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''EXPERIMENTAL INVESTIGATION ON THERMAL PERFORMANCE AND COMBUSTION CHARACTERISTICS OF JATROPHA BIODIESEL IN A DI DIESEL ENGINE USING NANO-PARTICLE"

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ABSTRACT

The demand for fuel is increasing everyday life and its risks poses a serious problem to this globalization. It is an unprecedented alternative fuel source for biodiesel designed to increase the value of fossil fuels and increase the longevity and purity of the diesel engine. The origin of fossil fuels will decrease in the coming years, besides, the price and demand for fuel will be rare. The negative environmental barrier prompted researchers to find alternative fuels for fossil fuels. Biodiesel from jatropha oil had a lot of appeal and could be a different alternative to diesel without any mechanical modifications. This will help protect the environmental status of crude oil in oil imports, which is expected to increase by 81% by 2020. The present study focuses on the comparative behavior of B-30 ,B-40 and B-40 Blends of biodiesel , which is zinc-dioxide (ZnO) with various nanoparticles size (65 PPM and 85 PPM). The experiment consists of investigation of the naturally aspirated singl cylinders four-stroke diesel engine fueled with Jatropha biodiesel and nanoparticles as additives. The operation with four test fuels was compared with that of neat diesel and Blends of 65 PPM and 85 PPM . The effect of zinc oxide (ZnO) nanoparticles with different concretion (65 PPM and 85 PPM) and Jatropha biodiesel with bland of B-30 , B-40 and B-50 used on the improvement in efficiency and emission characteristics of a Diesel engine are investigated. The ZnO nanofuel blends B-30 and B-40 with 65 PPM reduced the carbon monoxide, HC, and smoke opacity emissions by 24.5% and 14.1%. biodiesel blend is B-40+85 PPM. When compared maximum brake thermal efficiency and reduced emission when compare to ballnds B-30, B-40 and B-50 of 65 PPM and 85 PPM . The performance of Blends (B-30, B-40, B-50) is comparatively less effective than that of diesel because of lower calorific value. But the performance of ZnO nanoparticle fuel was better than neat diesel and neat Jatropha fuelled operation. Nanoparticles, due to their better combustion properties, prove out to be a good additive in diesel and biodiesel fuel. Results showed that nanoparticles can be a good solution for problems occurring during plain diesel and biodiesel operations

Key Words: *Diesel, Bio diesel, jatropha , ZnO, Performance, Emission parameters*.

I. INTRODUCTION

Energy plays a important role in our daily life. Energy is one of the prime movers of economic growth and play important role in sustenance of a modern economy. The economic growth depends on availability of energy from the sources that are reasonable, reachable and ecological friendly. Energy production has always been a concern for

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researchers and policy makers. There are many by which the amount of energy in the order of stored, and converted into useful form. It is reported that 74% of Indian energy comes from oil and natural gas while only 2.5% comes from biomass. The Indian economy uses a variety of energy sources, both commercial and non-commercial. Fuels like wood, animal waste, and agricultural residue are the traditional or non- commercial sources of energy that continue to meet the energy requirements. Renewable energy in the form of solar, wind, hydro, and bio-energy. In India, 25% of the primary energy needs are meeting through petroleum products. The main issue of fossil fuels is the environmental damage which create emission after the combustion of fossil fuels. The products of combustion in the atmosphere is CO_x, SOx, NO_X etc. which are responsible for global warming effects, temperature rise of the atmosphere due to which degradation and the harmful emissions of the existing fossil fuels for which alternative fuels to be investigate.

II. ALTERNATIVE FUELS FOR INTERNAL COMBUSTION ENGINES

Wide range of liquid and gaseous fuel for both spark-ignition and compression-ignition engine are used. The most common alternative fuels for SI engines are ethanol in blends with gasoline as well as compressed natural gas , liquefied natural gas and liquefied petroleum gas (LPG). Biodiesel, synthetic diesel, green diesel, and DME are the most common alternative fuels for CI engines. The alternative fuels include biodiesels and alcohol. Many technologies have been developed to reduce the harmful emissions. However, the cost of conversions is very high and the technologies are not economically viable. Therefore, the use of a renewable fuel is the best option. the renewable fuels include biodiesel, alcohols, compressed gas and hydrogen.

III. RENEWABLE ENERGY

Reasonable energy supplies are fundamental to economic stability and growth of any country. Future energy demand and supply are subject to numerous uncertainties, most of which are difficult to predict. Such as oil prices, global economic growth rate, technological advances, government policies and consumer behaviour. The projected energy consumption indicates that by 2020, the world will consume three times the amount of energy used 25 years ago. The world consumption is 76 million litres per day. The reserves are 800 billions of barrels. It looks like planet Earth has oil for about 10,000 days, i.e. about 27 years with no rise in oil consumption. If the consumption increases at an average of 5% a year, then oil is available for about 15 years. The share of renewable energy sources in electricity generation will increase from 18% in 2005 to 35% in 2050. So, there is a necessity to tap the renewable energy sources.

- Biodiesel can be used in the existing engine without any modifications.
- Biodiesel is made entirely from non-edible sources; it does not contain any sulphur, aromatic hydrocarbons, metals, or crude oil residues.
- Biodiesel is an oxygenated fuel so the emissions of carbon monoxide and soot tend to reduce.
- Unlike fossil fuels, the use of biodiesel does not contribute to any global warming as CO_2 emitted is once again absorbed by the plants grown for vegetable oil/biodiesel production.
- It is a non-flammable liquid.
- The use of biodiesel can extend the life of diesel engines due to better lubricating properties than the petroleum diesel fuel.

IV. BIODIESEL PRODUCTION

Oil can be extracted from a variety of plants and oil seeds. It is estimated that about 3 million hectares plantation is required to produce oil for 10% replacement of diesel.

V. JATROPHA CURCUS AS AN ENERGY SOURCE

Oil from jatropha curcus: There are number of variety of jatropha. Best among these are jatropha curcus. Jatropha oil is an important product from the plant for meeting the cooking and lighting needs of the rural population, boiler fuel for industrial purpose or as a viable substitute for Diesel. About one- third of the energy in the fruit of jatropha

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can be extracted as oil that has a similar energy value to Diesel fuel. Jatropha oil can be used directly in Diesel engines added to Diesel fuel as an extender or transesterified to a bio-diesel fuel. There are some technical problems to using jatropha oil directly in Diesel engines that have yet to be completely overcome. Moreover, the cost of producing jatropha oil as a Diesel substitute is currently higher than the cost of Diesel itself.

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VI. THE ADVANTAGES OF JATROPHA PLANT

1. Hardy shrub which grows in semi-arid conditions and poor soils
2. Can be intercropped with high value crops such as sugar, coconut palm, various fruits and vegetables, providing protection from grazing livestock and phyto-protection action against pests and pathogens
3. It is easy to establish and grows relatively quickly.
4. Yields around 4 tonnes of seed per hectare in unkept hedges are achievable
5. Has low nutrient requirements
6. Requires low labour inputs Multi-purpose plant

VII. ZINC OXIDE NANOPARTICLES

Zinc oxide is frequently used in several areas of technology. It is worthy to investigate highquality selftextured ZnO films synthesized on different kinds of substrates. In this study we investigate influence of the growth rate on morphology of ZnO deposited on Si and GaP substrates. Photoluminescence study was used for comparison of the growth condition influence on quality of the deposit. In the second part of the contribution we try to list some very important new areas of research ZnO. These are in particular : the core–shell nanorods for the photovoltaic dye-sensitized solar cells, transparent conducting oxide thin films, thin film transistors, removal of the hydrogen sulfide from natural gas streams,coal gas and chemical feedstocks, chemical gas sensors, diluted magnetic semiconductors, photocatalysis and toxicity.

1. An extensive investigation on CI Engine with different blends of biodiesel has been investigated for improvement in Performance, combustion, smoke and emission characterization.
2. Different Investigation with Nano-additives blends with fuel has investigated.
3. There is scope for further research on the ZnO Nano Additive effects of nanoparticles in Engine performance along with exhaust emissions have the very less research .
4. Analysis of the cost and complexity in the preparation of nanoparticles, encompassing public safety and economic feasibility, should be considered in future research.

Fig. No. 1.1 Zinc Oxide Nanoparticles

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VIII. Blends preparation

Biodiesel is a promising alternative fuel because it is renewable, environment friendly, and is produced easily in rural areas, where, there is an acute need. Biodiesel is usually produced by reacting methanol and vegetable oil in a batch stirred tank reactor using a liquid alkaline catalyst called transesterification. The transesterification of vegetable oils or animal fat with methanol using an alkaline catalyst such as NaOH or methoxides is a well known route for synthesizing the biofuel. Transesterification can be catalyzed by both acids as well as bases. The catalyst used in the transesterification process cannot be recovered from the reactor and is instead neutralized and disposed off as a waste stream. The removal of a base after the reaction is problematic as it results in saponification and formation of an emulsion. This makes separation of the ester difficult. In order to circumvent these problems a heterogeneous catalyst can be used for the preparation of biodiesel. The heterogeneous catalysts are environment friendly and render the process simplified. A wide variety of solid bases have been examined for this process. The present work reports the use of a hydrotalcite catalyst for the synthesis of Biodiesel from jatropha oil.

IX. Fuel and characterization

The major problem of using Jatropha oil in an engine is its viscosity. There are various ways of using Jatropha oil in a diesel engine, but this leads to the problems in the engine like injector clogging and gumming due to high viscosity.

X. Materials and methods Jatropha oil

Jatropha Biodiesel in different countries such as India, UK, China, Malaysia, Sweden, Thailand, Indonesia etc. In Indian scenario, different types of trees (Jatropha, Pongamia pinnata, Pongamia glabra, Azadirachta indica, Madhuca indica, Calophyllum inophyllum, Hevea brasiliensis, Simmondsia chinensis) have been identified as source of biodiesel production but Jatropha Oil is getting maximum attention in research and development field. Furthermore, the sustainability of JO for biodiesel production from global hype to local solution is a main goal of this doctoral research. Continuous supply of biodiesel at low cost is the main trait for its general acceptance JO was used as a mineral diesel substitute during the Second World War. The oil content of Jatropha seed ranges from 30% to 40% by weight. Fresh JO is a slow drying, odourless and colourless oil.

XI. Experimental procedures

Before starting the engine experiments, the fuel tank, engine oil level, coolant and other proper conditions of the test engine were checked and the test engine was started. The test engine was permitted to run until the stable condition is achieved. Then the engine load was increased gradually to maximum recommended load. At the same time, the dynamometer, all analyzers and meters for measurements were switched on and the proper preparations and settings for measurements were carried out .. When the engine reached the stable condition and when the initial setup is made for all measuring instruments, the experiment was started. The type of experiment is a steady state engine test. The applications of loads were at five levels and they were 0%, 25%, 50%, 75% and 100% loads respectively. The engine speeds at all load levels were adjusted for constant engine speed and fixed at 1800 rpm, in each load levels, the measurements of fuel consumption, intake air , temperature, exhaust gas temperature, engine coolant temperature, combustion pressure, crank angle, hydrocarbon (HC) emission, carbon monoxide (CO) emission, nitrogen oxides (NO_X) emission, carbon di-oxide emission (CO) and smoke emission were carried out and recorded the data..

XII. Comparison of performance, emission and combustion characteristics of biodiesel diesel blends with standard engine specification

The diesel and biodiesel blends (B-30, B-40, B-50) were tested along with different concretion of Zno Nano-particle at standard engine specification, which is at standard operating condition of diesel engines used in test rig important results of the experimental work are presented.

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XIII. BRAKE THERMAL EFFICIENCY

Comparison of brake thermal efficiency with brake power for diesel and biodiesel blends with different concretion (65 PPM and 85 PPM) of Nano-particle

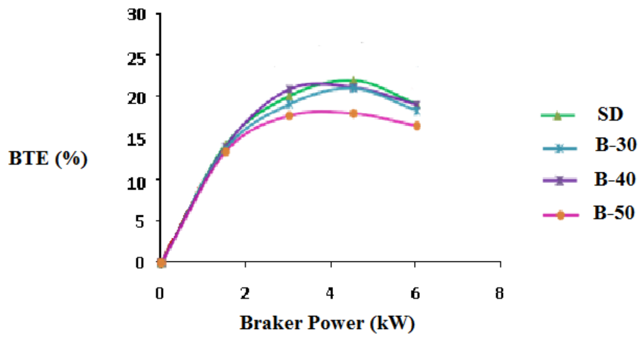

Fig. No. 1.2 Comparison of brake thermal efficiency with brake power for Diesel, B-30, B-40 and B-50 Bio-Diesel Bland

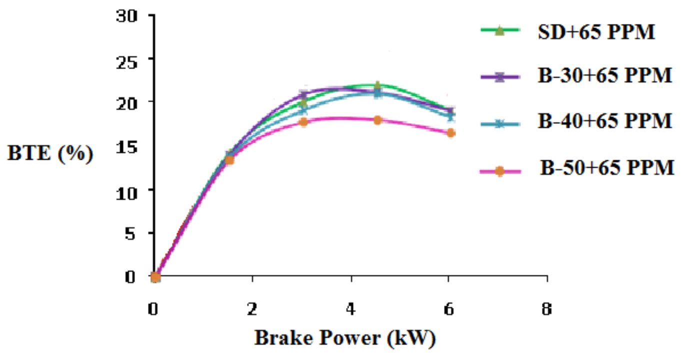

Fig. No. 1.2 Comparison of Brake Thermal Efficiency With Brake Power For Diesel, B-30, B-40 and B-50 Bio-Diesel Bland With 65 PPM of Zno

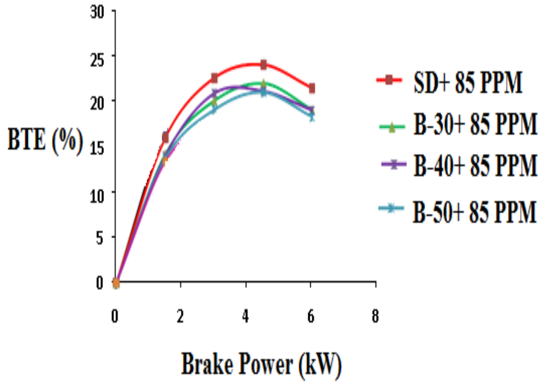

Fig. No. 1.3 Comparison of brake thermal efficiency with brake power for Diesel, B-30, B-40 and B-50 Bio-Diesel Bland with 85 PPM of ZnO

For all the blends, Brake thermal efficiency increases with increase in brake power. The maximum brake thermal efficiency is observed at three fourth of load for all fuels. The maximum brake thermal efficiency for neat diesel at three fourth of load was 31.42 %, where as it was decreases by 3.4%, 5.46% and 7.46% for B-30+85 PPM. It can be seen that the Brake thermal efficiency characteristics for diesel is highest and lesser in the case of all biodiesel blends. This may be due to the reduced calorific value and increased viscosity of biodiesel when compared to diesel.

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XIV. SPECIFIC ENERGY CONSUMPTION

The comparison of Specific energy consumption with brake power for diesel and biodiesel blends with Nano-Particle .

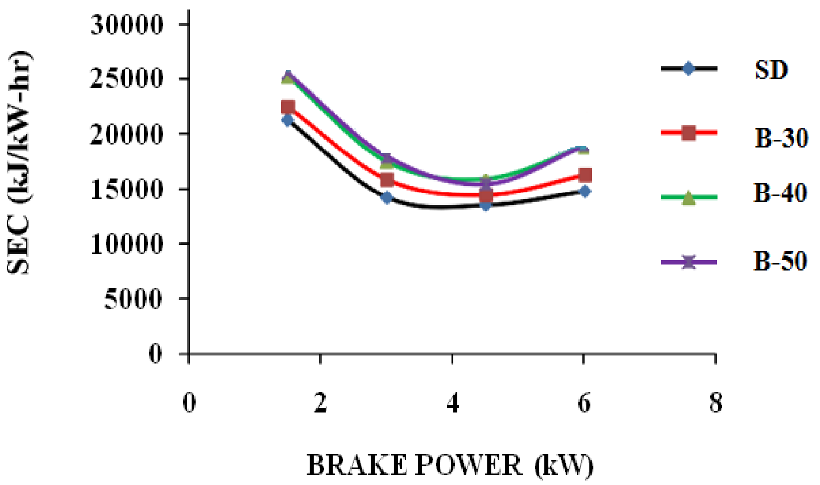

Fig. No. 1.4 Comparison of Specific energy consumption with brake power for Diesel, B-30, B-40 and B-50 Bio-Diesel Bland

For all the blends, specific energy consumption decreases up to part load and increases there on. The specific energy consumption at maximum load for neat diesel was 12848.13 kJ/kW-hr, where as it was increases by 8.96%, 9.93%, 11.7% for B-40, B-30, and B-50 blend at maximum load respectively. It is seen that the specific energy consumption characteristics for diesel is least and highest in the case of all biodiesel blends.
This may be due to the less energy content of biodiesel when compared to diesel. Thus engine will consume more blended fuel than the diesel to get the same power output owing to a decrease in the calorific value of the blend.

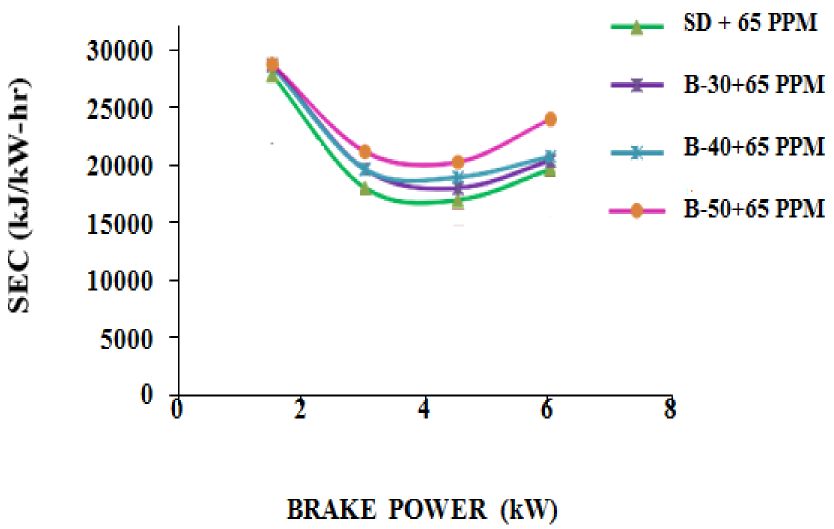

Fig. No. 1.5 Comparison of Specific energy consumption with brake power for Diesel, B-30, B-40 and B-50 Bio-Diesel Bland with Nano- Particle 65 PPM

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shows the specific energy consumption gradually increases with increasing percentage of blends of Zno (B30 to B500). This may be due to the reduction of the heating value of biodiesel blends B-30 to B-50, when compared to B30 blends.

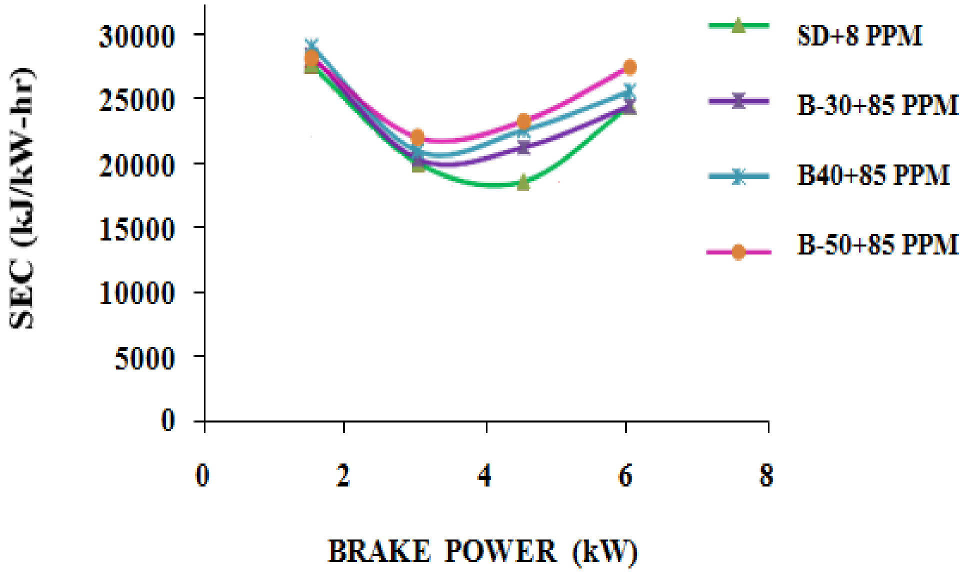

Fig. No. 1.6 Comparison of Specific energy consumption with brake power for Diesel, B-30, B-40 and B-50 Bio-Diesel Bland with Nano- Particle 85 PPM

Biodiesel blends B-40+85 PPM blend has lowest specific energy consumption at maximum load. This may be due to the higher energy content of the blend, which leads to better combustion when compared to other biodiesel blends.

XV. Hydrocarbon Emission

Comparison of Hydrocarbon emission with brake power for diesel and biodiesel blends along with different conceration of ZnO Nano- Particle

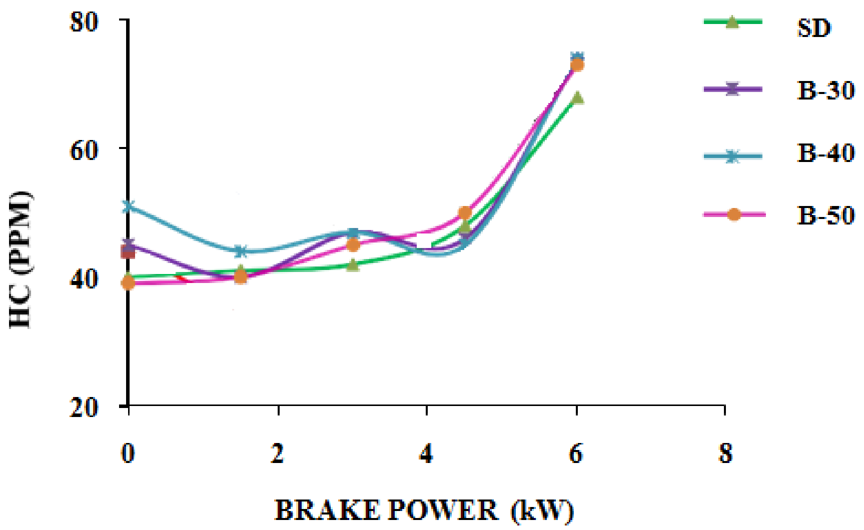

Fig. No. 1.7 Comparison of Hydrocarbon emission with brake power for Diesel, B-30, B-40 and B-50 Bio-Diesel Bland.

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Blends (B-30 , B-40 , B-50) , Hydrocarbon emission decreases up to part load and increases there on. The Hydrocarbon emission for diesel at maximum load was 65 PPM, where as it was decreases by 6.2%, 5.4%, 1.3% for B-30, B-50, B-40 at maximum load blend respectively. It can be seen that the Hydrocarbon emission characteristics for diesel is highest and lesser in the case of biodiesel blends.

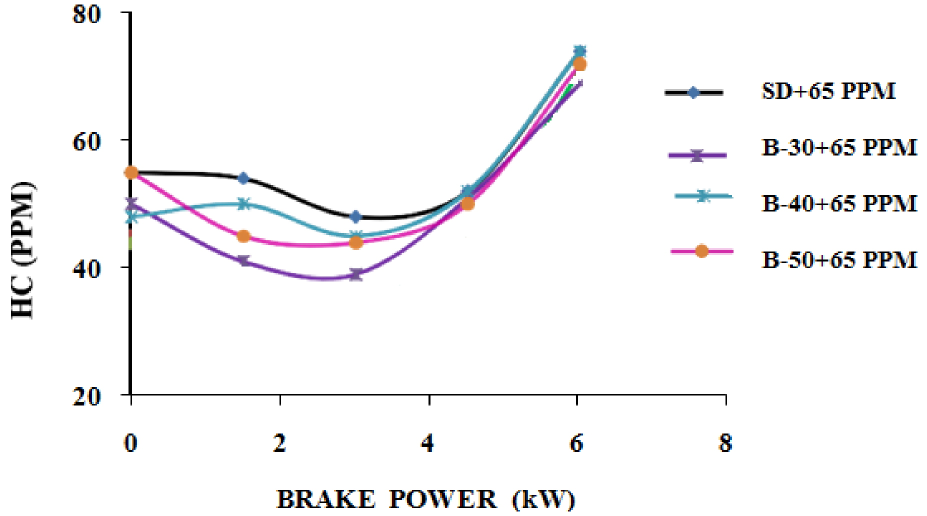

Fig. No. 1.8 Comparison of Hydrocarbon emission with brake power for Diesel, B-30, B-40 and B-50 Bio-Diesel Bland with 65 PPM of Nano- Particle.

This may be due to the fact that all the biodiesel contain oxygen in their chemical composition. This favors comparatively better combustion for biodiesel than diesel. of the blend, which leads to better combustion when compared to other biodiesel blends. hydrocarbon emission gradually decreases with increasing percentage of blends of ZnO Nano-Particle.

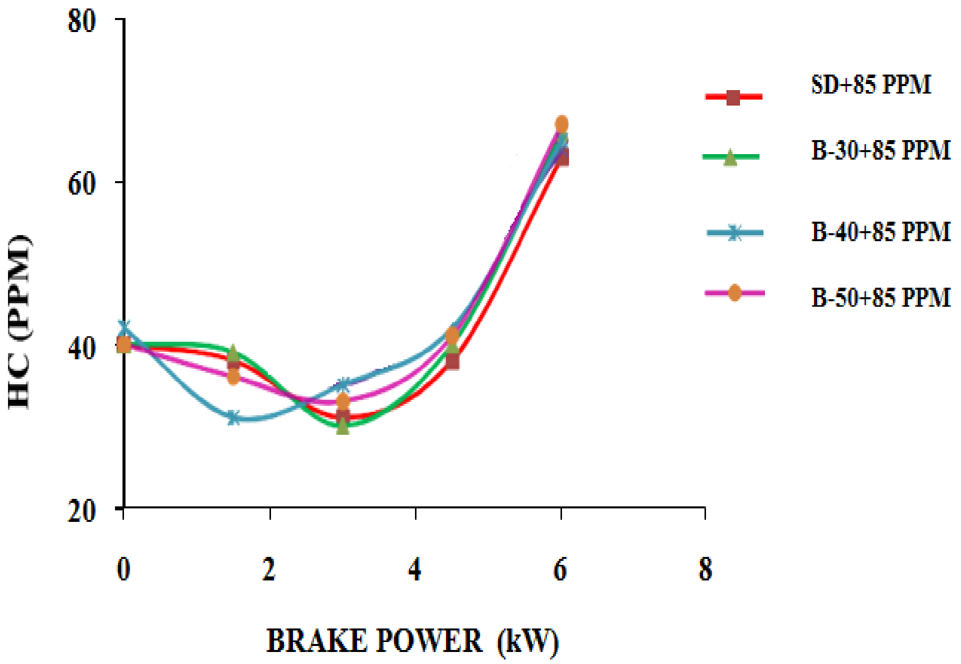

Fig. No. 1.9 Comparison of Hydrocarbon emission with brake power for Diesel, B-30, B-40 and B-50 Bio-Diesel Bland with 85 PPM of Nano- Particle.

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XVI. CONCLUSIONS

The experiment consists of investigation of the naturally aspirated singl cylinders four-stroke diesel engine fueled with Jatropha biodiesel and nanoparticles as additives. The operation with four test fuels was compared with that of neat diesel and Blends of 65 PPM and 85 PPM . The conclusions are listed below:

1. In the present Experimental investigation the effect of zinc oxide (ZnO) nanoparticles with different concretion (65 PPM and 85 PPM) and Jatropha biodiesel with bland of B-30 , B-40 and B-50 used on the improvement in efficiency and emission characteristics of a Diesel engine are investigated.
2. A single cylinder, water cooled, four stroke direct injection compression ignition engine with a displacement volume of 661 cc, compression ratio of 17.5:1, developing 6.02 kW at 1800 rpm was used for investigation. Variable load tests are conducted for no load, 2, 4, and 6. kW power output at a constant rated speed of 1800 rpm. The engine is coupled with eddy current dynamometer.
3. The Jatropha biodiesel was produced utilizing the transesterification reaction. Several characterization experiments were performed to determine the shape, scale, and contents of the synthesized ZnO Nano-Particle. The ZnO Nano-Particle surfactant were steadily distributed two stages (65 and 85 ppm).
4. The ZnO nanofuel blends B-30 and B-40 with 65 PPM reduced the carbon monoxide, HC, and smoke opacity emissions by 24.5% and 14.1%.
5. The best biodiesel blend is B-40+85 PPM. When compared maximum brake thermal efficiency and reduced emission when compare to ballnds B-30, B-40 and B-50 of 65 PPM and 85 PPM
6. Biodiesel can be a good replacement of conventional and ever depleting diesel fuel. JOME is stable and has strongly emerged as a strong alternative.
7. The ZnO nanoparticles worked even better both with diesel and Blaends. The fuel with nanoparticles was also found to be stable and eco friendly.
8. The performance of Blends (B-30, B-40, B-50) is comparatively less effective than that of diesel because of lower calorific value. But the performance of ZnO nanoparticle fuel was better than neat diesel and neat Jatropha fuelled operation.
9. The emission characteristics of biodiesel were better as compared to diesel except NOx. Nanoparticles further improved the results. CO, HC, smoke were reduced to a great extent by the combination of ZnO nanoparticles and Jatropha. Higher NOx emission of biodiesel fuelled engine was reduced considerably by the use of ZnO nanoparticles. However, it was slightly higher than diesel fuel. Nanoparticles, due to their better combustion properties, prove out to be a good additive in diesel and biodiesel fuel. Results showed that nanoparticles can be a good solution for problems occurring during plain diesel and biodiesel operations.

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