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Effect of Copper Oxide Emulsion Cashew Nut Shell Pyrolysed Oil Blended on the Performance and Emission of a DI Diesel Engine

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ABSTRACT

The project work is focus on the effect of copper oxide Nano particle used in cashew nut Shell Pyrolysis oil blended with Diesel fuel in a DI Diesel Engine. Pyrolysis process was used to extract the bio oil from the Cashew nut shell bio mass materials. The biomass used a Cashew nut shell at the reaction temperature of 550-850°C to obtain bio oil from fast pyrolysis method. The property studies were made on the bio oil called as CNPO, CNPO50D50 and CNPO40D50EM10 (40% CNPO+50% Diesel+ 5% Distilled water and 5%TWEEN80). Characterize it as fuel for Diesel, CNPO, CNPO50D50 and CNPO40D50EM10wasanalyzed.Prepared the blending of pyrolysis oil and diesel and blending with copper oxide Nano particles are by mixing of CNPO40D50CO50 (40% CNPO + 50% Diesel+ 50COPPM) and diesel fuel by volume. Fuels were tested in a single cylinder diesel engine for their performance as blended fuel. Engine test results showed that comparable performance for all CNPO50D50, CNPO40D50EM10and CNPO40D50CO50 with diesel fuel. At the maximum power output the brake thermal efficiency was found as 31.7% respectively with CNPO40D50CO50and where as it was 30.0% with BD. There is a considerable reduction for the smoke and NOx emissions, however HC and CO emissions lightly increased with the CNPO40D50CO50 as fuel compared to BD at all power outputs.

KEY WORDS: Cashew nut pyrolysis shell, Fast pyrolysis, copper oxide Nano particle, Diesel Engine.

1. INTRODUCTION

Diesel engines are mainly used in industrial, transport and agricultural application due to their high efficiency and reliability. However, they suffer from high smoke and oxide of nitrogen emissions. The increase in prices of diesel fuel, reduced availability, more stringent government regulations on the exhaust emissions and the fast depletion of worldwide petroleum reserves provide a strong encouragement to the search for alternative fuels. Among the different type non-renewable alternate energy resource, bio mass is an energy resource has promising characteristics to use as fuel in diesel engine. Hence an attempt was made in this work to investigate the efficient techniques to utilize it as fuel in diesel engine. Many alternative fuels for diesel engines such as vegetable oil esters, tyre pyrolysis oil, orange oil etc. were introduced from the recent researches. Depletion of petroleum derivatives and increase in emission in diesel engine increases the research interest in the area of alternative fuels. The heat volatilizes and decomposes the organic matter to produce a pyrolysis gas and liquid and solid char in relative proportions depending on the process parameters of temperature and pressure the performance and emission characteristics were found to be very interesting in comparing with diesel. In this part of work CNPO40D50EM10 andCNPO40D50CO50 is been concentrated since it has a maximum stability around a week.

Working principle of pyrolysis: The process of pyrolysis is selecting the cashew shell feedstock, then allowed to reduce its size and remove the moisture content from the raw material by allowing it to direct sunlight for few days and fed into the reactor for fast pyrolysis. The Biomass feedstock is fed into the reaction chamber by opening the lid of the reactor screws and the nitrogen gas is allowed to pass into the reaction chamber. The fast pyrolysis temperature is maintained to 100°C to 650°C throughout the reaction. And at the end of the pyrolysis reaction, gas vapor are produced which are allowed to be condensed by a condenser and the liquid fuel is collected in a steel container. The entire vapor takes few hours to get condensed completely into liquid. The condensed liquid is stored in a safe place and in the absence of sunlight. The temperature of the reactor is controlled manually to 650°C. Then the water is allowed to flow in the counter flow direction.

Fig.1. Pyrolysis reactor experimental set up

CNPO40D50EM10 and CNPO40D50CO50 oil Preparation: Cashew Nut Shell Pyro Oil is made blend in to diesel at various proportions and finally found that around 40% maximum stability is attained. Thus CNPO40D50EM10 is prepared in the laboratory with 40% volume of cashew nut pyro shell oil and 50% of neat diesel 5% Distilled water and 5% TWEEN 80.CNPO40D50CO50is prepared in the laboratory with 40% volume of cashew nut pyro shell oil and 50% of neat diesel and 50 ppm of copper oxide.

Table.1. Property of Different fuels

Properties	Diesel	CNPO	CNPO50D50	CNPO40D50EM10	CNPO40D50CO50
Density(kg/m3)	860	957	975	986	896
Viscosity at 50˚C (cst)	3.42	10.3	5.52	8.32	7.42
Flash point ˚C	51	63	55	63	54
Fire point ˚C	56	96	60	68	62
Calorific value (kj/kg)	43500	45000	44263	39543	40652
PH value	5.6	5.7	4.65	5.5	6.7

2. EXPERIMENTAL SET UP

A computerized kirloskar diesel engine of AV l model, four stroke direct injection, Naturally aspirated air cooled Engine was utilized to investigate this all four fuel study. The diesel engine was coupled with an eddy current dynamometer and a data acquisition system, so that the data can be saved. A five gas AVL analyzer was used to measure the emissions characteristics; smoke opacity has been measured using the AVL444 smoke meter. The engine was operated on diesel first and CNPO50D50, CNPO40D50EM10 and CNPO40D50CO50 with diesel fuel.

Fig.2. Photographic view of Engine test set-up.

3. RESULTS AND DISCUSSION

Results of Brake thermal efficiency with different fuels: The variations of brake thermal efficiencies at different load for various combinations have been shown. The thermal efficiency is 31.7% at full load for CNPO40D50CO50. It can also be observed that the efficiency for CNPO50D50 and CNPO40D50EM10 are 29.5% and 30.5% respectively. The thermal efficiency of CNPO40D50CO50 is higher compared to diesel fuel. The increase in the thermal efficiency for CNPO40D50CO50 due to the better fuel atomization due to lower viscosity and increases the volatility. The thermal efficiency of CNPO40D50EM10 and CNPO40D50EM10 blends are lower compared to Diesel fuel. The thermal efficiency is 30% at full load for Diesel fuel.

Specific fuel consumptions with different fuels: The specific fuel consumption is not a very reliable factor to compare the four fuels as the calorific value and the density of the all blends are slightly different from that of DF. It can be observed that as the load increases and SFC decreases for all four fuels.

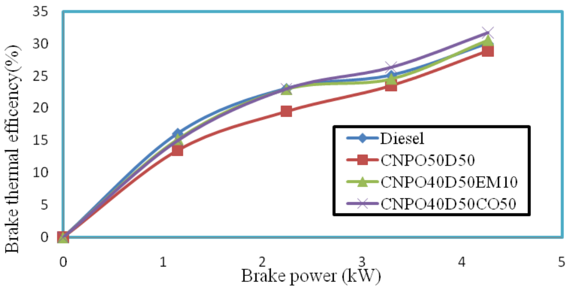


Fig.3. Brake power vs Brake thermal efficiency

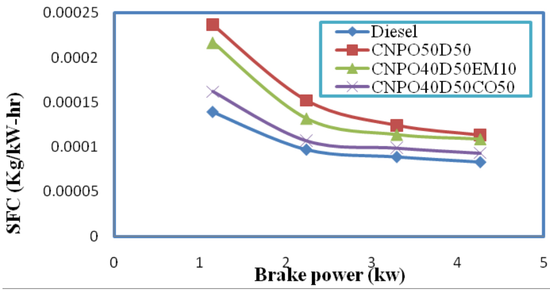


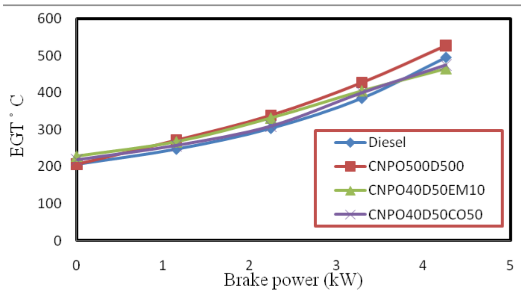
Fig.4. Brake power vs Specific fuel consumption

At the same time, it can be seen that SFC increases with lower load it is consume more fuel with CNPO50D50, CNPO40D50EM10 and CNPO40D50CO50 blends the diesel fuel, this is due to the combined effect of the fuel density, viscosity and lower calorific values of blends. It is observed that CNPO40D50EM10 and CNPO40D50CO50showvery closer SFC values with diesel fuel.

Exhaust gas temperature with different fuels: It can be observed that the exhaust gas temperature generally increases with increase in blend concentration and load.

The CNPO50D50 blends gives higher gas temperature varies from 207˚ C to 527˚ C at full load for DF whereas it varies from 219˚ C at no load to 475˚C at full load for CNPO40D50CO50. The reason for lower exhaust gas temperature for CNPO40D50EM10 and CNPO40D50CO50 blends are due to lower viscosity and water content of fuel which results a lesser penetration of the fuel into the combustion chamber and the lesser amount of heat is developed.

Hydro carbon Emission with different fuels: The comparison of hydrocarbon emission in the exhaust is shown in figure5.4. Un-burnt hydrocarbon emission is the direct result of the incomplete combustion of the fuel. It is apparent that the hydrocarbon emission is increasing with increasing load. HC emissions of 24 ppm at no load and 90 ppm at full load for the CNPO40D50CO50.It varies from 22 ppm at no load to 86 ppm at full load for CNPO40D50EM10. HC is slightly higher at peak load for CNPO40D50EM10 and CNPO40D50CO50.This may be attributed to the fuel spray does not propagate deeper into the combustion chamber and gaseous hydrocarbons remain along the cylinder wall and the crevice volume and left unburned and micro explosion of fuel.



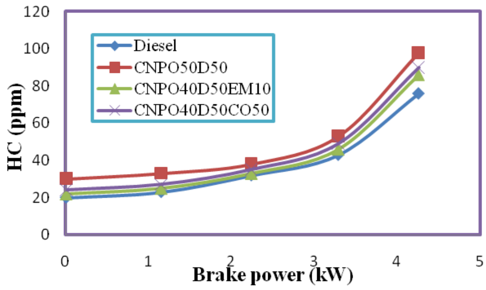
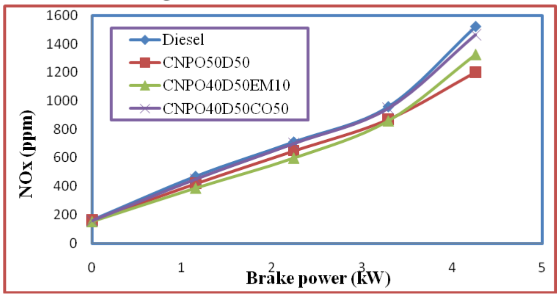


Fig.5. Brake power vs Exhaust gas temperature **Fig.6. Brake power vs Hydrocarbon emission**

Nitrogen oxide with different fuels: It can be observed from the figure that NOx emission increases with increasing the load, but all fuel lesser than that of diesel fuel. In the case of CNPO40D50EM10 and CNPO40D50CO50 blends, the lower in cylinder temperature is the reason for water content are present in the fuel due to the lower peak cycle temperature accord in the combustion because of the lower NOx levels than that of DF.

Carbon monoxide emission with different fuels: The emulsion of CNPO50D50 resulted in higher CO emissions as compared toCNPO40D50EM10, CNPO40D50CO50 and diesel fuel at all power outputs. The maximum CO emission was found as 0.51%, 0.41 % and 0.35% respectively for CNPO50D50, CNPO40D50EM10 and CNPO40D50CO50at the maximum power output of 4.4 kW. It was noted as 0.31% with BD. It is already explained that the emulsions of CNPO40D50EM10 and CNPO40D50CO50due to their poor energy content resulted in fuel richness which has lead to incomplete combustion of the fuel. It is seen that CNPO50D50 emitted highest CO emissions among the all fuels.



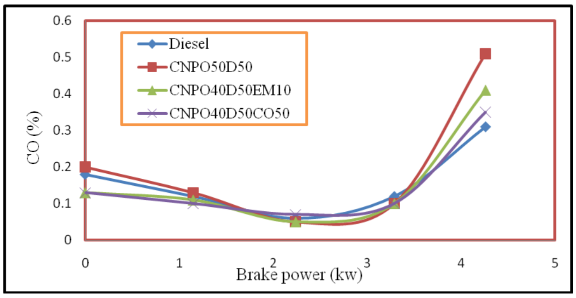


Fig.7.Brake power vs Nitrogen oxide emission **Fig.8.Brake power vs Carbon monooxide emission**

Heat release rate analysis with different fuels: It is clearly seen that BD resulted in maximum rate of heat release and the fraction of fuel burned during the initial period (i.e. premixed combustion) of time whereas the premixed combustion rate was lower and the diffusion combustion rate was slightly higher for CNPO40D50EM10 and CNPO40D50CO50 as compared to BD. The reduction in premixed combustion rate of the emulsions of CNPO40D50EM10 and CNPO40D50CO50 can be explained by the high viscosity and density of the fuels which resulted in combustion to be more in the diffusion combustion phase. CNPO40D50EM10 and CNPO40D50CO50 showed lower peak values as compared to BD.

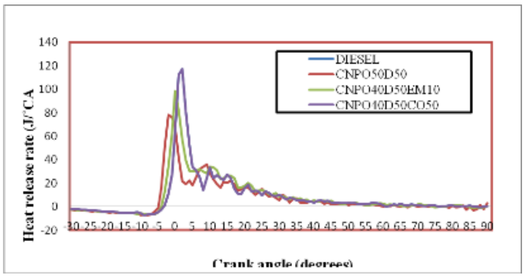


Fig.9.Variation of Heat Release Rate at Peak Power output

4. CONCLUSION

All Engine test use of the CNPO40D50EM10 and CNPO40D50CO50 fuels show that the comparable performance with diesel fuel at all power outputs. All the four tested fuels resulted in significant reduction in exhaust gas temperature and reduced the NOx emissions compare to base line diesel fuel.CNPO40D50EM10 and CNPO40D50CO50 show that HC and CO emissions were found to higher as compared to BD. It is concluded that pyrolysis of cashew nut shell can be used as a partial substitute for diesel fuel. To use cashew shell pyro oil as soul fuel, the fuel and engine need further modifications.

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