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Performance Analysis of Cobalt Oxide Nano Particles in Curcas Nut Bio-Diesel Blends in C I Engine

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***Abstract*—In today's scenario lot of research work in India are undergoing for the suitable renewable fuels that are eco friendly. As an alternative, biodegradable, renewable, and sulphur free bio-diesel is receiving increasing attention. Use of nanoparticles are increasing around the world for making it imperative and to fully understand the impacts of nanoparticles in biodiesel on the C I Engine combustion phenomenon and pollutantion formation. Therefore, in this study performance test of CI engine are conducted for different curcas nut bio-diesel blends with nano particle and without nano particle was carried out. Biodiesel was made by well known Transesterification process. Curcas nut seed is chosen for biodiesel production. Cobalt oxide nano particle was produced by combustion synthesis process. The experiment is conducted for B10, B20 and B30 with 75mg Cobalt oxide nano particles and without nano particles. The engine experimental results of Curcas nut bio-diesel blend with nano particle showed that efficiency including thermal efficiency is 2% increased, and mechanical efficiency was reduced by 2% for biodiesel blend with nano particle. However, slight increase in specific fuel consumption was experienced for biodiesel mixture with nano particle. The cobalt oxide nano particle acts as an oxidizing catalyst and also provides oxygen for complete combustion of the blends.**

***Index Terms*— Alternate fuel, diesel engine, engine performance, Curcas nut, Cobalt oxide (Co_3O_4), transesterification, combustion synthesis.**

I. INTRODUCTION

In the last few decades, the activity has grown up around the world to find a alternate of bio-diesel fuel. Biodiesel has become more interesting because of its eco friendly benefits and fact that it is made up of renewable resources (meaning their sources can be re-grown). Nano word deals with tiny objects which are nano-metric (10^{-9}) in size atleast in one dimension. Curcas nut oil or Jatropha oil is a species of tree in the spurge family, native in American tropics and also some sub tropical regions around the world. The tree grows to about 06 meter in height, the petiole length of the flower ranges from 6 - 23mm, generally jatropha curcas starts yielding after 9-12 months. The oxygen atoms in cobalt oxide particles can moderate the combustion reactions, much more than other nano particles. As a result, the combustion was cleaner when using the cobalt oxide additive added in bio-diesel blends.

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II. LITERATURE REVIEW

In this section, characterization of diesel fuel and biodiesel blends, performance and emission studies carried out by earlier researchers with regards to the use of various types of oils used as a fuel in diesel engines are presented.

- ✓ Avinash Kumar Agarwal [1]: this paper presents an experimental investigation on performance and emission characteristics of CI Enigne fuelled with karanja oil and its blends. Significant improvement have been observed in the performance parameters of the engine as well as exhaust emission, when lower blends of karanja oil were used with and without preheating condition.
- ✓ K Suresh Kumar [2]: This paper presents the results of performance and emission analysis carried out in an unmodified diesel engine fuelled with POME and its blends with diesel. The blend POME with diesel upto 40% by volume (B40) provide better engine performance (BSFC) and improved emission characteristics.
- ✓ N Stalin [1]: This paper presents a review of the alternative technological methods that could be used to produce karanja oil and their performance on IC Engine using different blends have been evaluated. The test results indicates that Biodiesel produced by alkali catalyzed transesterification process can be used without any engine modification for the dual fuel combination of B40 and also cost can be considerably reduced than diesel.
- ✓ N R Banapumath [1]: In this paper experiments have been conducted to analyze the performance on CI Engine operated in single fuel mode using honge, neem and rice brain oil and in dual fuel mode combination of producer gas and three oils at different injection timing and injection pressures. Dual fuel mode of operation resulted in poor performance at all loads when compared with single fuel mode at all injection timings tested .
- ✓ V Sajith [6]: This paper presents the experimental investigation on the influence of the addition cerium oxide nano particle in the biodiesel blends. The flash point and the viscosity of biodiesel were found to increase due to the inclusion nano particles. The emission levels of HC and NOx are appreciably reduced with the addition cerium oxide nano particle.

III. METHODOLOGY

- ✓ In this investigation the cobalt oxide nano particle is selected as an additive in jatropa curcas methyl ester blends. It acts as a good oxidizer, which provides complete combustion of the fuel.
- ✓ Cobalt oxide nano particle are produced by the combustion synthesis process.
- ✓ Curcas nut oil is selected for biodiesel, since it is cheaper and it can be used directly without modifying the engine design parameters.
- ✓ In this investigation different samples like diesel fuel, B10, B20, B30 Jatropha oil methyl ester with and without cobalt oxide nano particles of varying the weighing 75mg were used.
- ✓ Characterization of diesel fuel, jatropha oil methyl ester with and without nano particles blends are done before the test.
- ✓ Then the test samples are subjected for performance test on diesel engine.

A. Nano particle preparation

Nano particles are produced by solution combustion synthesis process. Synthesis refers to a combination of two or more entities that together form something new. Synthesis mainly classified into two approaches.

1. Bottom-up approach
2. Top-down approach

Cobalt nitrate [$Co(NO_3)_2$] is used as a oxidizer and glycine [$C_2H_5NO_2$] is used as a fuel. Both oxidizer and fuel are dissolved completely by selecting proper amount of water. The mixture is kept at preheated muffler furnace which is maintained at a temperature of 300^0C for about 5 minutes during which the chemical reactions takes place. After the reaction cobalt oxide nano particles are produced Then the cobalt oxide nano particle is subjected to calcination that is heated continuously for around 4-5 hrs in the presence of oxygen to remove the moisture in the cobalt oxide nano particles.

IV. Experimental Set Up And Procedure

Switch on the mains of the control panel and set the supply voltage from servo stabilizer to 220volts. Open the cooling water line to the dynamometer Engine is started by hand cranking under no brake power condition and allowed to run for 20 minutes to reach steady state condition. The engine software version V2.00 is run to go on online mode.

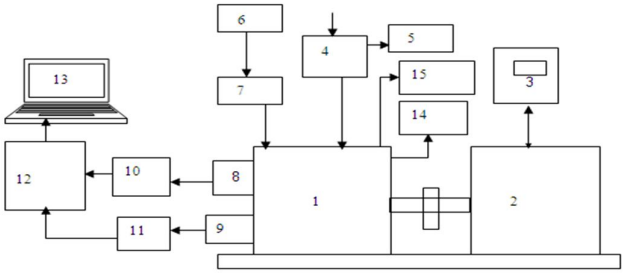

Figure 1: 4 stroke Diesel engine test rig

1) Diesel engine 2) Electrical Dynamometer 3) Dynamometer controls 4) Air box 5)U-Tube manometer 6) Fuel tank 7) Fuel measurement flask 8) Pressure pick up 9) TDC position sensor 10) Charge amplifier 11) TDC amplifier circuit 12) A/D card 13) Personal computer 14) Exhaust gas analyzer 15) AVL Smoke meter.

V. Results and Discussions

A. Mechanical efficiency

As shown in figure 2, In all the cases mechanical efficiency is increased due to reduced heat loss with increase in load. It is found that mechanical efficiency for biodiesel blend with nano particle in comparison to without nanoparticles in diesel engine is a better option for part load on which most engine runs. Addition of cobalt oxide nano particle in biodiesel blends slightly reduces the mechanical efficiency when compared with biodiesel blend without nano particle.

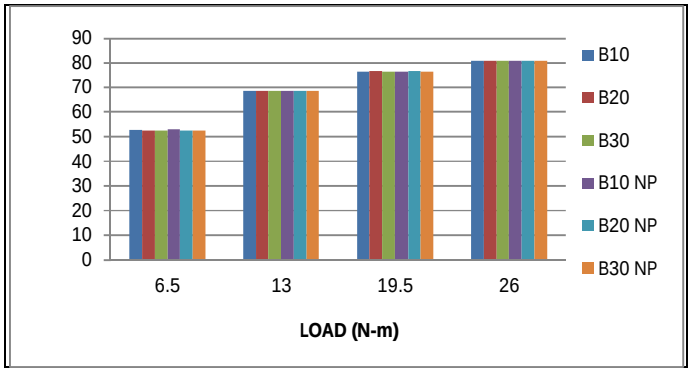

Figure 2: 4 Comparision of mechanical efficiency vs load

B. Brake specific fuel consumption

It is found that the specific fuel consumption is slightly increased for the blend with nano particle when compared it with the blend without nano particle as shown in figure 3. This is because of the combined effects of lower heating value and the higher fuel flow rate due to high density of the blends.

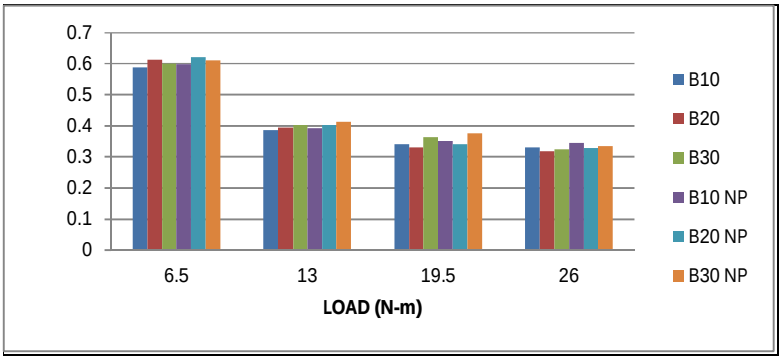

Figure 3: brake specific fuel consumption vs load

C: Indicated specific fuel consumption

It is found that the indicated specific fuel consumption is slightly increased for the blend with nano particle when compared it with the blend without nano particle because the oxygen from cobalt oxide nano particle will be released due to which combustion of fuel takes place completely. This is because of the combined effects of lower heating value and the higher fuel flow rate due to high density of the blends.

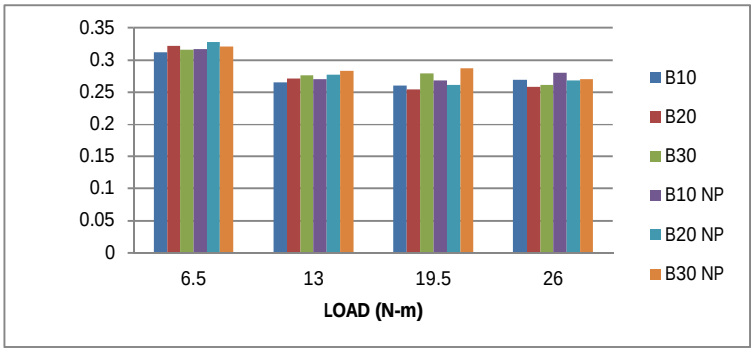

Figure 4: Indicated specific fuel consumption vs Load

D. Brake thermal efficiency:

It is found that the brake thermal efficiency for the different blends with nano particle are very closer than that of the blends without nano particles as shown in figure 5. By the addition of nano particle in the blends the brake thermal efficiency is decreased at all loads. This is because as the more oxygen provided for the combustion then the amount of heat generated will be less and also the combined effects of low calorific value and the high fuel flow rate due to high density of the blends.

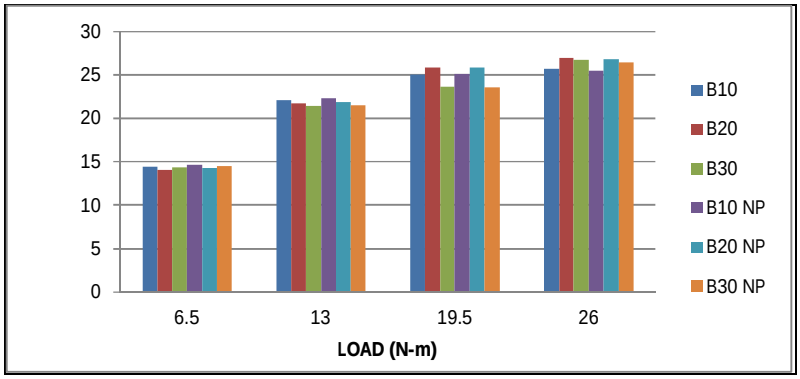

Figure 5: Brake thermal efficiency vs load

VI. CONCLUSION

The present study investigates the production of Curcas nut oil methyl ester using heterogeneous base catalyst i.e. calcinated Calcium oxide (CaO), conducting experimental analysis i.e. performance test of produced oil on TV1 Kirloskar, single cylinder, 4-stroke, direct injection, water cooled compression ignition engine for varying loads and various blends of biodiesels by varying the percentage of cobalt oxide nano particles by weight with compression ratio (17.5:1) and injection pressure (200 bar) as engine varying parameters. The following conclusions are drawn from this investigation.

1. The existing diesel engine performs satisfactorily on biodiesel blend with and without nano particles without any significant engine modifications.
2. The biodiesel blend with nano particle shows good brake thermal efficiency in comparison the blend without nano particles.
3. Addition of cobalt oxide nano particle in biodiesel blend resulted in slight increase in fuel consumption. This is due to the lower calorific value of the biodiesel blends with cobalt oxide nano particles.

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