loading condition is capable of measuring 0^0c to 300^0c.

The performance study has been carried out for different blends of biodiesels of rice brain oil with diesel oil. The emission level is also measured. The maximum load for the CI engine is 19.28kg. The net load, water temperature, exhaust gas temperature and time is taken for 10cc fuel have been recorded.

6. CONCLUSION

The energy sources such as these could partially replace the use of those fuels which are responsible for environmental pollution and may be scarce in the future.

The following conclusions have been drawn from this study:

- B20E3 proportion slightly increases in Brake thermal efficiency compared to the diesel.
- B20E1 and B20E3 increases in Indicated thermal efficiency compared to the diesel.
- The HC emission decreases in B20 compared to the diesel.
- The No_x emission of the B20E1 has closer performance results compared to the diesel
- The overall emission reduces for biodiesel of all range of blends.

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