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EFFECT OF NANO PARTICLES WITH DIESEL (Di-methyl Carbonate and Aluminum Oxide Additives)

Dande sai Krishna[1], M.Tech Student, Department of Mechanical Engineering, Advanced IC Engines, Jawaharlal Nehru Technological University Anantapur College of Engineering ,Anantapuramu, Constituent College of Jawaharlal Nehru Technological University Anantapur, Andhra Pradesh, India.
K. Kalyani Radha[2], Assistant Professor, Department of Mechanical Engineering, Jawaharlal Nehru Technological University Anantapur College of Engineering, Anantapur, Constituent College of Jawaharlal Nehru Technological University Anantapur, Andhra Pradesh, India.
dandesaikrishna1998@gmail.com[1], radha.mech@jntua.ac.in[2]

ABSTRACT

The main aim of this research work is to increase the efficiency of the engine and combustion of fuel then reduces the exhaust from the vehicles. So, less pollutes the environment and low contributes to global warming. In this work Di-methyl carbonate (DMC) and Aluminum oxide nanoparticles is mixed as additives to the diesel fuel. The performance and emission characteristics of the diesel engine operated with diesel mixed with DMC 4%,6%,8%,12% and aluminum oxide nanoparticles were added to the fuel by 100,125,150,175 PPM and these results can be evaluated with 100% diesel fuel. By using these DMC and Aluminum oxide nanoparticles had improving the combustion and emission performances without significant increase on NOx emissions. By evaluating these oxygenated fuel additives and metal based additives such as DMC and aluminum oxide additives with a percentage of DMC 8% and 150 PPM of Al_2O_3 gives the best results for emission values and performance of different blends.

Keywords: Nano particles, Di-Methyl Carbonate (DMC), Aluminum oxide (Al_2O_3).

INTRODUCTION

Vehicles, industries have become a necessary need for human beings. Moreover every work needs a vehicle for transportation. These vehicles are run by a different types of fuels such as diesel and petrol. These are the fossil fuels these are extracted from within the earth. The fuel on which a vehicle runs gets burned inside the engine which in turn emits various harmful gases, these gases that vehicles emits are carbon monoxide, nitrogen dioxide, sulphur oxide.

So many researchers are find a different types of alternative fuels such as biodiesels, these alternative fuels are extracted by a waste plastics, waste oils and seeds and etc.

Several investigation studies has been performed the combustion behaviour of diesel engine fueled by biodiesel by varying parameters such as injection timing, injection pressure, engine load, engine speed and compression ratio and etc. High viscosity, density and low volatility characters of biodiesels results in problems im long lasting engine performance tests while combustion quality in influenced by size of fuel molecules and blocking of fuel entrances in the cylinder are effected by higher viscosity of biodiesel and biodiesel also showed increase in PM and NOx emissions. To improve such properties and solve the problem, fuel additives are considered as an alternative solution. Different types of fuel additive were used to increase the performance and reduce the emission.

Additives:

An additive plays a significant role in increasing the performance of the diesel engine, improving the combustion and reducing the emissions

Different types of fuel additives are

1. Metal based additives

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2. Oxygenated fuel additives
3. Cetane number improver additives
4. Ignition promoter additives
5. Lubricant additives
6. Anti oxidant additives

Blend preparation:

The nano fuel additives were prepared separately with a combination of diesel like DMC 4%, DMC 6%, DMC 8%, DMC 10%, DMC 12%. The DMC 4% blend consist of 40 ml of di-methyl carbonate and 960 ml of pure diesel and 100 PPM of aluminum oxide nanoparticles, the second blend consist of 60 ml of di-methyl carbonate and 940 ml of pure diesel and 125 PPM of aluminum oxide nanoparticles and the third blend consist of 80 ml of di-methyl carbonate and 920 ml of pure diesel and 150 PPM of aluminum oxide and fourth blend consist 120 ml of Di-methyl carbonate and 880 ml of pure diesel with addition of 175 PPM of aluminum oxide.

Figure1 Preparation of Blends

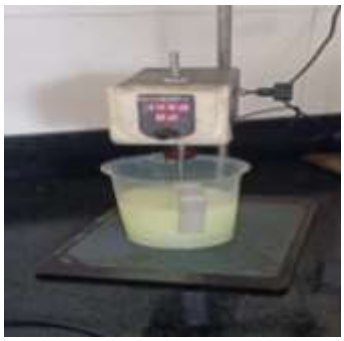

Figure 2 Ultrasonicator for stirring action of blends

In this work DMC and aluminum oxide nanoparticles are added in object and placed under a ultrasonicator. These ultrasonication is the best method for scattering between the nanoparticles in the fluid, fit for staying in suspension for a long time. The properties of diesel and DMC were evaluated to find the properties of density, viscosity, flash point. And calorific values of these additive blends which are tabulated in table 1.

Table 1 Properties of diesel and DMC and aluminum oxide

Properties	Diesel	DMC	Al_2O_3
Chemical formula	C13.77H23	CH_3O (CO)OCH_3	Al_2O_3
Molecular weight(kg/kmol)	190	90.1	0.102
Density (g/cm^3)	860	1.079	3.987
Boiling point	180-330 k	90.9 K	3250 k
Calorific value (MJ/Kg)	42.5	15.78	0.00088

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Flash point(^{0}C)	52	17	Non-flammable

Experimental setup:

The experimental investigation of engine performance and emission characteristics were performed on a four-stroke single cylinder, Kirloskar make direct injection diesel engine coupled with electrical dynamometer and forced circulation, water cooled type was used as a test rig for experimental work as shown in figure. The engine was coupled with a piezo-type cylinder pressure sensor, electromagnetic pickup and thermocouples to measure the various temperatures of the engine and manometer is used to measure the airflow and flow rates.

The performance and emission tests are performed in a engine cylinder with different trail runs.

Table 2. Specification of the engine

Specification	Type
Rated speed	1500 RPM
Cylinder bore	80 mm
Stroke Length	110 mm
Compression ratio	18
Length of connecting rod	234 mm
Brake power	5Kw
Engine	4 Stroke single cylinder, direct injection
Make	Kirloskar Engine
Type of cooling	Forced circulation water cooled system
Type of engine	Compression ignition Diesel engine

The first run of this experiment the nano fuel i.e diesel, DMC and aluminum oxide with percentage of diesel 96%, DMC 4% and Al_2O_3 100 PPM can be taken in a direct injection diesel engine to find the optimal blend results in terms of performance and emission characteristics of the engine.

Figure 3 Experimental setup of the Engine

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RESULTS & DISCUSSIONS

Load vs brake Thermal efficiency(BTE) :

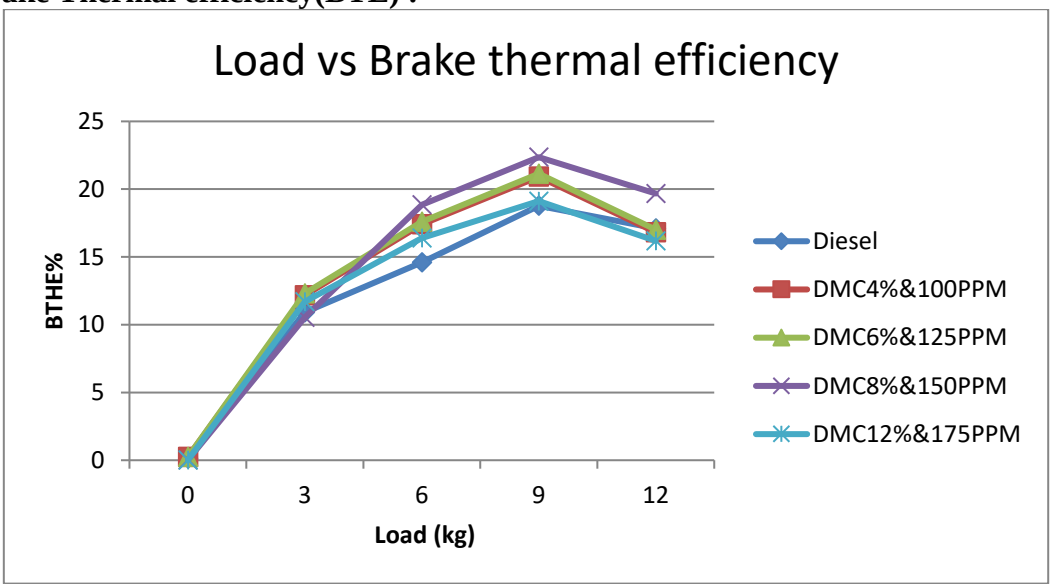

Fig 4 : Load vs Brake thermal efficiency

The figure shows the variation of brake thermal efficiency in the case of diesel 92%, DMC 8% and 150 PPM of Al_2O_3. It is clearly shown from the graph these blend can get highest BTE than the other percentage of fuels. This is because of higher volatility, lower viscosity, lower density, higher heat content in comparison with other fuels.

Load vs Mechanical efficiency:

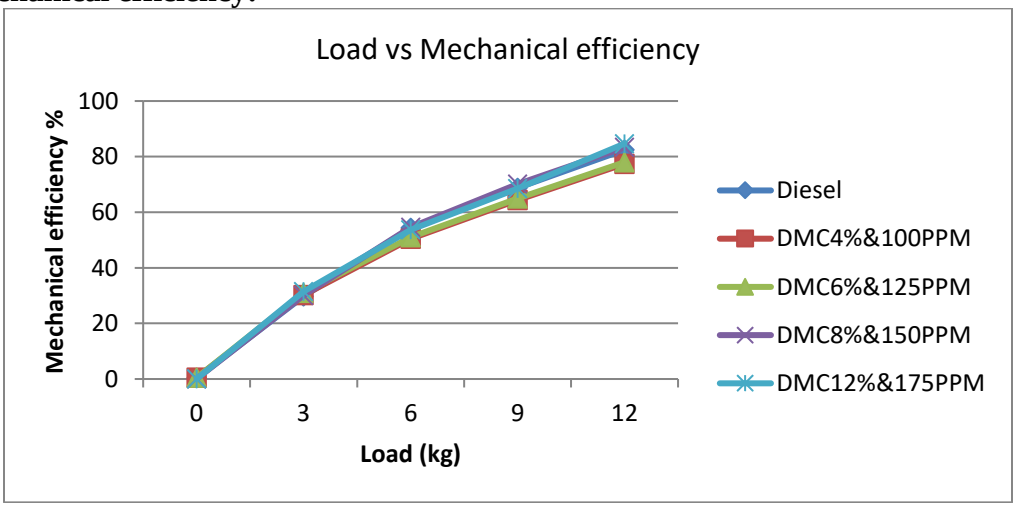

Fig 5: Load vs Mechanical efficiency

The figure shows the variations of the mechanical efficiency for diesel and different percentage of additive fuels or blends. It has been observed that the mechanical efficiency increases with load increases. It is due to effective combustion of fuel these highest mechanical efficiency can obtained from DMC12% and 175 ppm of Al_2O_3.

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Load vs Brake specific fuel consumption:

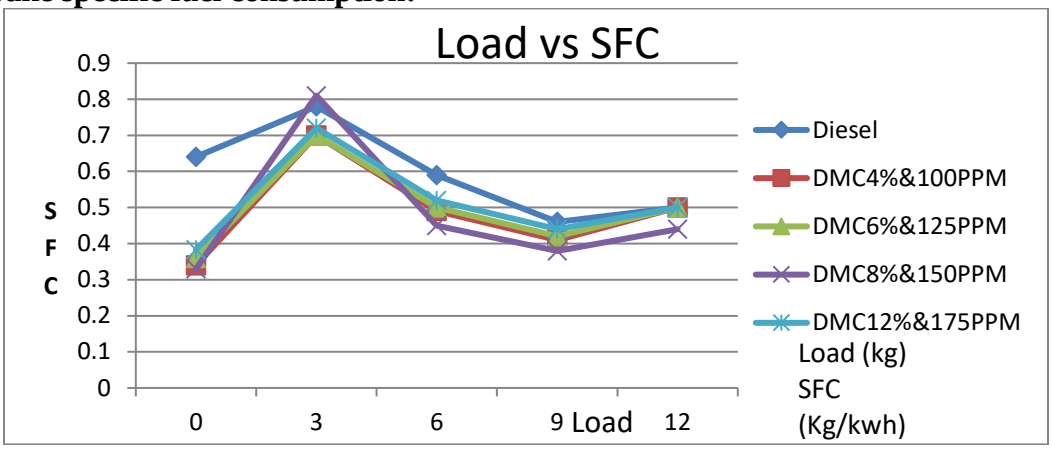

Fig 6: B.S.F.C for various blends

The figure shows the variation of brake specific fuel consumption (B.S.F.C). The itself shows that the load increases the brake specific fuel consumption decreases. It can be observed from the figure the brake specific fuel consumption of diesel was 0.46 kg/kwh at load condition was 9 kgs with pure diesel and diesel blend with DMC8% & Al_2O_3 150 PPM with a specific fuel consumption was 0.38 kg/kwh.

Load Vs Hydrocarbons

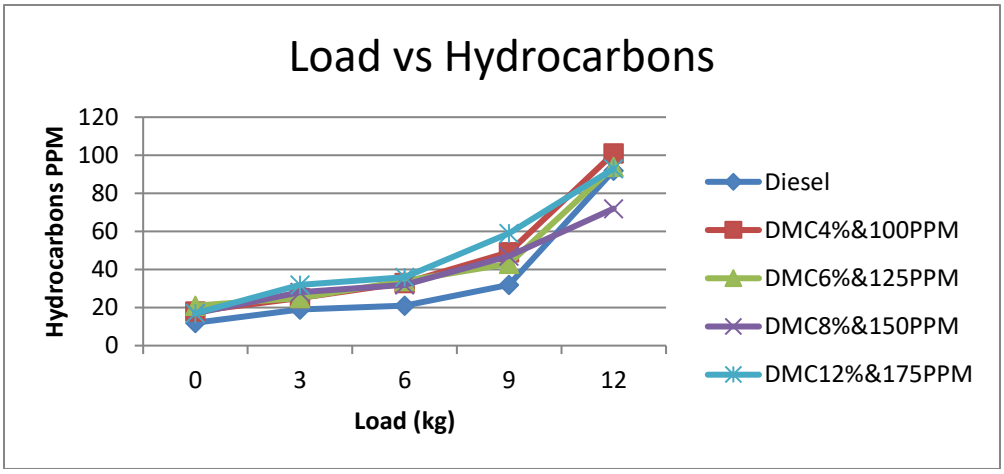

Fig7: Load vs Hydrocarbons

The Hydrocarbon emission is produced by gasoline engine that refers the air fuel mixture, incomplete combustion by the combustion process. From the graph the results can be showed that a DMC8% AND 150PPM of Al_2O_3. It gives the best results for reducing the hydrocarbon percentage.

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Load Vs Carbondioxide (CO_2):

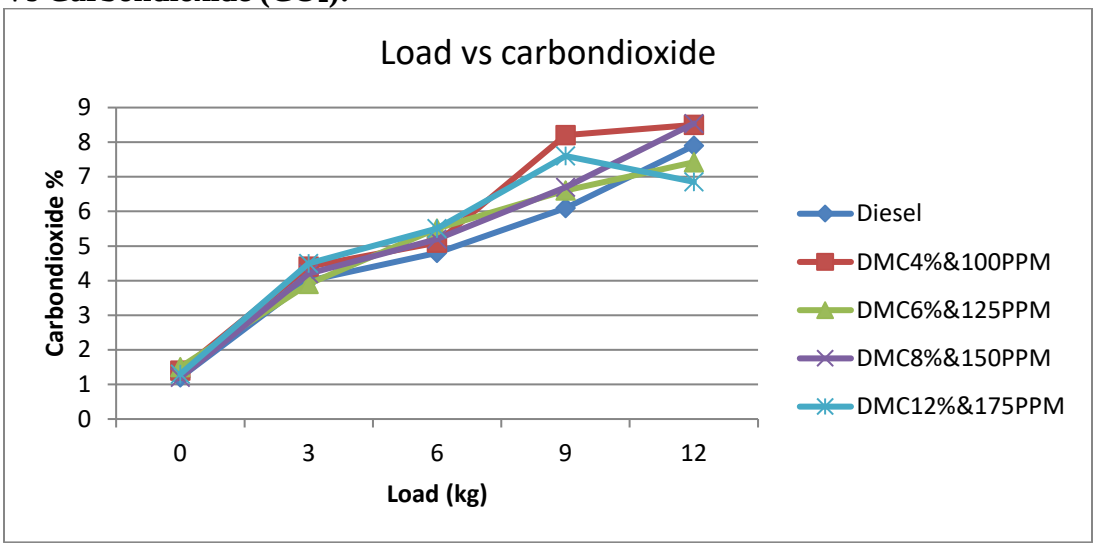

Fig8: Load vs carbondioxide

All most all burning of Fossil fuels and gaseous fuels are produced by the carbon dioxide. These carbon dioxide emissions are decreased by using a DMC8% and 150 PPM of Al_2O_3. These percentage of emissions also increases the combustion reaction is more than the combustion process the CO_2 will be higher with different percentages.

Load Vs oxides of Nitrogen (NO_x) :

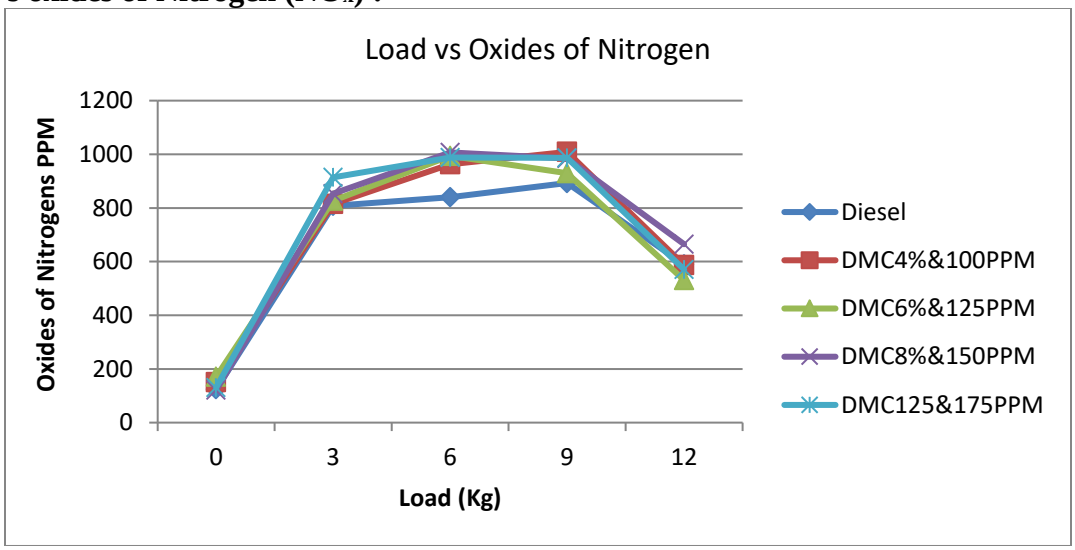

Fig9: Load vs Oxides of Nitrogen

The NO_x emission should be lower than the value of normal diesel fuel with load zero. The variation of oxides of nitrogen (NO_x) with the different loads as shown in figure. The DMC 8% and 150 PPM of Al_2O_3 gives the best results, the load increases the number of oxides of nitrogen from the engine increases.

Load vs Carbon monoxide:

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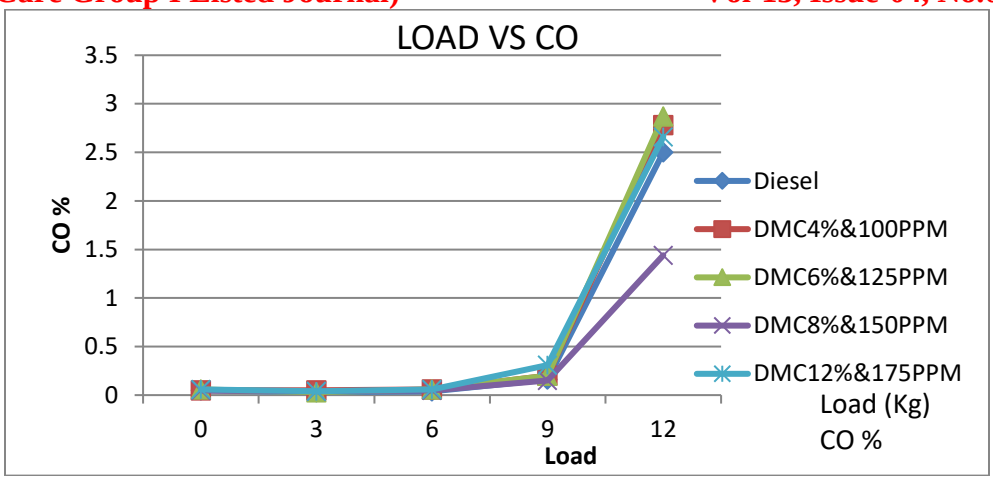

Fig10: Load vs CO

The carbon monoxide emission is released by the incomplete of combustion. By adding of aluminum oxide the actually the carbon monoxide will increased but the di-methyl carbonate will helpful complete combustion with ignition delay. So, the DMC with percentage of 8% with 150 PPM of Al_2O_3 gives the lower emission values.

Conclusion

These were able to be concluded from this work. A nano fuel additives plays a major role by increasing the performance of the engine.

- The brake thermal efficiency (BTE) increases with the percentage of additives added to the diesel fuel.
- The mechanical efficiency of the diesel engine will be increased by using theses additives than the pure diesel fuel.
- The BSFC will be slightly increased by the using of only DMC additive. So, here we can add the additive of Al_2O_3 to reduce the BSFC than the pure diesel.
- Compared to the pure diesel, D8% and 150 PPM Al_2O_3 additives give the best emission and performance values.

Future scope

- The more researchers can do a work on more additive fuels such as cetane number improver additives, ignition promoter additives and antioxidant additives.
- Di-methyl Carbonate (DMC) and Al_2O_3 can be used as higher percentages than diesel fuel and these percentages can be evaluated.
- The combinations such as metal based and oxygenated fuel additives or cetene number improver additives and ignition promoter additives can be added to the pure fuels and evaluate the results.

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