International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.11 No.02, pp 304-310, 2018

Performance and Emission Characteristics of Nano Additive Ceric Oxide- Di Ethyl Ether-Ethanol Blend on Single Cylinder Four Stroke Diesel Engine.

R.Vinoth Kumar*

Department of Mechanical Engineering, E.S.Engineering College, Villupuram,TamilNadu, India.

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 first phase a series of experiments have to be done by using ethanol-ceric oxide blend with various ratios in diesel engine the performance characteristics have to be studied. For preparation of ethanol and cerium oxide, Continuous magnetic stirring have to be done but the blend should not diluted completely. So by another method sonigation (ultrasonic bath) used to reduce the separation of fuels. At second phase Ethanol-cericoxide-Diethyl ether prepared by using additive to reduce the separation of fuels and the performance and emission characteristics have to be done. By this investigation the ceric oxide acts as oxygen donating catalyst and provides oxygen for the oxidation of CO or absorbs oxygen 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. The Diethyl ether which improves the cetane number of fuel molecules.
Key Word : Ethanol, Ceric Oxide, Di ethyl ether, Nox, CO, HC.

1.Introduction

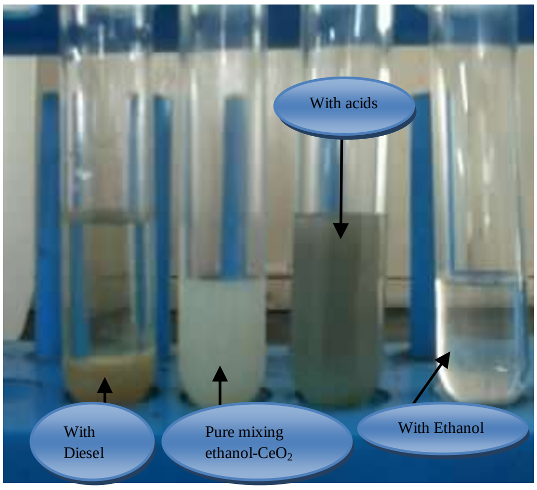
India being predominantly agricultural country requires major attention for the fulfillment of energy demands of a farmer. Irrigation is the bottleneck of Indian agriculture; it has to be developed on a large scale. It is well known that transport is almost totally dependent on fossil particularly petroleum based fuels such as gasoline, diesel fuel and liquefied petroleum gas. As the amount of available petroleum decreases, the need for alternate technologies to produce liquid fuels that could potentially help prolong the liquid fuels culture and mitigate the forthcoming effects of the shortage of transportation fuels increases. The increased use of diesel in agriculture, transportation and industrialization sectors has resulted in diesel crisis. Finding an alternative fuel for diesel fuel is critically important for our nation's economy and security. The complete substitution of oil imports for the transportation, industrialization and agricultural sectors is the biggest and toughest challenge for

International Journal of ChemTech Research, 2018,11(02): 304-310

DOI= http://dx.doi.org/10.20902/IJCTR.2018.110236

India. In view of this, promotion of biomass-based power generation in the country is being encouraged. There are several reasons for bio-fuels to be considered as relevant technologies by both developing and industrialized countries. They include energy security reasons, environmental concerns, foreign exchange savings, and socioeconomic issues related to the rural sectors of all countries in the world. Bio-fuels have become more attractive recently because of its environmental benefits [1–7]. From literature studies [8–18], it is evident that various problems are associated with vegetable oils being used as fuel in diesel engines due to the high viscosity, high density and poor non-volatility, which lead to problems in pumping, atomization and poor combustion inside the combustion chamber of a diesel engine in long term. Therefore, vegetable oils cannot be used directly in diesel engines at room temperature. In order to reduce the viscosity of the vegetable oils, three effective methods have been found; transesterification, mixing with lighter oil and heating .Transesterification and emulsification are found as effective methods for improving performance and reducing emissions of a diesel engine fuelled with vegetable oils. However, transesterification is a more expensive, time consuming and complex process due to the chemical and mechanical processes involved. Emulsions can be made by mixing water and surfactants with oil in a simple process. However, making stable emulsions with suitable surfactants is a difficult task. In addition to that use of emulsions in diesel engines results in inferior performance at part loads.

2. Ultrasonic Bath:



The ultrasonic bath which improves the mixing property of ethanol with cerium oxide.At initial testing the ceric oxide insoluble in water and other chemical solvents.The direct mixing of cerium oxide and ethanol leads to complete settle down of nano particles. 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 piston as well as high moisture content which leads to knocking, reduce in performance and high emissions. At second stage ultrasonic bath leads to improve the mixing property of ethanol with ceric oxide by using sonigator. Finally the Ceric Oxide- Ethanol Prepared by using ultrasonic bath.

3. ETHANOL AND CERICPROPERTIES :

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 was 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**	**Ethanol**	**E10Ce10D90**	**E10Ce15D90**	**E10Ce20D90**
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 at 400C (c P)	2.48	1.86	1.88	1.92	1.92
Flash Point (0C)	50	13.8	14	14.2	14.3
Calorific Value	42000	40670	40670	40670	40670

4.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, and 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.

Fig.1. 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

5. 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 blendsE10Ce10, 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). As the percentage of Ceric oxide in the blends increased, the calorific value increased. 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: 2, 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.

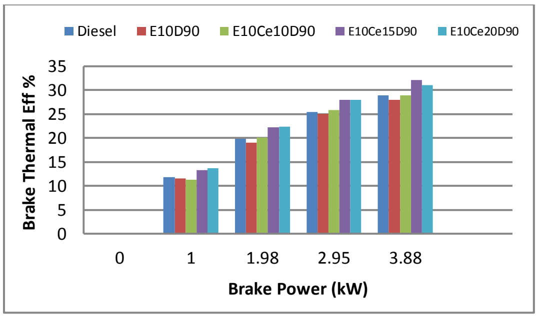


Fig.2. Engine BP Vs BTE

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: 3. 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. 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.

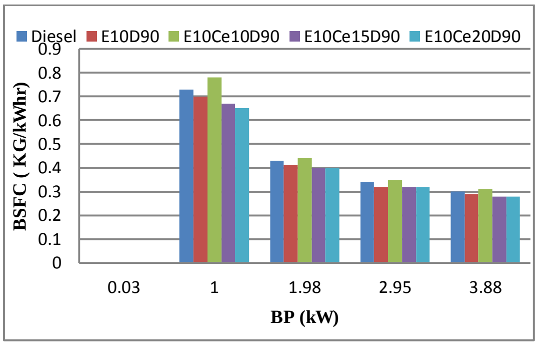


Fig.3. Engine load Vs B.S.F.C

Exhaust Gas Temperature

The variation of exhaust gas temperature for different blends with respect to the load is indicated in Fig. 3. 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.

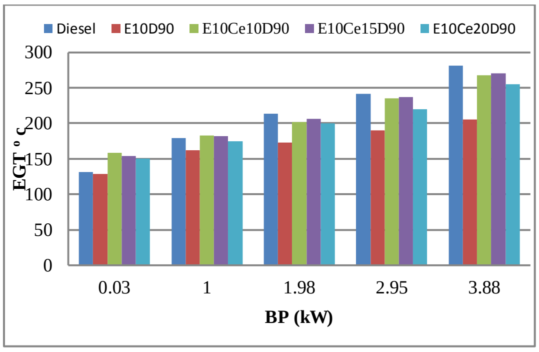


Fig.4. Engine load Vs E.G.T.

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.

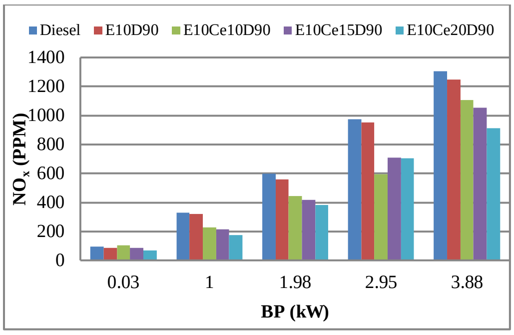


Fig.5 Brake Power VsNo_x

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.

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 5.

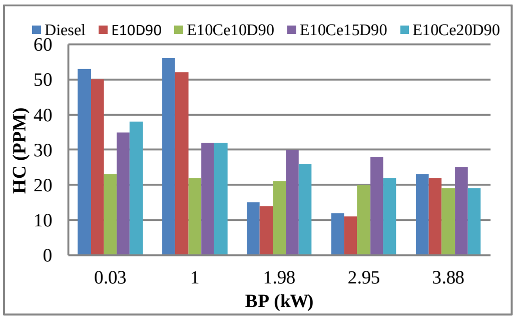


Fig 6 Brake power Vs HC

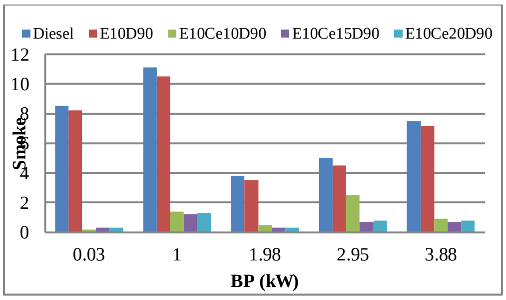


Fig. 7 Brake Power Vs Smoke

6. 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 nanoadditive in the blend.

7. References

1. Humke AL., Barsic NJ., Performance and emission characteristics of a naturally aspirated diesel engine with vegetable oils (Part-2). *Transactions of Society of Automotive Engineers*, 810955, 1981.
2. Czerwinski J., Performance of HD-DI diesel engine with addition of ethanol and rapeseed oil. *Trans SocAutomotEng*1994; 940545.
3. Senthil Kumar M, Ramesh A, Nagalingam B, Use of hydrogen to enhance the performance of a vegetable oil fuelled compression ignition engine. *Int J Hydrogen Energy 28*(10), pp1143–54, 2003.
4. Brecq G, Bellettre J, Tazerout M. A new indicator for knock detection in gas SI engines. *Int J ThermSci*, 42(5), 523–32,2003.
5. Brecq G, Bellettre J, Tazerout M, Muller T. Knock prevention of CHP engines by addition of N2 and CO2 to the natural gas fuel. *ApplThermEng*2003; 23(11):1359–71.
6. Senthil Kumar M, Ramesh A, Nagalingam B. An experimental comparison of methods to use methanol and Jatropha oil in a compression ignition engine. *Biomass Bioenergy* 2003; 25(3):309–18.
7. Muniyappa PR, Brammer SC, Noureddini H. Improved conversion of plant oils and animal fats into biodiesel and co-product. *BioresourTechnol*1996; 56(1):19–24.
8. Pryde EH. Vegetable oils as diesel fuels: *overview. JAOCS* 1983; 60:1557.
9. Murayama T, Oh YT, Miyamoto N, Chilahisa T. Low carbon flower buildup, low smoke, and efficient diesel operation with vegetable oils by conversion to monoesters and blending with diesel oil or alcohols. *SAE Paper* No. 841161; 1984.
10. Vellguth G. Performance of vegetable oils and their monoesters as fuels for diesel engines. *SAE Paper No*. 831358; 1983.
11. De Almeida SCA, Belchior CR, Nascimento MVG, Vieira LSR, Fleury G. Performance of a diesel generator fuelled with palm oil. *Fuel 2002*; 81:2097–102.
12. Ziejewski M, Kaufman KR. Laboratory endurance test of a sunflower oil blend in a diesel engine. *JAOCS 1983*; 60:1567- 75.
13. Graboski MS, McCormick RL. Combustion of fat and vegetable oil derived fuels in diesel engines. *Prog Energy Combust Sci*1998; 24:125–64.
14. Labeckas G, Slavinskas S, Ignatavicˇius T. The research of direct injection diesel engine performance parameters when operating on pure rapeseed oil, vol. 57. *Research papers of Lithuanian University of Agriculture VAGOS*; 2003. p. 117-23.
15. Labeckas G, Slavinskas S. The analysis of diesel engine performance on pure rapeseed oil. In: *Proceedings of 4th international conference TRANSBALTICA-03*, Vilnius Gediminas Technical University, Technika, Vilnius; 2003. p. 490–6.
16. Hazar H. Effects of biodiesel on a low heat loss diesel engine. *Renew Energy* 2009; 34: 1533–7.
17. Ani FN, Lal M, Williams A. The combustion characteristics of palm oil and palm oil ester. In: *Proceedings of the third international conference on small engines and their fuels for use in rural areas*; 1990. p. 58–66.
18. Dunn PD, Jompakdee W. Measurement of the rate of carbon build-up in diesel engines employing vegetable oil fuels. In: *Proceedings of the third international conference on small engines and their fuels for use in rural areas*; 1990. p. 9–15.
19. Murayama T, Fujiwara Y, Noto T. Evaluating waste vegetable oils as a diesel
20. fuel. *ProcInst Mech Eng*: Part D 2000; 214:141–8.
21. A.S. Ramadhas, S. Jayaraj and C. Muraleedharan. Use of vegetable oils as I.C. engine fuels—A review, *Renewable Energy* 29, 2004, pp 727–742.

*****