



PERFORMANCE AND EMISSION ANALYSIS OF CARDANOL OIL BLEND WITH IRON OXIDE NANOPARTICLES AS ADDITIVE IN SINGLE CYLINDER DIESEL ENGINE

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Abstract— Oxygenated fuel like biodiesel has the potential to provide a reliable and a cost effective alternative to India's increasing future energy demands. They have a prospective future since they are renewable and can be produced easily in India's rural areas. Due to rapid industrialization and the increased number of vehicles on the road, the energy needs of the country are increasing rapidly. Oxygenated fuels can substantially replace the large demand for diesel to generate power for the industries and to fuel diesel engines of the vehicles. Synthesis of Cardanol seed oil with Iron oxide as additive is investigated under relatively moderate conditions. Iron oxide additive to improve the properties of biodiesel. In assessing the potential of the various proportion of Iron oxide the performance and emissions were analyzed and directly compared with pure Diesel. In spite of advantages of using them, most of the researches have reported higher NO_x emissions, which is a deterrent to the market expansion of these fuels. The Iron oxide nano particle is doping with various proportions to the cardanol biodiesel and run by the single cylinder Direct Injection diesel engine. The results showed that, the performance and emissions of oxygenated fuels reviewed with different loads.

I. INTRODUCTION

ONE of the most important elements to effect world economy and politics is sustainability of petroleum resources, which is the main source of world energy supply. However, the world energy demand is increasing rapidly due to excessive use of the fuels but because of limited reservoirs and instabilities in petrol supplier countries makes difficult to always provide oil. Also, world is presently confronted with the crisis of fossil fuel depletion. The petroleum crises since 1970s and uncertain situation in suppliers like Venezuela, Nigeria, and Iraq have accelerated the increment of oil prices. The increasing demand of petroleum in developing countries like China, Russia and India has increased oil prices. Besides, the combustion of petroleum based fuels causes environmental problems, which threatens wild life and human health. In addition, the combustion products cause global warming one of the most important world problem.

Petroleum fuels are being used in diesel engines, which have a wide range of use in all sectors. With a probable situation that oil demand cannot be met by petroleum based fuels, all the sectors contributed by oil based energy will

negatively be effected. With any probable petrol crisis, for all the sectors the alternative fuel is vital to be developed. In addition, pollutants have formed because of combustion of petroleum based fuels in diesel engines. Pollutants from diesel engines include carbon monoxide (CO), carbon dioxide (CO₂), sulphur dioxides (SO₂), oxides of nitrogen (NO_x) and particular matter (PM). NO_x and PM are the two primary pollutants of diesel engines. It was stated by Lloyd and Cackete that Diesel emissions contribute to the development of cancer; cardiovascular and respiratory health effects; pollution of air, water, and soil; soiling; reductions in visibility; and global climate change. Research on reducing emissions resulted from diesel engines and studies on decreased fuel consumption are being founded worldwide, especially in EU countries. There are many works on reliable researching and implementations and useful results came to exist. Research and developing alternative diesel engine fuel is one of the aspects of these studies

The alternative fuels must be technically acceptable, economically competitive, environmentally acceptable and easily available. Researches on biodiesel derived from vegetable oils and animal fat are being maintained to



alternative this kind of fuels to petroleum based diesel fuel. It has been concluded by many studies that as an alternative engine fuel biodiesel reduces the emissions of carbon monoxide (CO), hydrocarbon (HC), sulphur dioxide (SO₂) and particulate matter (PM) but NO_x to increase in the exhaust compared with diesel fuel, no aromatics, almost no sulphur, contains high oxygen by weight, non-toxic, biodegradable and high lubricant ability are its attractive properties. Although biodiesel has many advantages, it still has several properties, needed to be improved, such as lower calorific value, lower effective engine power, higher emission of NO_x, and greater sensitivity to low temperature.

In this Transesterification process has been taken as a process for conversion of cardanol oil to biodiesel. After Transesterification process, the biodiesel has been tested at the blending ratio of B20 with diesel. After this process, the biodiesel has been tested by adding Iron oxide Nano particles at the various proportions of 25ppm, 50ppm, 75ppm, 100ppm at the blending ratio of B20 with diesel. The output value has been compared with the diesel at different loads set on the engine. The experimental study, done in a standard, fully instrumented, four strokes, single cylinder direct injection diesel engine located at the Internal Combustion laboratory, Annamalai University.

II. METHODOLOGY

A. MATERIALS

Instructions The experimental was started with the procurement of the Komeng coconut shell, epoxy resin, hardener, SRM mould and PP. The coconut shell was collected from the coconut farm. The resin used was epoxy resin 3554A with the density of 1.15 g/cm³. The SRM open mould type was used with rectangular shape according standard (ASTM D256) for Izod impact test and dumbbell-shape samples follow the standard ASTM D2099 for tensile test.

B. TRANS-ESTERIFICATION PROCESS

Trans esterification is a chemical reaction used for the conversion of vegetable oil to biodiesel. In this process vegetable oil is chemically reacted with an alcohol like methanol or ethanol in presence of catalyst. After the chemical reaction various components of vegetable oil break down to form new components. The triglycerides are converted into alkyl esters, which is the chemical name of biodiesel. If methanol is used in the chemical reaction, methyl esters are formed. In the chemical reaction alcohol replaces glycerin.

The biodiesel produced by the process of Transesterification has much lower viscosity, which makes it capable of replacing petroleum diesel in diesel engines. The

byproduct of Transesterification chemical reaction is the glycerin that originally formed the bond between the chains of fatty acids.

Glycerin can be used for various purposes. Thus during Transesterification process nothing goes to waste. All the products are utilized for various purposes.



C. BIODIESEL PREPARATION PROCESS

- The 1 Liter of raw oil is heated up to 60°C.
- Then, 5ml of H₂SO₄ and 100ml of methanol are added to the raw oil which is heated up to 60°C.
- Then that oil is mixed well with a mechanical stirrer for 3 hours with a constant temperature of 60°C.
- Then that resulting oil is taken and poured in a separation flask and allow to settle the residue for 24 hours. Now the oil is free from the soap content.
- At next stage, the oil is now obtained heated at 65°C.
- Then, 180ml of methanol and 18g of KOH is added to the oil which is at 65°C.
- Then mixed well in a mechanical stirrer and then poured into the separation flask and allowed for nearly 4-5 hours.
- Now, the oil is free from the glycerol.

shells were procured from a local grocer. Six pieces of coconut shells were ground to form a powder with the diameters of 50 to 200 μm using a grinding machine. The density of coconut shell is 1.60 g/cm³ Polyester resin and hardener were procured from a local supplier in Madurai, Tamilnadu. The resin is polyester resin 3554A with the density of 1.15 g/cm³. The weight ratio of the resin and hardener was 4:1.

Preparation of Polyester/Coconut:

The dimensions and shapes of cavities were made according to the size and shape of the samples as per ASTM Standard D 638-90 for tensile testing and ASTM Standard D 790-97 for flexural testing. Polyester and hardener were mixed in a container and stirred well for 5–7 minutes. Before the mixture was placed inside the mould, the mold has initially been polished with a release agent to prevent the composites from sticking onto the mold upon removal. Finally, the mixture was poured into the mold and left at room temperature for 24 hours until the mixture was hardened

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D. Preparation of Composites

A mold of 300 mm × 300 mm × 15 mm having base of glass and sides of wood was used for casting the composite sheets. For quick and easy removal of the composite sheet a mold release sheet was kept over glass plate. The weight percents of coconut shell powder (i.e. 20, 30 and 40 weight %), was mixed with the matrix material consisting of epoxy resin and hardener in the ratio of 5:4.

The dimensions and shapes of cavities were made according to the size and shape of the samples as per ASTM Standard tensile testing and for flexural testing. Epoxy and hardener were mixed in the container and mixed thoroughly for 10 to 15 minutes for the uniform distribution of hardener otherwise fast exothermic reaction takes place and entire process gets spoiled. After that coconut shell particulate added to the mixture and stirred well for 10 minutes for viscosity matching of particulate and resin.

Before the mixture is poured into the mould cavity a releasing agent (Mansion polish) were applied to the wooden mould for easy removal of specimen. Finally, the mixture was poured into the mould and left at room temperature for 48 hours until the mixture was hardened. When the composite were hardened, it was removed from the mold and finally composite were cured for 48 hours in room temperature.

III. EXPERIMENTATION PROCEDURE

A. SPECIMEN PREPARATION

The sets of ball particles were used to prepare the reinforced composites. Epoxy LY 556 resin, chemically belonging to the 'epoxide' family is used as the matrix. Its common name is BisphenolA Diglycidyl Ether. The low temperature curing epoxy resin (Araldite LY 556) and corresponding hardener (HY951) are mixed in a ratio of 10:1 by weight as recommended. The epoxy resin and the hardener are supplied by Ciba Geigy India Ltd.

The weight percent ratio of coconut powder and epoxy + hardener was selected as 10% : 90%. This filler weight percent was chosen because it had been reported by Harimi et al [8] that reinforcement of epoxy with a filler weight percent of 15% had clearly noticeable effect on the mechanical properties of the composite. The density of the epoxy + hardener was found to be 1.16 g/cc from the MSDS of the manufacture. The density was determined as 1.3847 g/cc (at 600 degrees) and 2.339 g/cc (at 800 degrees).

Materials used in this experimental work are Epoxy resin, Hardener and Coconut shell powder. Epoxy resin Moditite EL 301 is a thermosetting epoxy resin of medium viscosity supplied by Ruchi Organics Limited, Kanpur, Uttarpradesh,

India having outstanding properties as the matrix material like excellent adhesion to different materials, high resistance to chemical and atmospheric attack, high dimensional stability, excellent mechanical properties, nontoxic nature and negligible shrinkage.

Hardener MH-933 is used to harden matrix material. The chemical composition of coconut shell powder consists of Lignin (29.4%), Pentosans (27.7%), Cellulose (26.6%), Moisture (8%), Solvent Extractives(4.2%), Uronic Anhydrides(3.5%) and Ash(0.6%). The cleaned coconut shells were crushed into small pieces by using hammer. These small pieces then converted into powder by using hammer.

The collected powder was then sieved to different mesh sizes. For discriminating different CSP particle size about 1000g of CSP was put over the sieve shaker and shaken it for 20 min in shaker shown in Fig.1 (a). The sieves were arranged in the following order - crushed CSP, 600 micron (ASTM no. 8), 425 micron (ASTM no. 7), 300 micron (ASTM no. 6), 212 micron (ASTM no. 5) and then dust collector.

B. Mold preparation

Wooden board was taken and a Teflon sheet placed on it. A frame with square size stick of dimensions (15x6x0.6)cm was made using hammer. Heavy duty silicon spray was spread inside the frame to easily release the mould. The mixture was poured in to the frame and spread it thoroughly in order to avoid voids. When it will slightly harden, put one Teflon sheet on it and pressed it with various loads. After one day, the specimens were taken out from the frame.

IV. RESULT

The mechanical properties of the coconut shell particle composite with the epoxy resin processed following the same procedure and the addition of the coconut fine crushed and the semi crushed particles results was discussed the maximum result was obtained the coconut fine crushed particles provides the most significant strengthening.

V. CONCLUSION

A In this project the coconut shell was prepared to the required natural composites based on coconut shell filler particles at three different filler contents via, 40% and 50% was prepared to ASTM standard. A mold of 300 mm × 300 mm × 15 mm having base of glass and sides of wood was used for casting the composite sheets. For quick and easy removal of the composite sheet a mold release sheet was kept over glass plate.

The weight percents of coconut shell powder (i.e. 40 and 50 weight %), was mixed with the matrix material consisting of epoxy resin and hardener in the ratio of 5:4. The



dimensions and shapes of cavities were made.

After conducting the mechanical testing properties of the coconut shell particle composite with the epoxy resin processed following the same procedure and the addition of the coconut fine crushed and the semi crushed particles results was discussed the maximum result was obtained the coconut fine crushed particles provides the most significant strengthening.

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