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Impact of Al_2O_3 nano additives blended with biodiesel derived from chicken fat oil on performance and emission characteristics of a diesel engine

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Abstract- The experimental investigations on the influence of Aluminium Oxide Nanoparticles blended Chicken Fat Oil Biodiesel (Methyl Esters) on the Performance & Emission characteristics of CI engine is reported in this paper. In the experimentation, the proportion of 50ppm & 100ppm of Aluminium Oxide Nano-particles were mixed with Chicken Fat Oil Biodiesel. The analyses were progressed with a blending ratio of B20CFOME (Chicken fat Oil Methyl ester) individually and in combination of the blending ratio of B20CFOME with Aluminium Oxide Nano-particles in the proportion of 50ppm & 100ppm respectively. The results revealed that, there is a significant increase in brake thermal efficiency and reduction in brake specific fuel consumption for both B20CFOME blending and the B20CFOME with Nano additive-blends. The Emission parameters like hydrocarbons & carbon monoxides are decreased whereas, the slight increase in nitrogen oxides for B20CFOME & B20CFOME with Nano additive blends were noticed when compared with diesel. In conclusion, all the parameters studied were displayed better performance at in combination of B20CFOME with Nano additive-blends compared with an individual blending ratio of B20CFOME.

Key words: CI Engine, Chicken FatMethyl Esters (Biodiesel), CFOME, Aluminium Oxide nano particles

INTRODUCTION

Due to fast increase in the growth of several industries and vehicles, the necessity for fossil fuels is increased in the current situations. As these fossil fuels are depleting sources of energy, there is a need for search of new alternative sources. Biofuels are the key source of alternative energy sources since they are sustainable & Eco friendly.[1] Bio diesel is produced from Vegetable oils & Animal fats. Because of less environmental impact, the use of fat oils & their methyl esters are became popular now a day. The viscosities of these oils are considered as limit to use in IC Engines, the transesterfication process is used to reduce the viscosity of fat oils. The inclusion of biodiesel & metal oxide nano-additives to diesel fuel enhances the performance and emission characteristics of the CI Engine. This could decrease some dependency on the fossil fuel & also using of biodiesel & nano additives does not need any Engine modification.[2] In the present study Chicken fat oil methyl esters are used to study the Performance & Emission characteristics of CI Engine.

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MATERIALS & METHODOLOGY

Preparation of Al_2O_3 nano particles blended Chicken Fat Oil Biodiesel

Transesterification process is one of the most commonly used methods to produce biodiesel. In transesterification, 6.5gms NaOH and 150ml of Methanol is dissolved in the Chicken Fat oil. By keeping the flask on the magnetic stirrer, the mixture was stirred for half an hour without heating. Now turn on the heater and heat the mixture for 2 hours by maintaining the temperature around 50^0C - 60^0C. Then, transfer the mixture into the separating funnel and the mixture has allowed overnight to settle by gravity in a separating funnel. Then Glycerol was separated & the obtained Chicken Fat Oil Methyl ester was collected. The Chicken Fat Oil Methyl esters are then heated till 120^oC to evaporate the Methanol if present. Thus, the Chicken Fat Oil Biodiesel was obtained.

After obtaining the Chicken Fat Oilbio-diesel using transesterification process, the Al_2O_3 nanoparticles were dispersed in the Chicken Fat Oil biodiesel using Ultra-sonicator device. 35 nm of Aluminium oxide nanoparticles are dispersed in the Chicken Fat Oil methyl esters. 50 ppm & 100ppm of Aluminium oxide was weighed by using an electronic weighing machine. This weighed nano-additive were added into the B20CFOME blends & kept about 30min in the Ultra-sonicator to ensure that the dispersed nano-additives are homogeneously distributed in the biodiesel.

Fig 2.1: Aluminium oxide nano-particles

Fig 2.2: Ultrasonicator Device

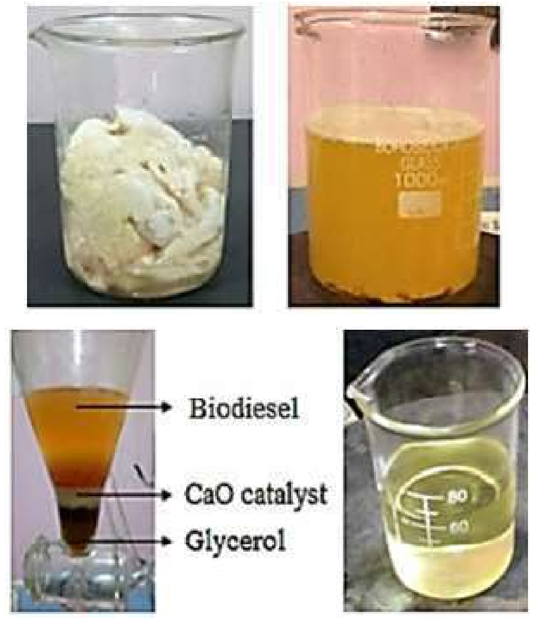

Fig. 2.3 E1: Chicken fat subjected for Oil, E2: WCF Oil, E3: Separation of Biodiesel and E4: Pure Biodiesel

Experimental Set Up and Measurement

The various components & specifications of the engine used in the present study are shown in Figure.3.1, Table 3.1 & Figure. 3.2 respectively

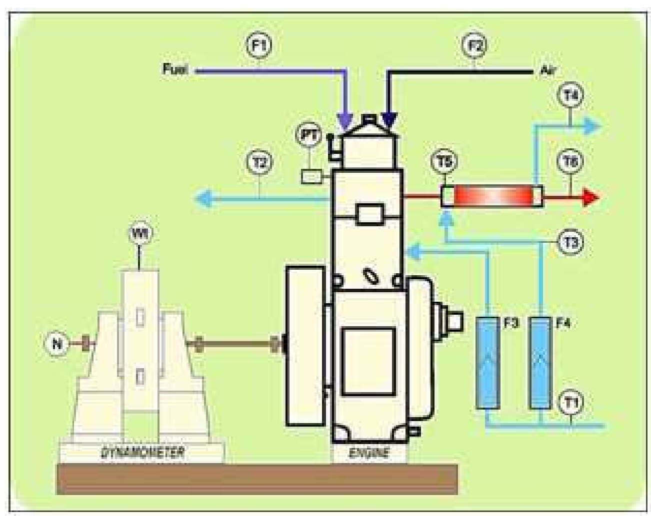

Fig 3.1: Schematic approach of various Parts of Engine Test Rig

Table 3.1: Technical specification of Engine

SL. No.	Product	Research Engine test setup 1cylinder, 4 stroke, Multi-Fuel VCR with open ECU for petrol mode (Computerized)
1.	**Engine**	Type 1 cylinder, 4 stroke, water cooled, stroke 110 mm, bore 87.5 mm. Capacity 661cc. Diesel mode: Power 3.5KW, Speed 1500rpm. BTDCECU Petrol mode: Power 3.5KW@1500rpm, Speed range 1200-1800 rpm, CR range 6:1-10:1
2.	**Dynamometer**	Eddy current type, water cooled, with loading unit
3.	**Fuel tank**	15 lit Capacity, Duel compartment, with fuel Metering pipe of glass
5.	**Crank angle sensor**	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
6.	**Engine control unit**	PE3 series ECU, full build potted enclosure.
7.	**Sensors for ECU**	Air temp, coolant temp, Throttle position and trigger.
8.	**Load indicator**	Digital, Range 0-50 Kg, Supply 230VAC
9.	**Fuel flow transmitter**	DP transmitter, Range 0-500 mm WC
10.	**Air flow transmitter**	Pressure transmitter, Range (-)250mmWC

Fig. 3.2: Computerized Single Cylinder 4 Stroke Diesel Engine

RESULTS & DISCUSSION

Performance Characteristics

In this Segment, influence of Alumina nano particles on the performance parameters is discussed. The investigations were performed at persistent Engine speed of 1500rpmby varying the load from zero percent to 100% for the fuel blends of D100, B20CFOME, B20CFOME + 50ppm Al_2O_3 & B20CFOME + 100ppm Al_2O_3.

Brake Thermal Efficiency (BTE)

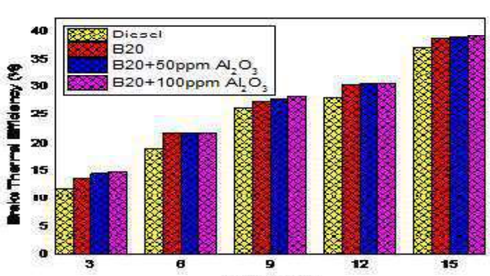

Fig.4.1: Variation of BTE with Load

Figure.4.1 shows the deviation of brake thermal efficiency versus load for all tested fuels. It clearly shows that, the BTE of blended fuel is more than the diesel. The greatest BTE is noticed for B20CFOME+100ppm Al_2O_3 and least is noticed for diesel at higher loads. There is 5.70 % increase in BTE for B20CFOME+100ppm Al_2O_3 when compared with diesel. From the graph it is also cleared that addition of Al_2O_3nano particles will enhance the BTE. The addition of nano particles supplies more oxygen for combustion which results in improved BTE. So there is increase in BTE for all B20 blends & B20 blends with Al_2O_3 nano particles (50ppm & 100ppm) than diesel.

Brake Specific fuel consumption

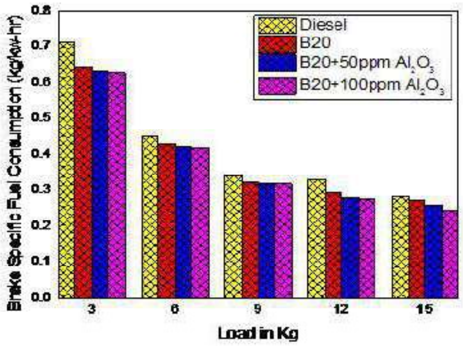

Fig.4.2: Variation of BSFC Vs Load.

Figure.4.2 shows the deviation of BSFC with load applied for all the test fuels. It is seen in the graph that BSFC reduced with increase in load. At maximum load, the higher BSFC is seen for diesel and least for B20CFOME+100ppm Al_2O_3. So there is decrease in BSFC for all B20 blends with Al_2O_3 nano particles (50ppm & 100ppm) than diesel. There is 13.47 % decrease in BSFC for B20CFOME + 100ppm Al_2O_3 when compared with diesel. It is because of consequence of lower calorific value of blended oils and further more considering better consuming, as a result of the more oxygen present in Al_2O_3 nano particles. BSFC for the biodiesel and its blends decreases because of the low calorific value of biodiesel in comparison with diesel.

Emission Characteristics

In this segment, the different emission characteristics like unburnt hydrocarbons, nitrogen oxide and Carbon monoxide emissions are studied.

Hydrocarbon (HC)

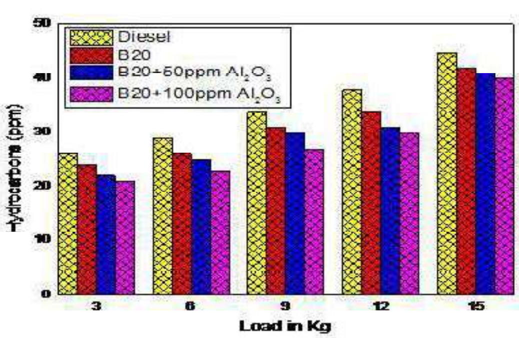

Fig. 4.3: Variation of UBHC Vs Load

Figure 4.3 shows the deviation of HC versus load. At all loads, the HC emission is low for the blended fuels compared with diesel. It is also observed from the graph that, When Al_2O_3 nano particles (50ppm & 100ppm) are added to chicken fat oil biodiesel, the hydo-carbon emissions reduced. The greatest and least HC emissions are noticed for diesel and B20CFOME+100ppm Al_2O_3 individually. There is 11.11 % decrease in HC emissions for B20CFOME+100ppm Al_2O_3 when compared with diesel. HC emissions are lesser than diesel because of higher catalytic property of Chicken fat oil fuel expands the surface to volume proportion and give oxygen to increase combustion rate thereby decreasing HC.

Oxides of Nitrogen (NO_X)

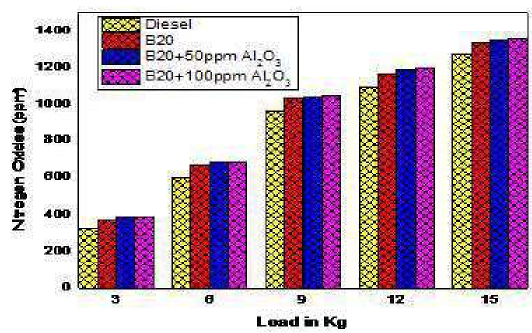

Fig.4.4:Variation of NO_X Vs Load

Figure 4.4 shows the deviations of NOx emission versus load. The Chicken fat biodiesel & Aluminium oxide nano additive provides oxygen for combustion & due to this temperature of combustion chamber in the cylinder increases. This increase in temperature of the combustion chamber cause higher Nitrogen oxide emissions From the figure 4.4 the best and least NOx releases were seen for B20CFOME and diesel separately. There is 4.71 % increase in NOx emissions for B20CFOME when compared with diesel.

Carbon Monoxide (CO)

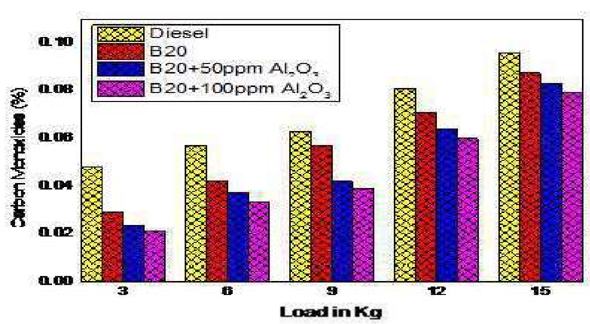

Fig. 4.5: Variation of CO vs Load

Figure 4.5 shows the CO emissions variation with respect to load. It is observed from the graph that, the CO emissions are low for B20CFOME & B20CFOME +

100ppm Al_2O_3 when compared with diesel. It is also seen from the graph that, the carbon monoxide emissions are low for B20CFOME+100ppm Al_2O_3 compared with B20CFOME. The greatest and least carbon monoxide emissions are noticed for diesel and B20CFOME+ 100ppm Al_2O_3 individually. It shows that when compared with diesel, there is a 17.70% reduction in the carbon monoxide emissions for B20CFOME+100ppm Al_2O_3.

CONCLUSIONS

- ⇨ The brake thermal efficiency is higher for the blended fuels than diesel. The maximum BTE is noticed for B20CFOME+100ppm Al_2O_3 & least is noticed for diesel.
- ⇨ The brake specific fuel consumption is lower for the blended fuels than diesel. The minimum BSFC is noticed for B20CFOME+100ppm Al_2O_3 & maximum is noticed for diesel.
- ⇨ The unburnt hydrocarbon emissions are lower for the blended fuels than diesel. The minimum UBHC is noticed for B20CFOME+100ppm Al_2O_3 & maximum is noticed for diesel.
- ⇨ The nitrogen oxide emissions are slightly higher for the blended fuels than diesel. The maximum NOx is noticed for B20CFOME+100ppm Al_2O_3 & minimum is noticed for diesel.
- ⇨ The carbon monoxide emissions are lower for the blended fuels than diesel. The minimum CO emission is noticed for B20CFOME+100ppm Al_2O_3 & maximum is noticed for diesel.

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