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Properties of biodiesel fuel blended with Nano particles

Amit
Assistant Professor, Department of Mechanical Engineering, U.I.E.T, M.D.U, Rohtak, Haryana, India

Abstract
Biodiesel is investigated as the main alternative fuel for compression ignition engines. In this research work properties of biodiesel fuel with nano-particles are determined. Combustion parameters such as density or specific gravity, viscosity and calorific value of different types of biodiesel fuel blended with nano-particles such as cobalt oxide and iron oxide are presented in this article. Cobalt and iron oxide nano particle was added with jatropha biodiesel in mixed proportion of 10,20,30,40,50,60 parts per million. The range of nano particle size was 30-70 nanometer.

Keywords: biodiesel, nano-particle, viscosity, calorific value

Introduction

Biodiesel is investigated as the main alternative fuel for compression ignition engines because of their properties such as heavy oxygen content and higher kinematic viscosity. Biodiesel containing 12 % oxygen helps in better combustion of the fuel. However the usage of biodiesel in engines is not familiar and commercialized. Many strategies have been followed by researchers around the countries such as biodiesel blends, engine modification and alteration in fuel formulations. Among them, fuel formulation techniques are considered as the most beneficial way of enhancing the engine performance substantially. Nano particle blended test fuels show better thermal properties because of advanced surface area to volume fraction of the nano particle.

Experimental Setup

The various properties of biodiesel blended with nano-particles are determined and compared with those of the base fuels. The properties studied are density or specific gravity, viscosity and calorific value. The method for preparation of the fuels with the nanoparticles additive along with the experimental methods for obtaining the fuel properties and the performance test are all presented below.

Preparation of Fuels

Jatropha Biodiesel is prepared by transesterification process with ethanol by using NaOH as catalyst. Cobalt and Iron oxide nano particles are prepared in Nano-Technology Laboratory. The morphology of the alumina and cobalt oxide nanoparticles are determined by Scanning Electron Microscope and the crystalline phase of nanoparticles are determined by X-ray Diffraction. Six types of test fuels are prepared by equally dispersing Iron Oxide (Fe_2O_3) and Cobalt Oxide (Co_3O_4) nano particles in mass fraction forming 10,20,30,40,50 and 60 ppm with Jatropha biodiesel. To prepare the JBD10F10C test fuel, nano particles Iron oxide (Fe_2O_3) and cobalt oxide (Co_3O_4) of 10 ppm each, are added to the Jatropha biodiesel and dispersed using an apparatus called Ultrasonicator. An Ultrasonicator is used for equally dispersing Fe_2O_3 and Co_3O_4 nano particles in Jatropha biodiesel for nearly 1–1.5 hours before the start of the experiment. The stability characteristic tests are carried out for the test fuels in graduated test tubes and found stable in 3 days. The same procedure is carried out to prepare JBD20F20C, JBD30F30C, JBD40F40C, JBD50F50C, JBD60F60C respectively. Where JBD10F10C is 10 ppm iron oxide nanoparticle and 10 ppm cobalt oxide nano particle in blend of jatropha biodiesel. JBD20F20C is 20 ppm iron oxide nanoparticle and 20 ppm cobalt oxide nano particle in blend of jatropha biodiesel. JBD30F30C is 30 ppm iron oxide nanoparticle and 30 ppm cobalt oxide nano particle in blend of jatropha biodiesel. JBD40F40C is 40 ppm iron oxide nanoparticle and 40 ppm cobalt oxide nano particle in blend of jatropha biodiesel. JBD50F50C is 50 ppm iron oxide nanoparticle and 50 ppm cobalt oxide nano particle in blend of jatropha biodiesel. JBD60F60C is 60 ppm iron oxide nanoparticle and 60 ppm cobalt oxide nano particle in blend of jatropha biodiesel.

Various Properties of blended fuel and their measuring devices

The various parameters and their measuring instruments are following:-

Viscosity: Viscosity is the physical property of fluid which measure the resistance offered by fluid particles during flow. It is considered as the measure of fluid friction while fluid is in motion. It is an important characteristic which determines the ease of atomization of fuel in C.I. engine. If viscosity of fuel is higher, higher will be difficulty in atomization of fuel. It will also create a problem of choking of inlet system of fuel. So viscosity of fuel should be lesser. Redwood viscometer was used in measurement of viscosity of blends.

Fig 1: Redwood Viscometer

To measure the viscosity of oil, cylindrical oil cup is filled with oil up to the mark in cup. The oil is heated by heating the water bath. Thermometer is used to stir oil and measure the temperature of water bath and oil. When the oil reaches the temperature at which viscosity has to measure, the ball valve is lifted and oil is allowed to collect in 50cc flask.

Density or specific gravity

Density measures the mass of substance per unit volume. Specific gravity measures the density of fuel relative to the standard substance i.e. water. Density of different was measured using hydrometer. Different blends were taken in a jar and hydrometer was dipped into it and readings were taken.

Fig 2: Hydrometer

Calorific Value (C.V.)

Calorific Value of a fuel is the quantity of heat produced by its combustion - at constant pressure and under "normal" conditions (i.e. to *0ºC*, under a pressure of 1,013 mbar). There are two types of calorific value. One is Higher Calorific Value (H.C.V.) which is measured when the water vapour produced in combustion is entirely condensed and the heat contained by it is recovered. Other is Lower Calorific Value (L.C.V.) which is measured when heat of water vapour is not recovered. The calorific value of the fuel was determined with the Isothermal Bomb Calorimeter as per the specification given in ASTM D-240.

Result and Discussions

Various Properties such as viscosity, density and calorific value of blended fuel are determined from this experiment which are shown in form of graph.

Kinematic Viscosities for diesel and different blends (´ 10^{-6} m^2/s)

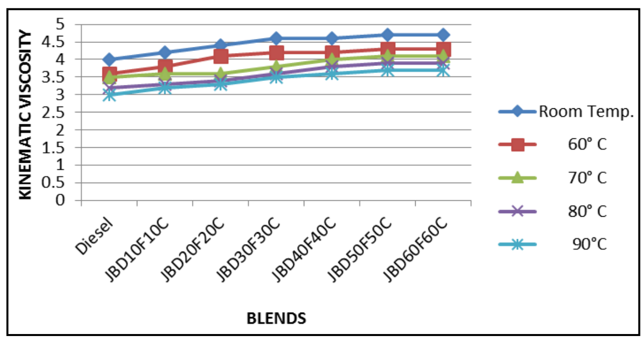

Fig 3

The above graph shows us the viscosity of diesel and its blends with jatropha biodiesel and nanopartcles. it is clear from the graph that the viscosity of blended fuel increases as the proportion of nanoparticles increases in the blend. As the temperature increases, viscosity of diesel and blended oil decreases. This improves the properties of blended oil as fuel.

Density or specific gravity

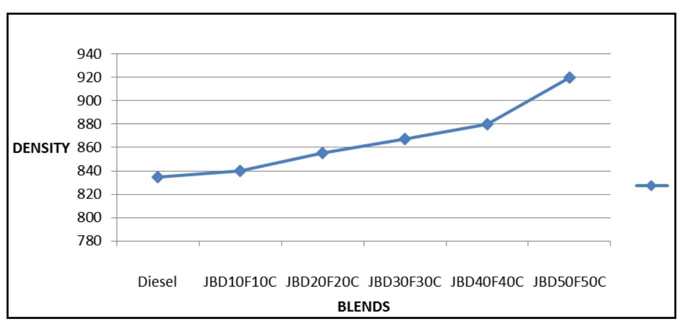

Fig 4

As shown by the graph density of blends of biodiesel fuel with nanoparticle is increased as the proportion of nano-particle increased in the blend.

Calorific Value (C.V.)

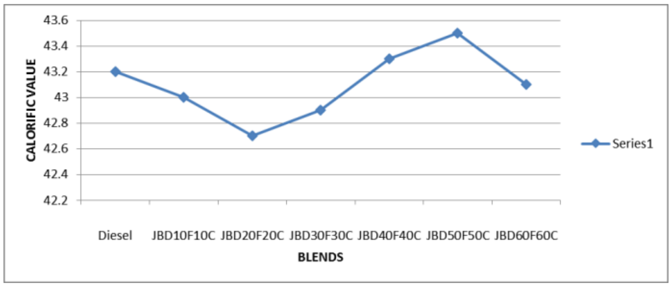

Fig 5

As shown by the graph calorific value of the fuel is decreased first for JBD10F10C and JBD20F20C and then increased for JBD30F30C and JBD40F40C and then decreased for JBD50F50C.

Conclusions

Blended fuel of jatropha biodiesel with nanoparticles of cobalt oxide and iron oxide show better physical properties as compare to diesel oil.

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