International Journal of Research in Advent Technology, Special Issue, May 2018
E-ISSN: 2321-9637
3rd National conference on "Emerging Trends in Mechanical Engineering" (NCETM -2018)
Available online at www.ijrat.org

Experimental Investigation of PerformanceAnd Emissions of CI Engine Using Alumina nanoparticles withNeem Bio Diesel

Ramesh D K, Manjunatha, Kaushik, Avinasha, Bishtappa Talawar, Tavanappa Bahusab Kamagouda
Department of Mechanical Engineering..
University Visvesvaraya College of Engineering
Bangalore, India.
dkramesha@bub.ernet.in

Abstract- The present world is facing the threat of consequences of depleting conventional fuels. Petroleum fuel which is non-renewable in nature is the widely used conventional fuel in CI engine. In order to minimize the depletion effect of such fuels, use of biodiesel is a promising backup. It is evident in recent research works that the use of nanoparticles enhances the performance of biodiesel. In the present world Neem biodiesel is used along with Al_2O_3 as additive. BTE of B20 Neem Al_2O_3 (B20N+ Al_2O_3) showed 8.64% and 5.39 % increase than diesel and B20 Neem. There was increase in peak cylinder pressure with B20 Neem Al_2O_3 compared to diesel and B20 Neem. CO and UBHC emission were appreciably lower for B20 Neem Al_2O_3 compared to diesel and B20 Neem. However NO_x emission was marginally high than that of diesel and B20 Neem.

Keywords—biodiesel,alumina nanoparticle, break thermal efficiency, carbon monoxide, waste plastic oil, CI engine, B20 Neem.

1. INTRODUCTION

Over the last two decades in world, there has been a tremendous increase in the number of automobiles. Currently, the motor vehicle population in India is about one hundred million. Even though the transport sector plays a pivotal role in the economic development of any country, it brings an unavoidable specter of environmental deterioration along with it. This is specially a huge problem for developing country like India. Development of new energy resources has become important agenda in relation to national energy policy. According to estimates of the oil and gas journal, crude oil production is expected to reach a peak in another one decade, and from then on, it is eventually going to decrease. With this, the crude oil, will be expensive progressively until it becomes unaffordable while putting pressure on the import bill and increasing the import bill deficit. Thus, there is a need to look at other options as far as energy needs are concerned. Based on the recent research, biodiesel has become attractive because of its environmental benefits and the facts that it is non-toxic, biodegradable and can be made from the renewable resources. But biodiesel is also having few drawbacks, such as higher viscosity, higher molecular weight, lower volatility and higher pour point compared with diesel. These drawbacks cause poor atomization and lead to incomplete combustion. So, to reduce above mentioned drawbacks additives are used. Additives will help out the petroleum to recover its engine performance, combustion and emission environmental standards. Additives can be classified in terms of their applications and drawbacks are listed out.

1) Metal based additives
2) Oxygenated additives
3) Antioxidant additives
4) Cetane number improver additives.

Biodiesel is produced from renewable sources such as vegetable oils, animal fats and recycled cooking oils. Chemically it is defined as the "mono alkyl esters of long chain fatty acids" derived from renewable liquid sources[4]. The food crops are not considered as raw materials for biodiesel esterification due to their higher prices and higher consumption in domestic purpose which pays the way for non-edible sources for biodiesel production. Many vegetable seeds used as non-edible sources such as rubber seed, jatrophacureas, pongamiapinnata, rapeseed, karanja**,** mahua& neem etc.Plastics are non-biodegradable polymers mostly containing carbon, hydrogen and few other elements like nitrogen. Due to ots non-biodegradable nature plastic waste management [10].

Preparation of Neem Bio diesel

In this experimental study the neem oil biodiesel was produced through the single step alkali catalyst using transesterification process. Transesterification process is used to produce biodiesel from neem oil [12]. In this process take one litre of neem crude oil and heated up to 75 ^{0}C using electric heater. A solution of 300ml of NAOH crystal% by weight and methanol was prepared [2]. The neem oil temperature reaches 75 ^{0}C the mixture of methanol and NAOH was added gradually to the neem oil. The mixture was stirred continuously for few minutes and then 1% by volume of H_2SO_4 was added. Then after this mixture we give 24h for settle down. So that biodiesel floats above glycerol and glycerol settles down.

Plastic oil

Plastic material is a synthetic organic solid that is moldable. Plastic are high molecular polymers, most commonly derived from petrochemicals. They are widely used in making domestic products and in packaging industries. Plastic is a non-biodegradable material. The used plastic products have become a common feature at overflowing bins and landfill. After food and paper wastes, Plastic waste is major constitute of municipal and industrial waste. The pilot level method of recycling waste plastic in India produces waste plastic oil of 25000 litres/day [11]. Daily plastic waste generated is approximately 1150 tons worldwide. Converting waste plastics into fuel hold great promise for both the environmental and economic scenarios.

Preparation of Plastic oil- Pyrolysis

A recent development in providing a solution to the waste plastic managements by converting it into liquid fuel. The process of converting waste plastic into value added fuels simultaneously tackles problem of waste plastic disposal and of fuel shortage. Waste Plastic is converted into liquid fuel by pyrolysis process, which breaks the polymer chains to convert them to Petroleum Products which is used as fuels [9]. **Pyrolysis is the** thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen). It converts Plastic Polymer chain into monomer hydrocarbon by breaking the polymer bonds.

Preparation of nano fluids

In present study, nanoparticle was used with biodiesel in the form of nano emulsion and the effect of diesel engine characteristics was experimentally investigated. For preparation of the blend, commercial diesel fuel as the base fluid neem biodiesel are employed. Alumina Nano particles were used as additives in biodiesel blend and it is observed that in order to improve the performance, combustion and emission characteristics of engine evenly, nanoparticle will be the most promising additive[6]. For the experimental test fuels are prepared. Investigation, two types of Denoted as bxcy (x means volume fraction and y means ppm). They are: B20N (containing 20% biodiesel and 80% diesel in volume percentage). B20N+ Al_2O_3 (containing 20% biodiesel and 70% diesel and 10% WPO in volume percentage and 25 ppm alumina). To prepare homogenous fuel blend, it was stirred using magnetic stirrer for 45 minutes, to obtain proper dispersion nanoparticles with fuel.

Nanoparticles behave has solid surfactants and are capable of aligning themselves at the water oil interface. One of the rarest earth element. It has dual valence state and excellent catalytic activity. Ball mill process is the one of the most preferred process for the preparation of nanoparticles. The term illustration of the Alumina oxide nanoparticles. (properties are given in table).

TABLE I. PROPERTIES OF ALUMINA NANO PARTICLE.

Properties	Specification
Chemical name	Gamma Aluminum Oxide (Alumina, Al_20_3) Nano powder, gamma phase,99.9%
Average particle size	20-50nm
Appearance	White
Melting point	2045 ºC
Boiling point	2980 ºC
Density	3.9 g/cm^3

2. EXPERIMENTAL SETUP FOR ENGINE TESTING

Experimentations were carried out on a single cylinder, four stroke, water cooled C.I engine [KIRLOSKAR MAKE] to study the performance, combustion and emission characteristics of neem biodiesel with cerium oxide as additive. The above figure illustrates the various parts of the test engine. The test engine was united with an eddy current dynamometer to control the engine torque for loading the engine. A high speed computer digital based data acquisition system consisting of a sensor is used to measure fuel intake, load, speed and BMEP etc.

Exhaust emission parameters were measured with i3sys gas analyser and i3sys smoke meter EDM 1601 was used for measuring amount of smoke emitted.

Experimental tests were carried out at five different levels with an increment of 25% along the consecutive loads ranging from 0%, 25%, 75% and

100% loads keeping the speed constant at 1500 rpm. Initially the test engine was run with diesel for 20 mins to warm it up before testing otherblends. Then, the test was carried for diesel, biodiesel and biodiesel with additive.

Performance, emission and combustion characteristics for various loads were measured using eddy current dynamometer and corresponding emissions with gas analyser and smoke meter. The obtained results were compared for diesel, biodiesel and biodiesel with cerium oxide at standard operating conditions.

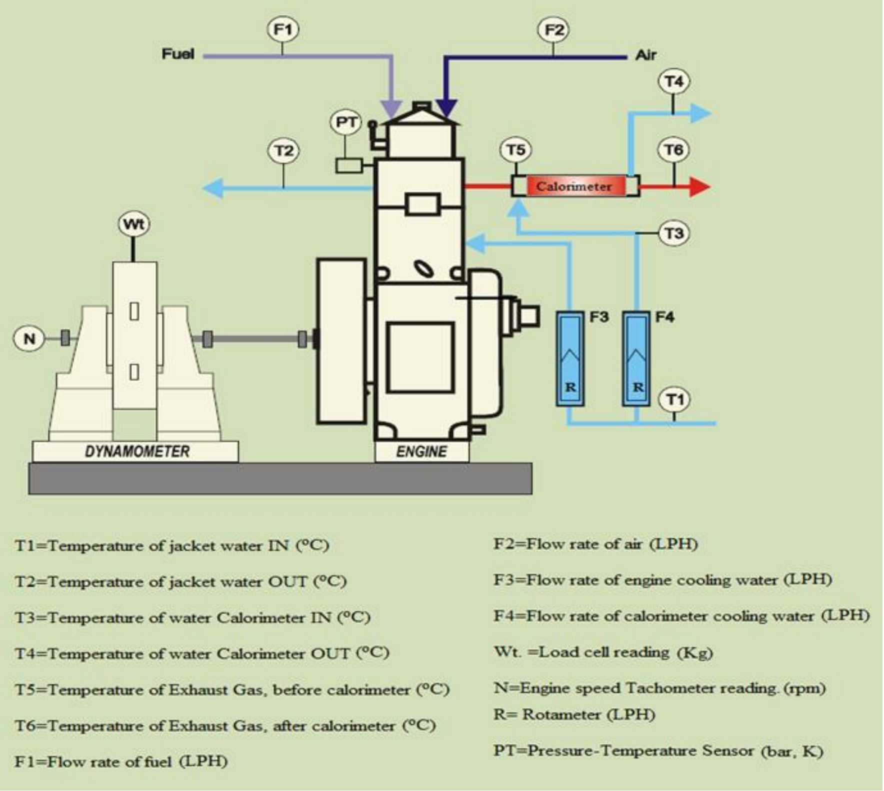

TABLE 2. TEST ENGINE SPECIFICATIONS.

Engine make	Kirloskar AVI
Type of engine	CI engine,4-Stroke,Single Cylinder
Cooling method	Water cooled
Rated B.P	3.5KW
Rated Speed	1500rpm
Compression Ratio	16.5:1
Fuel injection	Direct injection
Injection pressure	175 bar
Stroke length	210.00mm
Arm length	150.00mm
Clearance volume	38.00cc

Table 3. Properties of the Different Biodiesel Used For Engine Testing

Property	Straight Diesel	Neem oil	Pure Plastic Oil	B20N	B20N WPO
Density(kg/m^3)	850	920	835	848	810
Sp gravity	0.85	0.92	0.835	0.848	0.81
Kinematic Viscosity(at 40 °C, cst)	2	35.83	2.52	3.21	3.8
Calorific Value(kJ/kg)	42000	44650	44340	44980	46,988
Flash Point (°C)	50	100	42	69	82

3. RESULTS AND DISCUSSIONS

With the above described experimental setup, the diesel engine is tested for performance, combustion and emission characteristics with test fuels. The engine is tested under constant speed of 1000rpm with varying load from zero load to full load.

Performance characteristics

In this section various performance characteristics like Break thermal efficiency and Specific fuel consumption were discussed.

Brake Thermal Efficiency

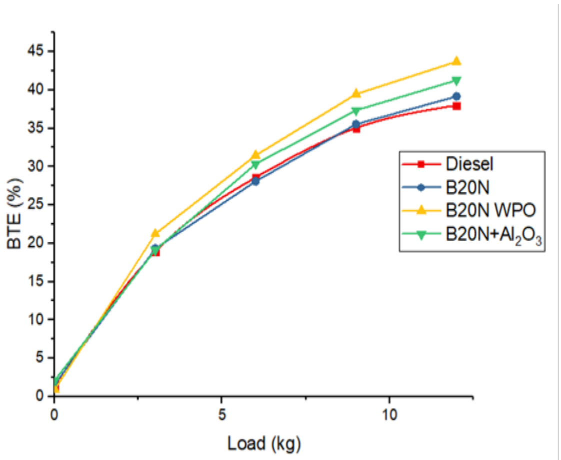

Fig 2 Variation of BTE

Fig 2 shows the variation of BTE with load for all test fuels. It has been observed that for all test fuels, the BTE is higher than the neat diesel. The maximum BTE is accounted for B20N WPO (45.74%) and minimum is observed for diesel (36.996%). This shows that there is 8.2% and 4.7% increase in BTE compared to diesel and B20N respectively. This is because of better air fuel mixing, improved combustion. The increase in BTE is also accounted for alumina nanoparticles which provide oxygen for combustion.The addition of Al_2O_3 nanoparticles further increases efficiency due to high surface area to volume ratio of nanoparticle resulting in fine atomization and rapid evaporation of fuel [5].

Specific Fuel Consumption

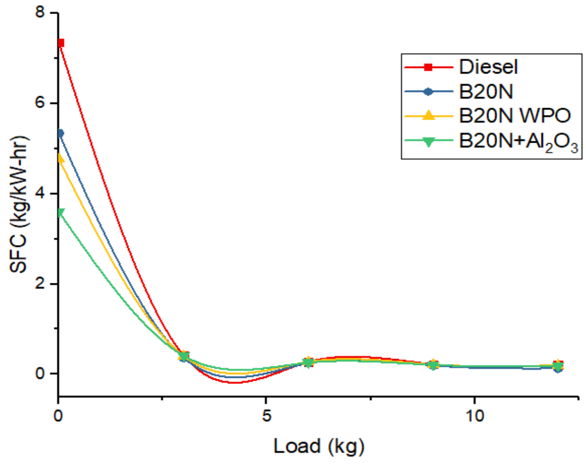

Fig3 Variation of SFC

Fig 3 shows the variation of SFC with respect to load applied for test fuels. It is clear from the graph that SFC decreases with increase in load. At full load the maximum SFC is observed for diesel (7.2 Kg/kW-hr) and minimum for B20N+ Al_2O_3 (3.8 Kg/kW-hr). So there is 46.4% decrease in SFC of B20N+ Al_2O_3 than diesel [8]. This is because of lower calorific values of blended oils and also because of better combustion, due to the fine atomization property of Al_2O_3 nanoparticles.SFC for the biodiesel and its blend increases due to the low calorific value of biodiesel in comparison with mineral diesel [1].

Emission Characteristics

This section is deals with the emission characteristics such as CO, UBHC and NO_x emissions for all test fuels with varying load.

CO Emissions

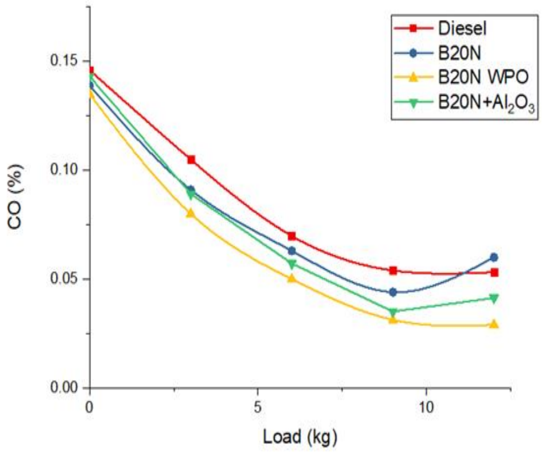

Fig 4 variations of CO

CO is one of the colorless, odorless and poisonous gas present in the emission gases.Fig shows the variation of emission of CO with respect to load. The graph clearly shows the decrease of biodiesel blends compared to neat diesel. The CO emission is maximum for diesel and minimum for B20N WPO. From the graph it is clear that, the emission of CO in B20N WPO is reduced by 28.93% compared to diesel. This is because of the fine atomization and oxygen content in the fuel which results in complete combustion. The Al_2O_3 nanoparticles acts as a catalyst, they provide oxygen for the fuel due to which CO is converted into CO_2 [5].

NO_x emissions

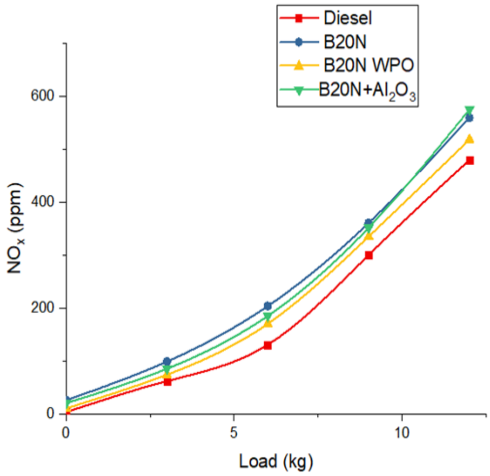

Fig5 Variation of NO_x

Fig 5 shows the variations of NO_x emission with respect to load. Nitrogen reacts with oxygen only at high temperature and pressure, the high temperature in cylinder results in reaction of nitrogen with oxygen, NO_x emission increases with increase in temperature. From the graph the maximum and minimum NO_x emissions were showed for B20N+Al_2O_3(570ppm) and diesel (430 ppm) respectively. So there is a difference of 140ppm compared to diesel.The mechanism of the NOx formation is dependent on the intensity of these effects during combustion. However, ethanol could reduce the cetane number of the blended fuel, which means longer ignition delay period and a larger amount of fuel burned in the premixed phase and causes the increase in NOx emission [7].

UBHC Emission

Fig 6 shows the variation of UBHC with respect to load. At all loads the UBHC emission is low for all the test fuels compared to diesel. The maximum and minimum UBHC emissions are observed for diesel (15.8 ppm) and B20N WPO (14.484ppm) respectively. UBHC emissions are 9% lower than diesel due to high catalytic property of Al_2O_3 nanoparticles increases the surface to volume ratio and provide oxygen for complete combustion there by reducing UBHC [13].

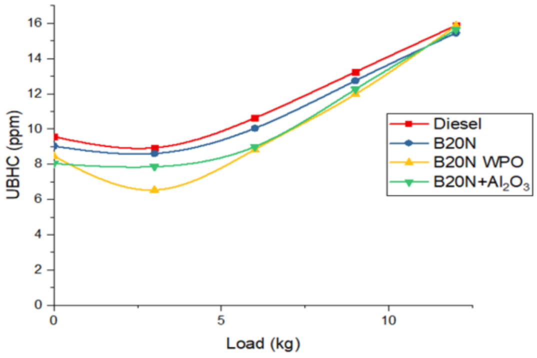

Fig 6 variation of UBHC

4. CONCLUSION

Based on the investigated various characteristics like performance, combustion and emission of C I diesel engine with test fuels, the following conclusions were made.

- The maximum BTE is accounted for B20N+ Al_2O_3 (45.74%) and minimum is observed for diesel (36.996%). This shows that there is 8.2% and 4.7% increase in BTE compared to diesel and B20N respectively. We can observe there is a 16.5% decrease in SFC.
- The Al_2O_3 nanoparticles which provide oxygen for complete combustion reduces the emission of CO and UBHC, However we can see NO_x is increased for B20N+Al_2O_3 due to high oxygen content and increased cylinder pressure.
- Due to the reduced ignition delay and advancement of premixed combustion zone, we can see that the cylinder peak pressure and Heat release rate are reduced.

Finally we can conclude that the metal based additive plays an important role in controlling emissions and improving performance and combustion.

REFERENCES

[1] AtulDhar, Roblet Kevin, Avinash Kumar Agarwal, "Production of biodiesel form high-FFA neem oil and its performance, emission and combustion characterization in single cylinder DICI engine".

[2] S SRagit, S K Mohapatra and K Kundu, "Performance and emission evaluation of a diesel engine fueled with methyl ester of neem oil and filtered neem oil".

[3] N.R. Banupurmath ,RadhakrishnanSankaran , A.V. Tumbal , Narasimhalu T.N, A.M Hunashyal , N.H . Ayachit , "Experimental investigation on direct injection diesel engine fuelled with graphene, silver, and multiwalled carbon nanotubes-biodiesel blended fuels".

[4] K Tarun, G Saignanarka, S Abhinav, K Saisatvik, "Performance characteristics of neem bio diesel".

[5] Experimental Investigation on Combustion, Performance and Emission analysis of Honge oil biodiesel blended with Alumina nanoparticle and Ethanol".

[6] Ramesh D K, Dhananjaya Kumar J L, Hemanth Kumar S G, Namith V, ParashuramBasappaJambagi, Sharath S, "Study on effects of Alumina nanoparticles as additive with Poultry litter biodiesel on Performance, Combustion and Emission characteristics of Diesel engine".

[7] Huang, J., et al., "Experimental investigation on the performance and emissions of a diesel engine fuelled with ethanol–diesel blends, Applied Thermal Engineering".

[8] MrKaustav Mukherjee, Prof C.Thamotharan, "Performance and Emission Test of Several Blends of Waste Plastic Oil with Diesel and Ethanol on Four Stroke Twin Cylinder Diesel Engine".

[9] IoannisKalargaris, Guohong Tian, Sai Gu, "Combustion, Performance and Emission analysis of a DI diesel engine using plastic pyrolysis oil".

[10] M. Mani,C.Subash, G.Nagarajan, "Performance, emission and combustion characteristics of a DI diesel engine using waste plastic oil".

[11] M. Mani, G. Nagarajan, S. Sampath, "Characterization and effect of using waste plastic oil and diesel fuel blends in compression ignition engine".

[12] D K Ramesh, G Premakumara, Abhishek Jain C N, Akash B, Babureddy, Kalappa M Kammar, "Experimental investigation on Combustion, Performance characteristics of a Plastic oil and B20 Pongamia Boidiesel as a substitute fuel in Diesel Engine International Conference on Environment and Energy".

[13] S Karthikeyan, A Elango, S M Silaimani and A Prathima, "Role of Al2O3 nano additive in GSOBiodiesel on th wprking characteristics of a CI engine".