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Preparation of biodiesel fuel with iron oxide nano-fuel additives

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Abstract
There has been lots of development on biodiesel in different countries in the latest time and important things have picked up for it to produce it simply. In this investigation Jatropha seed oil (non-edible) is used and it is mixed with nano particle to find out its suitability for use as petro-diesel fuel. Investigation has been done to find out the different properties of blended fuel. Biodiesel was prepared from jatropha oil by transesterification process with ethanol by using NaOH as catalyst. The morphology of the nanoparticles are determined by Scanning Electron Microscope and the crystalline phase of nanoparticles are determined by X-ray Diffraction. The fuel obtained from experiment could be a major step towards the creation of an eco-friendly transportation fuel.

Keywords: biodiesel, transesterification, nano-particles, jatropha oil

Introduction

Due to gradual depletion of world petroleum reserves and the impact of environmental pollution, there is an urgent need for suitable alternative fuels for use in diesel engines. In view of this, vegetable oil is a promising alternative because it is renewable, environment- friendly and produced easily in rural areas, where, there is an acute need for modern forms of energy. Seeing the cost and edible oils consumption, the use of non-edible oils compared to edible oils is very significant. Jatropha tree or shrub grows practically all over India under a variety of agro-climatic conditions and it is commonly found in most of the tropical and subtropical regions of the world. Thus it ensures a reasonable production of seeds with very little inputs. It is evident that there are various problems associated with straight vegetable oils being used as fuel in compression ignition engines, mainly caused by their high viscosity. Although short term tests using neat vegetable oil showed promising results, longer tests led to injector coking, more engine deposits, ring sticking and thickening of the engine lubricant. These experiences led to the use of modified vegetable oil as a fuel. Although there are many ways and procedures to convert vegetable oil into a diesel like fuel, the transesterification process was found to be the most viable oil modification process.

Biodiesel, defined as the mono- alkyl esters of fatty acids derived from vegetable oil or animal fat, has demonstrated a number of promising characteristics, including reduction of exhaust emissions Transesterified, renewable oils have proven to be a viable alternative diesel engine fuel with characteristics similar to those of diesel fuel. In the present investigation, Jatropha oil is a non-edible oil and its methyl ester has been chosen to find out its suitability for use as fuel oil. The oil content of jatropha seed ranges from 30 to 35% by weight and common byproducts produced while processing the biodiesel are glycerol and oil seed cake. Glycerol is a byproduct of transesterification process Nano particle blended test fuels show better thermal properties because of advanced surface area to volume fraction of the nano particle. So, in this present experimental investigation, nano particles are blended in various parts per million (ppm) with Jatropha biodiesel to prepare fuel.

Biodiesel Production Methodology

Transesterification Process Jatropha methyl ester

Among the non-edible seeds produced in India, Jatropha is the most preferred because of its high oil content and biodiesel yield, Its Oil content is around 40%. Direct use of vegetable oil is not applicable to most of diesel engines as the high viscosity would prevent atomization and might damage the engine, So to decrease the viscosity and to make it useable in diesel engine, there is a process called transesterification. It is the process of reacting triglyceride of fatty acids (vegetable oil) with alcohol in the presence of a catalyst to produce glycerol and fatty acid esters. These fatty esters are known as biodiesel. Transesterification is the most common method for biodiesel production due to its simplicity, thus this method has been widely used to convert vegetable oil into biodiesel.

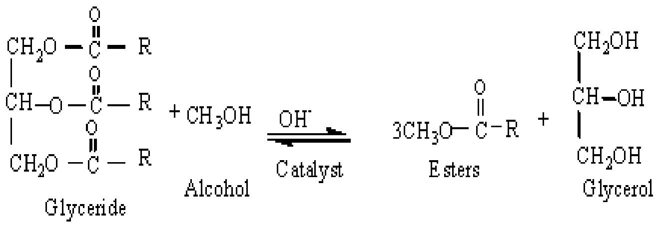

Fig 1: Transesterification Process

We prepared jatropha biodiesel by transesterification process of jatropha oil mixed with ethanol reacting with NAOH (sodium hydroxide) as catalyst heated to 50-60°C temperature with the help of magnetic stirrer with hot plate.

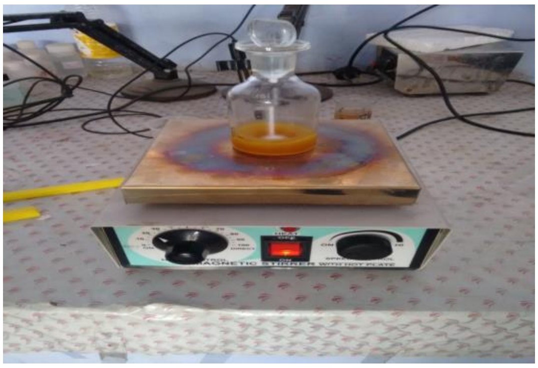

Fig 2: Jatropha biodiesel heated with magnetic stirrer hot plate

Fig 3: Prepared Jatropha biodiesel

Characterization Studies of Nanoparticles

The Iron oxide nanoparticles were prepared in nano-techonology laboratory and their detailed specifications are listed in the Table. The crystalline phase and the size of the iron oxide nanoparticles was determined by X-ray Diffraction (XRD) The morphology of the cobalt oxide nanoparticles are determined by Scanning Electron Microscope (SEM) and the crystalline phase of nanoparticles are determined by X-ray Diffraction.

Table 3: Details of Iron Oxide Nanoparticles

Item	Specification
Manufacturer	NIT-Kurukshetra, India
Chemical name	Iron Oxide (Fe_2O_3)
Molecular Weight	159.69 g/mol
Average particle size	41 Nm

Preparation of Nanoparticles Blended Biodiesel Fuels

The ultrasonication technique was adopted to disperse the Iron oxide nanoparticles in the biodiesel fuel. The Iron oxide nanoparticles were weighed individually by means of a digital weighing machine to a different dosage of say 10, 20, 30, 40, 50 and 60 ppm. Six types of test fuels are prepared by equally dispersing Iron Oxide (Fe_2O_3) nano particles in mass fraction forming 10, 20, 30, 40, 50 and 60 ppm with Jatropha biodiesel.

To prepare the JBD10F test fuel, nano particles Fe_2O_3 of 10 ppm, were added to the Jatropha biodiesel and dispersed using an apparatus called Ultrasonicator. An Ultrasonicator is used for equally dispersing Fe_2O_3 nano particles in Jatropha biodiesel for nearly 1–1.5 hours before the start of the experiment. The jatropha biodiesel was mixed with mechanical homogenizer set at the various agitation speeds of 1000, 1500, 2000, 2500 and 3000 rpm for 15 minutes at a room temperature of 32 °C. The stability characteristic tests are carried out for the test fuels in graduated test tubes and found stable for 3 days.

The same procedure is carried out for preparation of different blends JBD20F, JBD30F, JBD40F, JBD50F, JBD60F respectively. Where JBD10F is 10 ppm Iron oxide nano particle in blend of jatropha biodiesel. JBD20F is 20 ppm Iron oxide nano particle in blend of jatropha biodiesel. JBD30F is 30 ppm Iron oxide nano particle in blend of jatropha biodiesel. JBD40F is 40 ppm Iron oxide nano particle in blend of jatropha biodiesel. JBD50F is 50 ppm Iron oxide nano particle in blend of jatropha biodiesel. JBD60F is 60 ppm Iron oxide nano particle in blend of jatropha biodiesel.

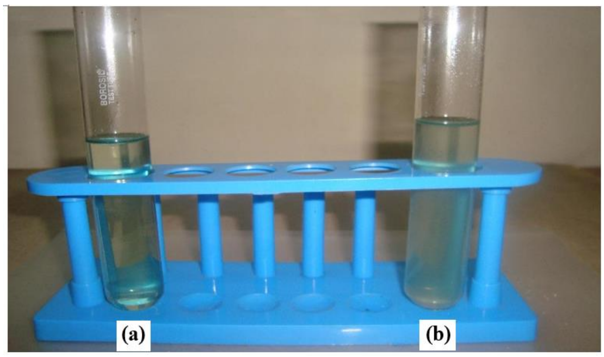

Fig 3.3.1: **(**a) Diesel (b) Nanoparticles immersed with diesel

Results and Discussion

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). The result is showed by graph which shows that for JBD10F and JBD20F there is decrease in C.V but for JBD30F, JBD40F and JBD50F there is increase in C.V which shows this better than diesel fuel.

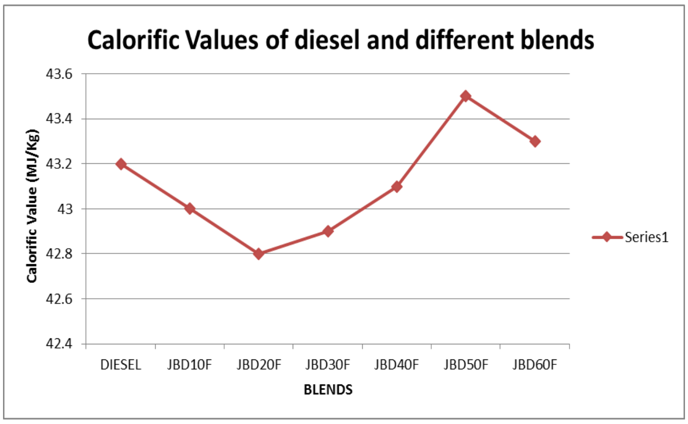

Fig 4

Conclusion

This study suggests that the jatropha oils can be used as a source of biodiesel by transesterification process and its blend with nano particle cobalt oxide shows better calorific value of fuel. The highest calorific value obtained for JBD50F.

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