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Experimental Investigation of Nano Additive Ceric Oxide (Ceo_2) - Ethanol Blend on Single Cylinder Four Stroke Diesel Engine.

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***Abstract* - Diesel engines are widely used for their low fuel consumption and better efficiency. An experimental investigation carried out to establish the performance and emission characteristics of single cylinder diesel engine by using ethanol-ceric oxide blend. At initially preparation phase, the ethanol and cerium oxide by Continuous magnetic stirring has to be done but the blend should not mix completely. The another method of preparing blend by sonigation (ultrasonic bath) used for complete mixing of blend and highly reduced separation of ethanol–cerium oxide. At the second phase Ethanol-cerium oxide-Diesel blend prepared by using adding acetone and di-ethyl ether to reduce the distribution of fuel particles. The performance and emission characteristics have to be done. By this investigation the cerium oxide acts as oxygen donating catalyst and provides oxygen for the oxidation of CO or absorbs oxygen for the reduction of NOx. The ethanol-cerium oxide acts to burn off carbon deposits within the engine cylinder and the combustion chamber and prevents the deposition of compounds on the cylinder wall results in reduction of HC emissions. The di-ethyl ether which improves the cetane number of fuel molecules.**

***Keyword*-- Ethanol, Ceric Oxide, Di ethyl ether, Acetone, Nox, CO, HC**

I. INTRODUCTION

Diesel engines are widely used in transportation and for small power applications. Due to their overall lean Operation and higher compression ratio, they tend to emit less CO and unburned hydrocarbons with higher Thermal efficiency than do alternate technologies [1,2]. The Continuous depleting oil resources and stringent emission norms leads to increase in interest in Biodiesel fuel. Historically, fossil diesel fuel has successfully contributed in all sectors such as agricultural, transportation and industrial sectors because of their adaptability, high combustion efficiency, availability, reliability as well as the handling facilities. Diesel engine is widely used in heavy trucks, city transport buses, locomotives, electric generators, farm equipments, underground Mine equipments etc. it plays a very important role in energy economy and also contributes to pollution significantly [3-7]. There are many possible alternative energy sources for use in Diesel engine as biodiesel, Biogas and alcohols. However, their reserves are wiping out every day [8-11].

Biodiesel as an alternative fuel is one of the best choices among other sources due to having immense potential to reduce pollutant emissions and to be used in compression ignition engines [12,-15]. Automotive industry has been strongly required to develop clean technologies of lower fuel consumption for ambient air quality improvement, green house gas reduction and energy security. As a result, fuels and engines used in transportation have to face two main challenges of improving fuel economy and reducing emissions in a highly competitive economy [16-20].

II. ULTRASONIC BATH

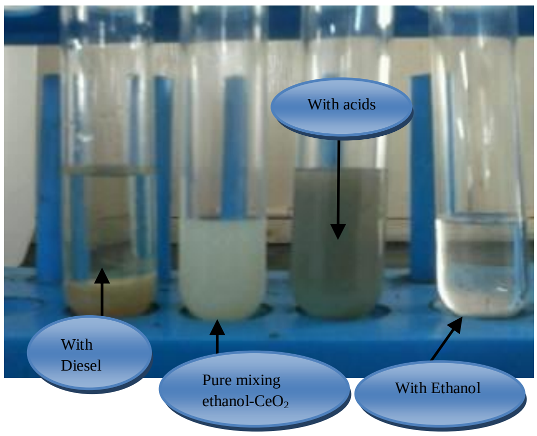

Fig 1.0 Testing of cerium-ethanol blends

The sonigation bath which improves the mixing property of cerium oxide with ethanol. At initially testing of cerium oxide insoluble in water and other chemical solvents. The direct mixing of cerium oxide and ethanol leads to complete settle down of nano particles as shown in fig 2.0. The cerium oxide diluted only in strong acids like sulphuric acid and Nitric acid. But this Concentrated acids enters inside the engine should corrode the engine cylinder as well as high moisture content which leads to knocking and detonation which reduce the performance and leads high emissions. At second stage ultrasonic bath leads to improve the mixing property of ethanol with cerium oxide by using sonigator. Finally the Cerium Oxide- Ethanol Prepared by using vibrational bath.

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III. Ethanol And Ceric Properties

Table 1
Test Fuel Nomenclature

E20D80	10% Ethanol + 90% Diesel+ 1% DEE
E10Ce10D90	10%Ethanol + 10gm Cerium Oxide + 90% Diesel +1% DEE
E10Ce15D90	10%Ethanol + 15gm Cerium Oxide + 90% Diesel + 1%DEE
E10Ce20D90	10%Ethanol + 20gm Cerium Oxide + 90% Diesel + 1%DEE
D100	100% Diesel

The properties of diesel, ethanol blend are shown in Table 2. The purity of the ethanol used is of 99.9%. A series of tests was performed to observe the solubility of ethanol and diesel with the help of additive and biodiesel. Diesel, ethanol were mixed into a homogenous blend in a container by stirring it. The blend was kept in cylindrical glass container to study the solubility and phase stability. The low volume percentage, i.e., 5 and 10 of ethanol is easily miscible and found to be stable as much as 7 to 17 days but higher concentration of ethanol with diesel is not stable for longer period of time. Phase separation was takes place soon after stirring. To overcome this problem additive is added in equal proportion to the ethanol. In case of ethanol and diesel blend, it was clearly visible that they were stratified into two layers, whereas diesel, ethanol were relatively miscible and not had any clearly visible interface. the status when the blend were formed after magnetic stirring. The volume percentages tested were 5%, 10%, ethanol with diesel (0.7% and 1% additive respectively) and 15% and 20% of ethanol with equal amount of biodiesel and diesel (1% additive in each)

Table2.
Physical properties of diesel, Ethanol blends

Properties	Diesel MJ/kg	Ethan ol	E10Ce10D 90	E10Ce15D 90	E10Ce20D 90
Diesel Content (%vol)	100	80	90	90	90
Ethanol Content(% vol)	0	20	10	10	10
Density at 150 C (Kg/m3)	843	831	833	836	838
Viscosity at400C (c P)	2.48	1.86	1.88	1.92	1.92
Flash Point (0C)	50	13.8	14	14.2	14.3
Calorifc Value kJ/kg	42	40.6	40.67	40.670	40.670

IV. Experimental Method

The engine used for the study was computerized, single cylinder, four stroke, air cooled, constant speed, direct injection, compression ignition engine. The engine is coupled with Rope brake dynamometer was used for loading the engine. Tests were conducted at D100, E10D90, E10Ce10D90, E10Ce15D90, E10Ce20D90 and of rated load for all fuels. Engine speed was maintained at 1500 rpm (rated speed) during all experiment. Fuel consumption, inlet airflow rate and exhaust temperatures were also measured. The detailed specifications of the engine and alternator are given in Table 3.

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Fig.2.0 Experimental setup

Table 3: Technical specification of the engine

Type	**Four stroke, Water cooled, Diesel**
No. of cylinder	One
Bore	87.5 mm
Stroke	110 mm
Combustion principle	Compression ignition
Cubic capacity	0.661 liters
Compression ratio 3 port	17.5:1
Peak pressure	77.5 kg/cm2
Max. Speed	2000 rpm
Min. idle speed	750 rpm
Min. operating speed	1200 rpm
Fuel timing for std. engine	230 BTDC
Brake mean effective Pressure at 1500 rpm	6.35 kg/cm2
Lub. oil pump delivery	6.50 lit/min.
Sump capacity	2.70 liter
Connecting rod length	234 mm

V. RESULTS AND DISCUSSION

Fuel Characteristics

Various physical and thermal properties of (E10Ce10, E10Ce15and E10Ce20) were evaluated vs. diesel. These properties include density, viscosity, flash point, fire point and calorific values. The results are shown in table 2. The kinematic viscosity of Ethanol was found to be less than that of diesel determined at 40ºC. After blending, the kinematic viscosity reduced at blends E10Ce10, E10Ce15 and E10Ce20 is 1.88, 1.92 and 1.92 respectively than that of pure Diesel. Similar reduction in density was also observed. However, the calorific value of neat Ethanol was found to be 26.40 MJ/Kg which is less than the calorific value of diesel (43.66 MJ/Kg). Flash point of blends were found to be lesser than 100ºC, which need safe storage and handling.

Brake Thermal Efficiency (BTE)

The variation of Brake Thermal efficiency with load for different fuel blends are shown in fig: 2. In all the cases brake thermal efficiency is increased due reduced heat loss with increased in load. The maximum efficiency obtained in this experiment was 21.27% (E10Ce10) 20.43% (E10Ce15) and 19.60% (E10Ce20). But considering the viscosity E10Ce10 is the better option and this value is comparable with the maximum brake thermal efficiency for diesel (34.51%). From fig: 3, it is found that brake thermal efficiency for Ethanol in comparison to diesel engine is a better option for part load on which most engine runs. Oxygenated fuel gives a better fuel combustion delivering improved thermal efficiency. The fuel samples show comparatively lower thermal efficiency possibly due to larger droplet size in the fuel spray. It can also be observed that the thermal efficiency generally increases with increase in blend concentration.

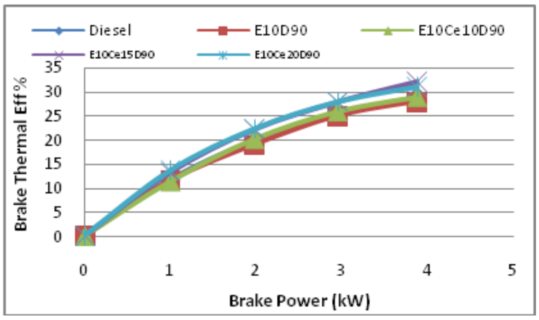

Fig.3. Engine BP Vs BTE

Brake Specific Fuel Consumption (BSFC)

The BSFC is the mass rate of fuel consumption per unit brake power. The BSFC for neat Ethanol blends is the higher than for fossil diesel are shown in fig: 4. Blends E10Ce10, E10Ce15and E10Ce20 are decreases 1.16%, 1.4% and 1.3% as comparable to fossil diesel. This is mainly due to the combined effects of the fuel density, viscosity and lower heating value of blends.

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Higher density of blends containing higher percentage of Nano additive leads to more fuel flow rate for the same displacement of the plunger in the fuel injection pump, thereby increasing BSFC.

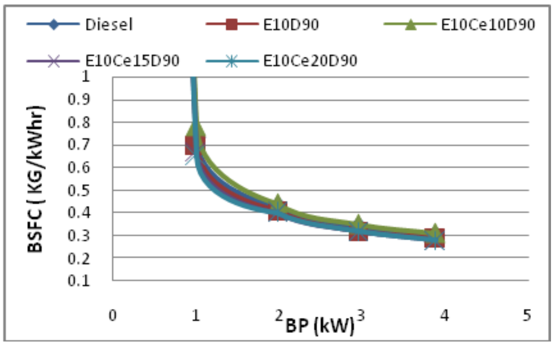

Fig.4. Engine load Vs B.S.F.C

Exhaust Gas Temperature

The variation of exhaust gas temperature for different blends with respect to the load is indicated in Fig. 4. The exhaust gas temperature for all the fuels tested increases with increase in the load. The amount of fuel injected increases with the engine load in order to maintain the power output and hence the heat release and the exhaust gas temperature rise with increase in load. Exhaust gas temperature is an indicative of the quality of combustion in the combustion chamber. At all loads, diesel was found to have the highest temperature and the temperatures for the different blends showed a downward trend with increasing concentration of Ethanol and cerium oxide in the blends. This is due to the improved combustion provided by the Cerium oxide due to its Oxidation.

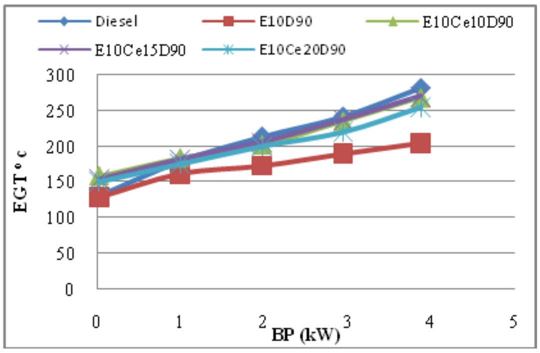

Fig.5. Engine load Vs E.G.T.

Emission Characteristics:

Oxygen for the oxidation of CO or absorbs oxygen the Ceric oxide acts as oxygen donating catalyst and provides for the reduction of NOx.

The activation energy of cerium oxide acts to burn off carbon deposits within the engine cylinder at the wall temperature and prevents the deposition of non-polar compounds on the cylinder wall results reduction in HC emissions.

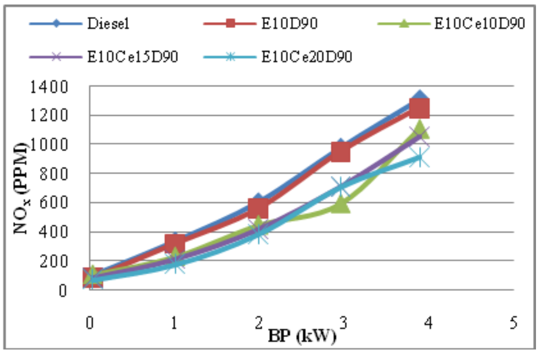

Fig.6 Brake Power Vs No$_x$

Increasing the rate of nano additive (less than 40 ppm) leads to increase in oxidation of fuels inside combustion chamber leads to better combustion, reduce in knocking, good turbulence, lower emission rate.

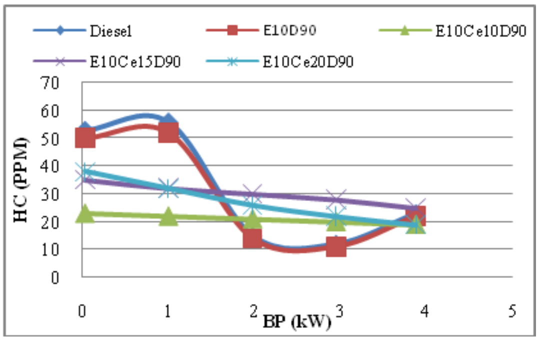

Fig 7 Brake power Vs HC

The formation of No$_x$ is highly dependent on in-cylinder temperature, oxygen concentration in the cylinder and also dependent on engine technology. The variation of No$_x$ with respect to brake power shown in fig 6.

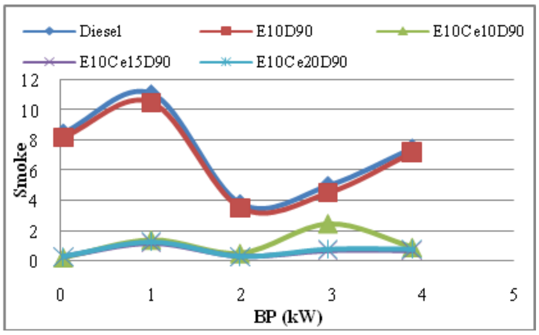

Fig. 8. Brake Power Vs Smoke

VI. CONCLUSIONS

Based on the result of this study i.e. physical and chemical properties of Ethanol cerium oxide blend suggest that it can be used directly as CI engine fuel due to lower viscosity, density which will result in high volatility and better atomization of oil during fuel injection in combustion chamber causing complete combustion and low carbon deposits in combustion chamber. The physical and chemical properties results of all blends show that blend of cerium oxide upto 30% have value of better performance and density equivalent to specified range for CI engine fuel, therefore it can be concluded that upto 30% blend can be used to run the stationary CI engine at short term basis. Further study of volatility of Ethanol and cerium oxide needs to be investigated to know the effect on engine. The properties of blend may be further improved to make use of higher percentage of Cerium oxide nano additive in the blend.

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