Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12015 - 12023
Received 05 March 2021; Accepted 01 April 2021.

Influence of Nano Additives in Bio-Diesel Blends: An Experimental Analysis

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ABSTRACT
An experimental work is carried out to examine and analyze the influence of Multi Walled Carbon Nanotubes (MWCNT) in cottonseed oil biodiesel blends. The performance, and emission characteristics were examined in single cylinder, 4-stroke DI diesel engine for constant speed at various load conditions. A methyl ester of cottonseed oil had prepared and mixture with diesel by three compositions varying from 10%, 20% and 30% with the constant additive of Multi walled carbon nanotubes as 30 ppm in each blends and was mixed in to the biodiesel-diesel blends with the aid of ultrasonicator. The experimental work was carried out with inclusion of additive and without additive. From that, it shows significant raise in brake thermal efficiency and it was observed around 2 to 3 % under load conditions ranges from 6 to 12 kg for biodiesel nano additive blends. Brake specific fuel consumption of biodiesel was equal to that of pure diesel. The emission characteristics were remarkably reduced due to addition of nano additives, which induce to speed up the combustion rate and thus decrease in ignition delay.
Keywords: *Cotton seed oil, Multiwalled carbon nanotubes, Ultrasonicator.*

1. Introduction

Due to the run out of fossil fuels, we need to go for another resource which is useful for betterment for our future. Since the petroleum juncture in gulf countries and worldwide there is a rapid increase in prices especially in India which is very dependent on these fuel requirements. Increased number of automobile vehicles has commensurately increased the effect of greenhouse gases. Biodiesel is one of the important sources of renewable energy and are available in plenitude especially in agricultural countries like India. Their yield also makes the environment “greener”. Vegetable oils can be trans-esterified to biodiesel, which was substituted fuel for diesel engines without any changes.A large yield of 92 % biodiesel was notified at maximum effect temperature ,time of methanol/oil ratio and compound loading rate were 60˚C,50 min,12:1 and 3% respectively. (Duple Sinha, S.Murugavelh He et al 2016). To analyse the effect of Di- tertiary peroxide (cetane improver) and done the experiment and significantly reduced the oxides of nitrogen and hydrocarbon emissions for overall engine speeds. (K.Senthilkumar, R.Rhun dil karupa raj He et al 2016). Studied the effects of nano additives in jojoba methyl ester and experiments were performed in DI engine with dosage level of 10 to 50 mg/L for every blend. From experiments the results shows that biodiesel blends of 30mg/l had maximum efficiency and minimum emissions. **(**Ahmed I. EL–sessy He et al 2016) Done in an experiment on single cylinder DI diesel engine and the evident shows that TFC is less for cotton seed oil than biodiesel. Emission of CO, CO_2, HC and Nox are less for cotton seed oil at various loads. **(**Karunamurthy krishnasamy He et al

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2010) Experiments are done at variable compression ratio and different blends range from 5% to 20% in steps of 5%.There is reduction in CO and smoke in full range of compression ratio and loads. (Anand ramanathan, Sivan velmathi He et al 2009). The experiments were done by using several fuel mixtures of diesel, ethanol and cottonseed oil methyl ester and results indicated that Nox and CO_2 emissions decreased. **(**R.Senthil raja, Sivakumar He et al (2014) . Reviewed and analysed how the additives plays a significant role in performance and emission in an engine. **(**H.K rashedul He et al 2014). Studied the effects of adding diethyl ether and experiments were performed in HCCI-DI engine and premixed fuel ratio was varied from 0% to 40% and results were compared. **(**Can cinar, serdar Yucesu He et al 2009) Experiment conducted at various blend ratios and performance of brake thermal efficiency was improved. **(**Gvidonas labeckas He et al 2014). Various types of reviews were analyzed in nanoparticles and examined the effect of nanoparticles for enhancing the thermal efficiency, heat transfer characteristics, thermal stability and dielectric properties. (V. Sridhara, L.N. Satapathy He et al 2015).

Table 1. Test rig specifications

ENGINE SPECIFICATIONS	
Manufacturer	Kirloskar oil Engine Ltd. India
Type of Engine	Direct Injection Diesel Engine Single Cylinder, Four Stroke
Cooling type	Water Cooling
Engine Speed	1500 rpm
Brake Power	5.2 kW @ 1500 rpm
Bore Diameter	87.5 mm
Stroke Length	110 mm
Type of Loading	Electrical Loading (Eddy Current Dynamometer)
Method of Starting	Key start
Compression Ratio	17.5:1
Orifice Diameter	0.02 m
Dynamometer Arm Length	0.185 m

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Table 2. Properties of diesel & cottonseed oil

Property	**Diesel**	**Cottonseed**
Density (kg/m^3)	830	915
Viscosity (cP)	2.7	3.7
Cetane number	50	42
Flash point(°C)	>61	234
Auto ignition point (°C)	200-400	232
Higher heating value (MJ/kg)	43.35	38.7

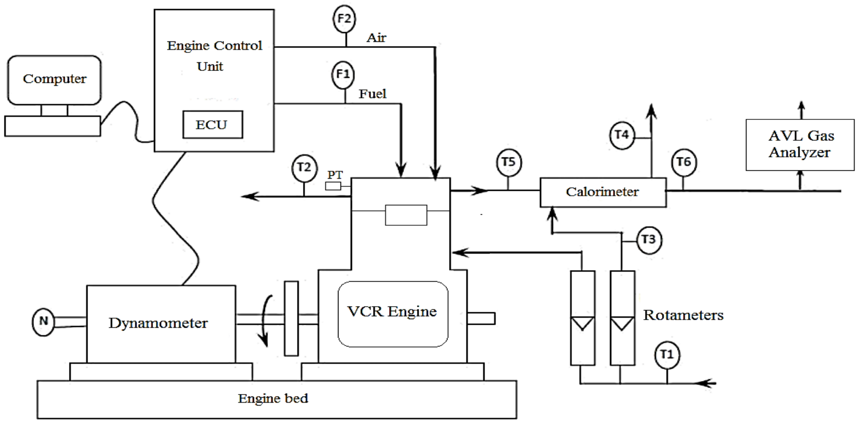

Fig 1. Line diagram setup

Table 3. Properties of MWCNT

Property	Specification
Diameter	10-20 nm
Length	3-8 µm
Purity	>99%
Amorphous Carbon	<1%
Average interlayer distance	0.34nm
Real density	1-2 g/cm^3

2. Methodology

Through the esterification process, the triglyceride has bonded with alcohol by the occurrence of a catalyst, typical a strong alkaline like sodium hydroxide or potassium hydroxide. Eventually, the bio-diesel with low viscous was obtained. The shown figure described about the chemical process for methyl ester biodiesel.

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Fig 2. Sedimentation of Glycerine

Fig 3. Bio diesel after washing

Table 4. Ratio of blend of bio diesel and pure diesel

Blend Name	Composition of Biodiesel		
	Cottonseed Oil (%)	**Diesel (%)**	**MWCNT (ppm)**
B10 D90	10	90	-
B20 D80	20	80	-
B30 D70	30	70	-
B10 D90 CNT30	10	90	30
B20 D80 CNT30	20	80	30
B30 D70 CNT30	30	70	30

2.1 Ultra Sonicator

MWCNTs additives of recommended composition as shown in table are dispersed in to a mixture of cottonseed oil and bio diesel fuel by using ultrasonicator pointed at a frequency of 24 kHz for 30 minutes. The Nanoparticles are scattered into biodiesel blends by ultra-sonication technique to avoid the nanoparticles accumulation in the fuel blends.

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2.2 Testing of biodiesel

The engine was run with pure diesel for few minutes as a warm-up, meanwhile the engine cooling and flow pressure is set as desired. After verification of test engine setup, it is tested at several loads with compression ratio of 16.5 for about 20 minutes with varying the load to the engine by an increment of 3 kg.

Readings were recorded by software of the test rig setup as per the program for all the loads i.e., 0, 3, 6, 9 and 12 kg. The first test results of all the fuels which are produced as shown in table are tested and readings were saved.

3. Results and Discussions

For finding the performance, emissions and combustion characteristics for different stirred fuels, an exhaust gas discharge test was conducted and noted down. Based on the test results, tabulation was created. By using that observed values, the following calculations are determined.

3.1 Engine Performance Parameters

The deviation of specific fuel consumption with brake mean effective pressure is shown in fig. The gainful load of the engine is recognized as 0.1533MPa for the related least specific fuel consumption. It was followed that the specific fuel consumption reduces with the rise in brake mean effective pressure.

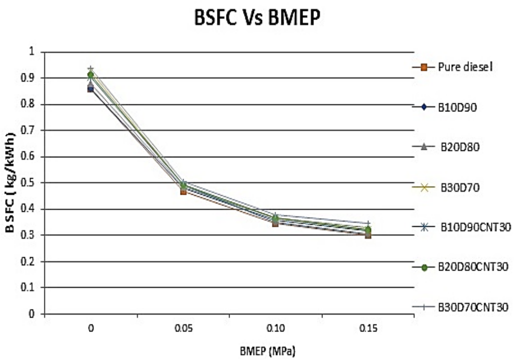

Fig 4. BSFC Vs BMEP

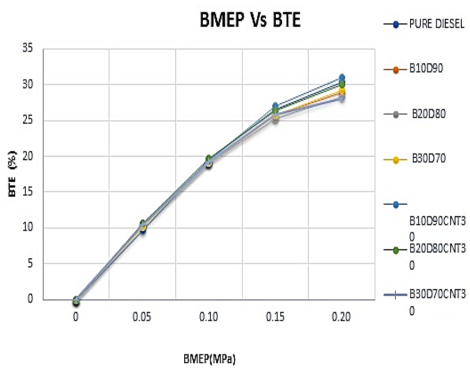

Fig 5.Brake Thermal Efficiency Vs BMEP

The accumulation of MWCNT reduces the specific fuel consumption when compared to the B10D90, B20D80, B30D70 blends as the supplement of MWCNT enrich the combustion.

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The least specific fuel consumption was reckoned as 0.32kg/kWh for the fuel blends B30D70CNT30, whereas for the B10D90CNT30 blend it was 0.36kg/kWh at the same brake mean effective pressure of 0.1533MPa.MWCNT promote the ignition and the collective effect of these nanoparticles improver source for the enhancement in fuel economy and thus improve the brake thermal efficiency. The brake thermal efficiency for the B10D90CNT30 blend is observed as 30.03%, whereas the pure diesel brake thermal efficiency for max load is 30.38%.This study shows that substantial increment in brake thermal efficiency when biodiesel produced from vegetable oil was used as fuel.

3.2 Engine emission analysis parameters

HC Emission

The HC emission of Nano additive blends of B10D90CNT30, B20D80CNT30, and B30D70CNT30 were lower than the pure diesel. It causes partial combustion of fuel and decrease in ignition delay. The HC emission of without Nano blends was determined to be close to diesel fuel. This is because it only contains 15% vegetable oil, whereas the mixture contains 10% vegetable oil and has a considerably lesser HC emissions. Only at no-load condition the HC emission equals the diesel fuel. By increasing the loads by 3, 6, 9 kg, the emission of HC is reducing from 55 PPM to 40 PPM and ends up with 0 PPM at 12 kg, the maximum load.

All the biodiesel blends showed reduced hydrocarbon emission when engine load increased. In case of B10D90, B20D80, B30D70 bio diesel fuel blends, the hydro carbon emission was greater than diesel at the engine load of 0 to 6 kg. When load increased more than 6 kg the value of HC emission is showing lesser than the pure diesel.

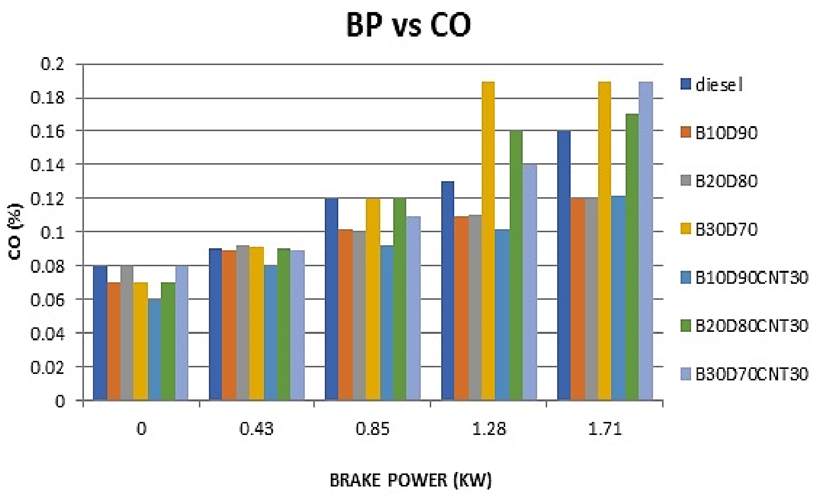

Fig 6. CO Emission Vs Brake power

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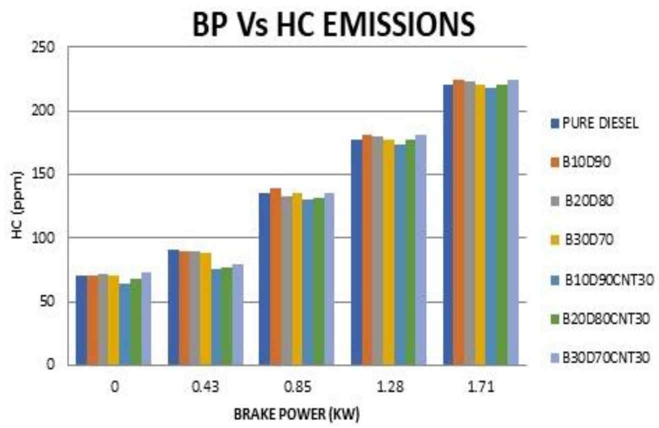

Fig 7. HC Emission Vs Brake power

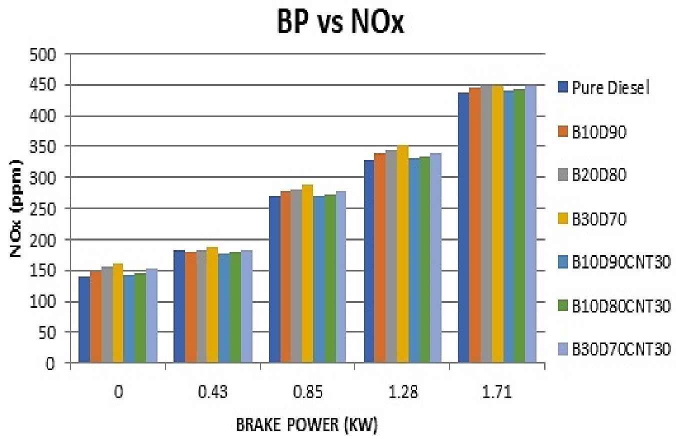

Fig 8. NO_X Emission Vs Brake power

The Nano additive blend (B10D90CNT30) shows lower CO emissions and its lead to increase in cylinder pressure and complete oxidation of fuel and releases to CO_2. The graph reveals that the emission of NOx in the above biodiesels shows slight decrease in NOx due to thermal stability of MWCNTs. The Nano additive biodiesel blends of B10D90CNT30, B20D80CNT30, and B30D70CNT30 shows the values of 440ppm, 444ppm and 450ppm respectively and it compare to that pure diesel value of NOx is 437 ppm at max loads .The main reason for adding Nano additive (MWCNTs) to diminish the NO_x emission by utilizing the property of thermal stability. This sample showed an emission level under 550 PPM which is a 20% reduction when contrast with diesel at maximum engine load. At the loads of 3, 6, 9and 12 Kg, the emission values is increasing from 150 to 500ppm.

4. Conclusion

This work has investigated the efficiency and emission analysis using cotton seed oil methyl ester with nano additive in DI diesel engine. The experimental conclusions of this investigation can be summarized as follows: BSFC was obtained to have slightly minimum for pure diesel as compared to bio diesel. However at high loads 9 and 12 kg, there is less BSFC as contrast with pure diesel

The brake thermal efficiency was observed as increases with increase in all engine loads. The maximum values vary between 27.32 – 30.45% for biodiesel blends and 21.31 – 27.34% for

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pure diesel. The HC emissions are lesser than the pure diesel for all blends. The CO emissions from the biodiesel mixture are lesser than diesel fuel at the engine maximum load. Generally, all tested biodiesel blends can be used safely without any modification in engine. So, blends of cotton seed oil biodiesel with Nano additives could be successfully used.

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