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Performance and Emission Study on Diesel Engine Using Different Blends of Neem Bio-Diesel

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Abstract: **In developing countries like India where adversely impacted by fossil fuels and continuing rise in global price of crude oil.Bio-diesel is fuel comprised of mono alkyl ester of long chain fatty acids derived from vegetable oil.Bio-diesel is an oxygenated fuel and regarded as clean alternative fuel to reduce exhaust emissions.Bio-diesel is produced by trans-esterification of triglycerides of edible and vegetable oil using methanol with alkaline catalyst NaOH/KOH.Trans-esterification under lab setup blended with various ratios (10%,20%,30%,40%,50%).The experimental investigation was carried out on single cylinder diesel engine using different blends of neem bio-diesel at various.**

I.INTRODUCTION

In the modern world, the demand for non-renewable energy sources is increasing day by day due to modernization and mechanization. Demand for electricity and enormous increase in the number of automobiles has resulted in greater demand for petroleum products. The increasing demand for the petroleum based fuels has led to oil crises in the recent times. Therefore attention has been focused on developing the renewable or alternate fuels to replace the petroleum based fuels for transport vehicles. Fossil fuels are still being created today by underground heat and pressure; they are being consumed more rapidly than they are being created. Insufficient quantities or unreasonable price of petroleum fuels deeply concerns us whereas the renewable energy is a promising alternative solution because it is clean and environmentally safe .Due to petroleum fuel, Pollution and accelerating energy consumption have already affected equilibrium of the earth's landmasses and biodiversity. Since petroleum diesel and gasoline consist of blends of hundreds of different chemicals of varying hydrocarbon chains, many of these are hazardous and toxic. Carbon monoxide (produced when combustion is inefficient or incomplete), nitrogen oxides (produced when combustion occurs at very high temperatures), sulfur oxides (produced when elemental sulfur is
present in the fuel), and particulates that are generally produced during combustion are other specific emissions of concern. So it is time to search for its alternative fuels .There are several alternative sources of fuel like vegetable oils, biogas, biomass, primary alcohols which are all renewable in nature. Among these fuels, vegetable oils appear to have an exceptional importance as they are renewable and widely available, biodegradable, non-toxic and environment friendly. The alternative fuel that much closer to diesel engine is 'biodiesel'. Biodiesel refers to a family of products made from vegetable oil or animal fats and alcohol, such as methanol or ethanol, called mono alkyl esters of fatty acids. Study shows that, on the mass basis, biodiesel has an energy content of about 12% less than petroleum based diesel fuel. It reduces unburned hydrocarbons (HC), carbon monoxide (CO), and increase oxides of nitrogen (NOx) than diesel-fueled engine. It is a domestic, renewable fuel for diesel engine derived from natural oil like Neem oil. Biodiesel is environment friendly liquid fluid similar to conventional diesel fuel in engine tests, the power and fuel consumption. Neem is a tree in the family 'maliaceae' which grows various parts in Bangladesh. It's scientific name '*Azadirachta indica'*. The evergreen tree is large, reaching 12 to 18 meters in height with a girth of up to 1.8 to 2.4 meters. The seeds have 40% oil which has high potential for the production of biodiesel. It has a higher molecular weight, viscosity, density, and flash point than diesel fuel. Neem oil is generally light to dark brown, bitter and has a strong odor that is said to combine the odors of peanut and garlic. Neem comprises mainly of triglycerides and large amounts of triterpenoid compounds. It contains four significant saturated fatty acids, of which two are palmitic acid and two are stearic acid. It also contains polyunsaturated fatty acids such as oleic acid and linoleic acids.

II,BIODIESEL PRODUCTION

Biodiesel production is the process of producing the biofuels, biodiesel, through either transesterification or alcoholysis. It involves reacting vegetable oils or animal fats catalytically with a short-chain aliphatic alcohol .The major steps required to synthesize biodiesel are as follows:

2.1 FEEDSTOCK PRE-TREATMENT:

If waste vegetable oil (WVO) is used, it is filtered to remove dirt, charred food, and other non-oil material often found. Water is removed because its presence causes the triglycerides to hydrolyze, giving salts of the fatty acids (soaps) instead of undergoing transesterification to give biodiesel.

2.1.1 Determination and treatment of free fatty acids:

A sample of the cleaned feedstock oil is titrated with a standardized base solution in order to determine the concentration of free fatty acids (carboxylic acids) present in the waste vegetable oil sample. These acids are then esterified into biodiesel, esterified into bound glycerides, or removed.

2.1.2 Reactions:

While adding the base, a slight excess is factored in to provide the catalyst for the transesterification.

2.1.3 Product purification:

Products of the reaction include not only biodiesel, but also by products, soap, glycerine, excess alcohol, and trace amounts of water. All of these by products must be removed, though the order of removal is process-dependent.

The density of glycerine is greater than that of biodiesel, and this property difference is exploited to separate the bulk of the glycerine by product. Residual methanol is typically removed through distillation and reused, though it can be washed out (with water) as a waste. Soaps can be removed or converted into acids. Any residual water must be removed from the fuel.

2.2 Transesterification process:

Animal and plant fats and oils are typically made of triglycerides which are esters of free fatty acids with the trihydric alcohol, glycerol. In the transesterification process, the alcohol is deprotonated with a base to make it a stronger nucleophile. Commonly, ethanol or methanol is used. As can be seen, the reaction has no other inputs than the triglyceride and the alcohol.

Normally, this reaction will proceed either exceedingly slowly or not at all. Heat, as well as an acid or base are used to help the reaction proceed more quickly. It is important to note that the acid or base are not consumed by the transesterification reaction, thus they are not reactants but catalysts.

Almost all biodiesel is produced using the base-catalyzed technique as it is the most economical process requiring only low temperatures and pressures and producing over 98% conversion yield (provided the starting oil is low in moisture and free fatty acids). However, biodiesel produced from other sources or by other methods may require acid catalysis which is much slower. Since it is the predominant method for commercial scale production, only the base-catalyzed transesterification process will be described .

An example of the transesterification reaction equation, shown in skeletal formulas Since natural oils are typically used in this process, the alkyl groups of the triglyceride are not necessarily the same. Therefore, distinguishing these different alkyl groups, we have a more accurate depiction of the reaction:

During the esterification process, the triglyceride is reacted with alcohol in the presence of a catalyst, usually a strong alkali (NaOH, KOH, or Alkoxides). The main reason for

The calculated quantity of base (usually sodium hydroxide) is added slowly to the alcohol and it is stirred until it dissolves. Sufficient alcohol is added to make up three full equivalents of the triglyceride, and an excess of usually six parts alcohol to one part triglyceride is added to drive the reaction to completion.

doing a titration to produce biodiesel, is to find out how much alkaline is needed to completely neutralize any free fatty acids present, thus ensuring a complete transesterification. Empirically 6.25 g / L NaOH produces a very usable fuel. One uses about 6 g NaOH when the WVO is light in colour and about 7 g NaOH when it is dark in colour.

The alcohol reacts with the fatty acids to form the mono-alkyl ester (or biodiesel) and crude glycerol. The reaction between the bio lipid (fat or oil) and the alcohol is a reversible reaction so the alcohol must be added in excess to drive the reaction towards the right and ensure complete conversion.

III.Methodology

- Raw neem oil was bought from the commercial oil vendor.
- 500 ml of raw neem oil is introduced into reacter flask and heated to 60^0C F for about 10 mins.
- 300 ml of methanol is mixed to the oil (60%v/v of oil).
- 6 ml of concentrated sulphuric acid (H_2 SO_4) is mixed to the mixture.
- This mixture is stirred on hot plate at 50^0C for 1 hour after which it is allowed to settle for 2 hours.
- The water content at top surface is removed by pouring the mixture into separation flask.
- To convert the ester of neem to methly ester of neem oil transesterification process is done.
- 1% of NaOH catalyst is dissolved in 6:1 of alocohol to oil.
- The alcohol mixture is mixed to the esterified neem oil in round bottom flask and heated at 60^0C and stirring is done.
- After the completion of reaction the mixture is poured into gravity separation flask and allowed to settle down for 4-5 hours.

- The layer formed at the bottom contains glycerol while the upper part is biodiesel.
- The biodiesel contains traces of catalyst and methanol in it.
- The traces of catalyst are removed by warm water wash.
- Before removing the catalyst it is necessary to remove methanol to avoid formation of soapy solution.
- The boiling point of methanol is 65^0C, it can be removed by heating the oil to 75^0C and keeping at this temperature for about 5-10 mins.
- Then the biodiesel is mixed with 10% of warm water and kept in separating flask and leaving it to settle down for 5-6 hours.
- The lower layer contains traces of catalyst while upper layer is pure biodiesel.
- To check whether the catalyst is removed or not, Phenolphthalein indicator is added, if it turns into pink colour it means the biodiesel still contains traces of catalyst and waster wash need to be repeated.
- The pH of the biodiesel is checked whether the biodiesel contains any water content in it.
- After the trans-esterified oil was obtained, the biodiesel is blend with diesel in the ratio like (B20,B40,B100) and the performance test is conducted.

IV.PERFORMANCE TEST

4.1 SETUP

An experimental setup was made with necessary instruments to evaluate the performance and emission parameters of the engine. The overall view of the experimental setup is shown in the figure below. The chapter discusses the details of the experimental setup, instruments used and software needed for the work.

4.2 Test engine

A Single cylinder vertical air cooled four stroke direct injection compression ignition engine with a compression ratio 17.5:1, developing 4.4 kW power at 1500 rpm was used for our work. The details of the engine are given in appendix 1. The engine was always run at its rated speed of 1500 rpm. The governor of engine was used to control the speed of engine. Cooling of the engine was accomplished by supplying water trough the jackets on the engine block and cylinder head. The engine had a hemispherical combustion chamber with overhead valves operated through push rods.

Figure 5.2: Kirlosker four stroke Single cylinder vertical air cooled engine

4.3Computerised digital data acquisition system

The cylinder pressure and TDCSignals were acquired and stored on a high speed computer based digital data acquisition system. The stored Signals were processed with specially designed software to obtain the performance parameters (B.P., volumetric efficiency, etc.) combustion parameters like peak pressure, maximum rate of pressure rise etc

4.4 Optical TDC positioning sensor

An electro optical sensor was fabricated and used to give a voltage pulse exactly when the TDCposition is reached. This sensor consists of a well aligned pair of infrared diode and phototransistor so that infrared rays emitted from diode fall on the phototransistor when not interrupted. Voltage Signals from the optical sensor were fed toanalog to digital converter and then to data acquisition system along with pressure Signals for recording.

4.5 Load and speed measurement

The engine was coupled to an electrical dynamometer. The specifications of the electrical dynamometer are given in appendix 3. The dynamometer unit comprises basically a rotor mounted on shaft running on bearings which rotates within a casing supported in ball bearing trunnions which forms the part of the bed plate of the machine. The dynamometer load measurement is from a strain gauge load cell and speed measurement is from a shaft mounted with a sixty tooth wheel and with magnetic pulse pickup. The voltage pulses from the sensor are sent to digital data rpm meter for pulse conversion and it displays the engine speed with an accuracy of 1 rev/min.

4.6 Temperature measurement

The temperature of the exhaust gas was measured with thermocouple. The digital indicator with automatic room temperature compensation facility was used. The temperature indicator was calibrated periodically.

4.7Pressure measurement

In cylinder pressure was measured using a standard AVL PRESSURE TRANSDUSER GH12D smoke measuring system. The measuring instrument consists of a sampling pump that sucks a definite quantity of exhaust sample through a white filter paper. The specification of the diesel tune is given in the appendix 6. The reflectivity of the filter paper was then measured using a evaluating a unit. The unit is mounted in a steel box that comprises a photoelectric cell pick up. The unabsorbed portion of light is reflected back on to the annular photoelectric cell that surrounds the light source. The intensity of the reflected light generates a current that is measured by a sensitive ammeter which gives the smoke reading in terms ofbosch units.

4.8 Five gas analyzer

An AVL DIGAS 444 (FIVE GAS ANALYZER) make analyzer was used. The analyzer is a fully microprocessor controlled system employing non-destructive infrared techniques. The 444 measures CO, HC, CO_2, O_2, NO, and another channel for measuring CO_2 plus a further channel employing electrochemical measurement of oxygen.

.4.9 Test procedure:

The performance testing is done so as to get the various performance parameters of the engine after running it in the compression ignition engine. The test is completed in a no. of steps explained as follows:

- First B20 at 23^0 pressure 200 bar.
- Second B40 at 23^0 pressure 200 bar.
- Third B100 at 23^0 pressure 200 bar.
- Diesel at 23^0 pressure 200 bar.

- The neem oil biodiesel is filled in the fuel tank and any air bubbles present in the flow line was removed so that there is no air lock.
- The engine was started with no load and was kept running for sometime till it stabilized.
- Then the performance characteristics were checked in the attached computer using lab view software.
- Emission characteristics were noted using the AVL gas analyser by inserting the gas analyser probe in the exhaust.
- The same procedure was repeated for different electrical loads like (0% ,25%,50% ,75%, 100%) and subsequently the performance characteristics were recorded.

IV CONCLUSION

Biodiesel is a domestic fuel alternative and can contribute to a more stable supply of energy. The biodiesel fuel production process has evolved considerably to minimize the original problems with viscosity. Today, biodiesel is an increasingly attractive, non-toxic, biodegradable fossil fuel alternative that can be produced from a variety of renewable sources. Neem oil has potential as an alternative energy source. But it is not possible for oil alone to solve dependency on foreign oil within any particular time frame. Significant commitment of resources would require increasing production of Neem oil. These needs are being met with recent advances in instrumentation technology. The emphasis should be made to invest in agriculture sector for exploitation of existing potential by establishing model seed procurement centers, installing preprocessing and processing facilities, oil extraction unit, transesterification units etc. The organized plantation and systematic collection of Neem oil, being potential bio-diesel substitutes will reduce the import burden of crude petroleum.

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