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Impacts of Al_2O_3 nano additive and waste cooking biodiesel on performance and emission characteristics of CI engine

The running down of fossil fuel resources and strict regulation on emission parameters, it is essential to search for improved diesel engine performance and cleaner combustion. Elective energizes are the up-and-comer powers of the present and what is to come. An ever increasing number of vehicles are exchanging over to elective energizes around the world, demonstrates a definite indication of their need. It is clear that without alternative fuels, mankind will not have sustained eco-mobility in the future. Using additives will play a very good role in improving the performance and emissions. The effect of waste cooking oil biodiesel and AL_2O_3 nano additives on the performance and emission of diesel engines are clearly discussed in this article. In this article mainly focused on waste cooking oil and effect of nano additives. The different properties of this fuel are evaluated using ASTM test standard and compared in relation to that of conventional diesel oil. All experimentation carried out on TV2, Kirloskar, single acting, 4-stroke, water cooled diesel motor having an evaluated yield of 16HP at 1800 rpm and a pressure proportion of 17.5:1, with varied load 0% to 100% of full load with increment of 20%. Waste cooking oil biodiesel and AL_2O_3 nano additives shows marginal variation in performance, combustion and emission characteristic like (UBHC, CO, NO_x) have been evaluated and compared to diesel.

Keywords: CI engine, waste cooking oil, AL_2O_3 nano additives, performance, emissions and combustion characteristics.

1.0 Introduction

Throughout the most recent twenty years in India, there has been a colossal expansion in number of vehicles. As of now the engine vehicle populace in India is around hundred millions. The financial advancement of a nation will be chosen by the measure of fuel utilization per capita. India is home to in excess of billion individuals, around "one 6th" of the world human populace. One factor that has decelerated India's pace of financial improvement is the need to import of about 70% of petrol request which costs around Rs.8,79,000 corers per annum. The pressure start has acquired the name and distinction by serving the general public from various perspectives viz. auto transportation, industrial and horticultural areas. With expanding request on the utilization of oil based goods, a more grounded danger to clean climate is being readied as the consuming of these fills is related to outflows like CO, CO_2, NO_x and smoke density, which is presently the predominant worldwide wellspring of emanations. These outflows are significant reasons for air contamination and thus the climate. The most engaging elective energizes are those, which can be utilized with minor or without alterations of existing motors. Advancement of new energy assets became significant plan corresponding to public energy strategy.

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2.0 Objectives and methodology

2.1 Objectives

It is seen from the literature survey that very few progress has been made in the concept of waste cooking oil used as alternative fuel for CI engines. However using of non-edible waste oil as substitute for diesel remains largely unexplored. In this research waste oil like waste cooking oil are used for investigation.

The following objectives are:

- Preparation of biodiesel from waste cooking oil.
- To modify waste cooking oil by using transisterification process method.
- To study and compare the properties of waste cooking oil and its blends with diesel oil. Optimized blend of waste cooking oil with diesel fuel.
- The experiments are conducted at no load, 20%, 40%, 60%, 80% and 100% of full load condition with waste cooking oil blend.
- To run the typical diesel engine on B20WCO results are compared to conventional diesel operation.

- The experiments were repeated using exhaust gas recirculation and to evaluate the performance, emissions, and combustion characteristics and compare this with conventional diesel operation.

2.2 Methodology

2.2.1 Waste cooking oil

Waste cooking oil is from hotel industries. Approximately 17 million tonnes waste cooking oils are produced per annum in the world. From the fatty oils within the sight of alcohalr with transesterification response we can deliver biodiesel. The biodiesel creation from squander cooking oil with methanol within the sight of nano-sized calcium oxide nano-impetus was done at a research facility scale.

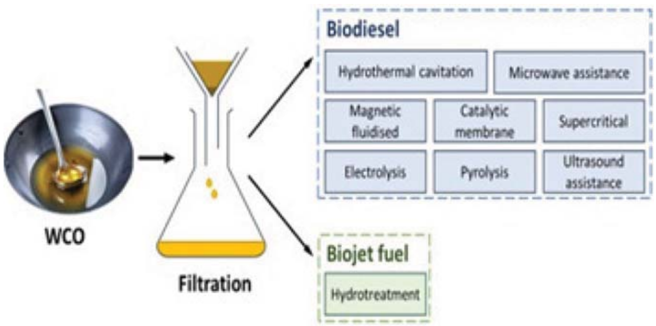

Fig.1: Shows the WCO to biodiesel process

2.2.2 Nano fluids

In present evaluation, nanoparticle was utilized with biodiesel as nano emulsion and the impact of CI engine qualities was most likely investigated. For accessibility of the mix, diesel fuel as the basefuel and waste cooking oil biodiesel are utilized. For the fundamental test powers are ready. They are: B20WCO (80% diesel and 20% biodiesel in volume rate). B20WCO+AL_2O_3 (80% diesel and 20% biodiesel and 25 ppm alumina oxide). To get ready homogenous fuel mix by utilizing sonicator to get genuine scattering nanoparticles with fuel.

Nanoparticles act has strong surfactants and are ready for changing themselves at the water oil interface. May be the most uncommon earth parts, it has twofold valence state and inconceivable synergist action. Ball plant measure is the perhaps the most favoured cycle for the game-plan of nanoparticles. The term diagram of the alumina oxide nanoparticles. (Properties are given in Table 1).

2.3 Test engine set-up and experimentation

Experimental tests were done at five distinct levels with an augmentation of 20% along the sequential burdens going from 0%, 20%, 40%, 60%, 80% and 100% burdens keeping the speed consistent at 1800 rpm. At first the test CI engine was run with flawless diesel for 20 mins to warm it up prior to testing different mixes. Then, at that point, the test was conveyed for diesel, biodiesel and biodiesel with added substance.

Table 1: Properties of an alumina nanoparticles

Properties	Specifications
Chemical name	Gamma aluminum oxide (alumina, Al_2O_3) Nano powder, gamma phase, 99.9%
Appearance	White
Normal molecule size	20-50mm
Density	3.95 g/cm^3
Boiling point	2979°C
Melting point	2046°C

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 alumina oxide at standard operating conditions.

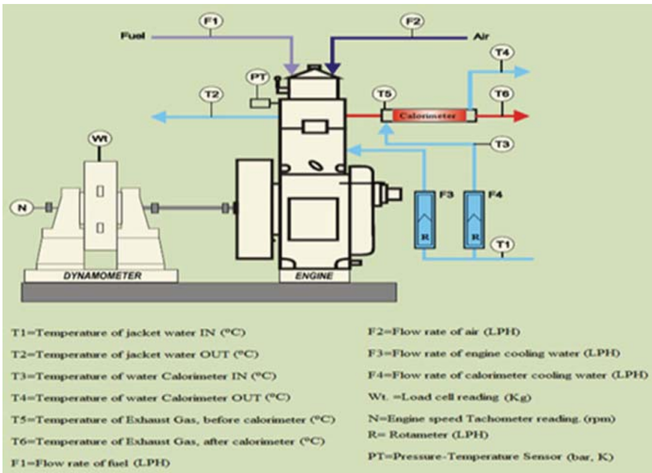

Fig.2

Table 2: Test engine specifications

Engine make	Kirloskar AVI
	Single cylinder, 4-stroke, CI engine
Cooling method	Water cooled
Rated B.P	3.5 kW
Rated speed	1500 rpm
Compression ratio	16.5:1
Fuel injection type	Direct injection
Injection pressure	175 bar
Stroke length	210.00 mm
Arm length	150.00 mm
Clearance volume	38.00 cc

3.0 Results and discussion

3.1 Performance attributes

In this segment different execution qualities like SFC and BTE were examined.

3.1.1 Brake thermal efficiency

The Fig.3 is plotted for load vs thermal efficiency. It is clearly shown that BTE of biodiesel is higher than the perfect diesel. The greatest BTE is represented B20WCO+AL_2O_3 (37.74%) and least is noticed for diesel (32.996%). This shows that there is increase in BTE contrasted with diesel and B20WCO separately. This is a direct result of better air fuel blending, further developed burning.

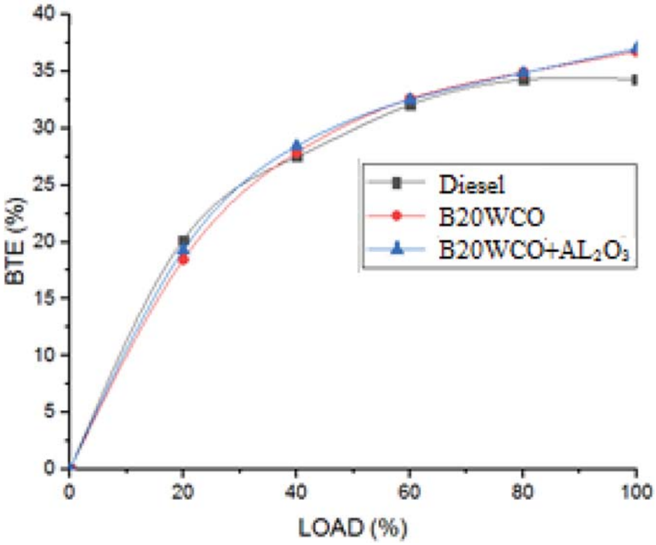

Fig.3: BTE vs. load

3.1.2 Specific fuel consumption

Fig.4 shows the SFC varieties regarding load applied for every all tested fuels. It is obvious from the graph that SFC diminishes with expansion in load. At full load the most extreme SFC is noticed for diesel (0.28 Kg/kWhr) and least for B20WCO+AL_2O_3 (0.25 Kg/kWhr). So there is decrease in SFC of B20WCO+AL_2O_3 than diesel. This is a result of lower calorific values of blended oils and furthermore due to better ignition, because of good atomization AL_2O_3 nanoparticles.

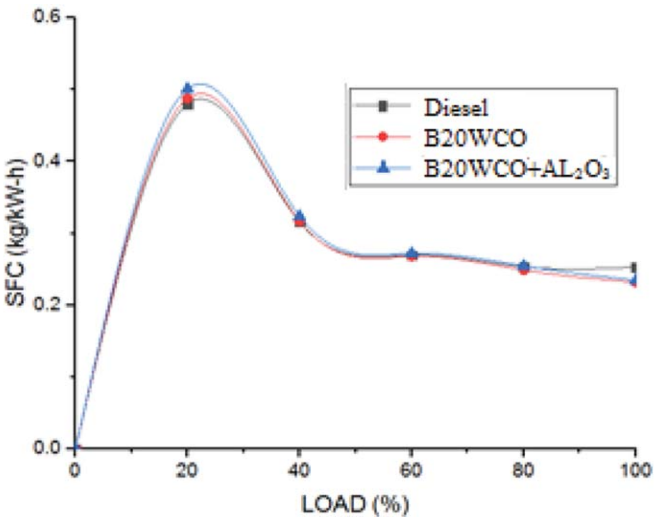

Fig.4: SFC vs. load

3.2 Combustion Characteristics

The ignition cycle can influence the discharge and execution qualities of CI motor. In this segment the ignition characteristic, for example, peak chamber pressure are talked about.

3.2.1 Peak cylinder pressure

Fig.5 shows the varieties of peak pressure concerning load. The peak chamber pressure increments with increase in load. It is relatively high for blended fuels than diesel. It is most extreme for B20WCO+AL_2O_3 than B20WCO because of the expansion of AL_2O_3 nanoparticles. This higher pressure is a direct result of the great reactant movement of AL_2O_3 nanoparticles and diminished start delay, which advances expansion in burning rate thereby expanding the chamber pressure.

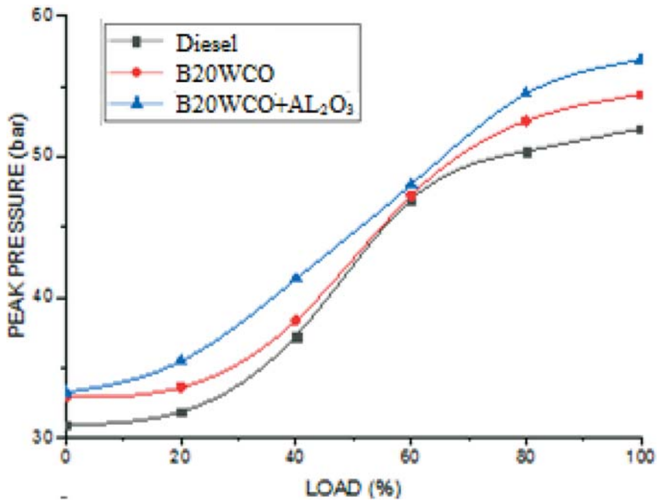

Fig.5: BMEP vs. load

3.3 Emission characteristics

3.3.1 CO emissions

Fig.6 shows the emission of CO vs. load. The Fig.4 clearly shows the decrease of biodiesel blends appeared differently

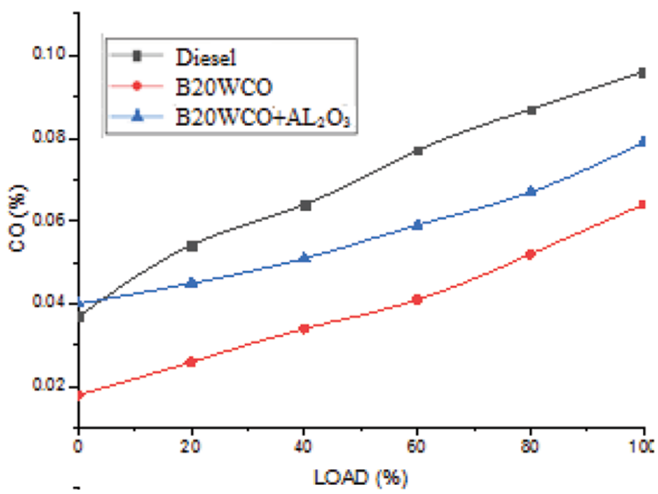

Fig.6: CO vs. load

in relation to impeccable diesel. The CO emission is most noteworthy for diesel and least for B20WCO. From the Fig.6 clearly, the emission of CO in B20WCO is diminished by 16.66% appeared differently in relation to diesel. This is an after effect of the fine atomization and oxygen content in the fuel which achieves expansion in burning rate. The AL_2O_3 nanoparticles goes probably as a catalyst, they offer oxygen to the fuel in view of that CO is convert into CO_2.

3.3.2 NO_x emissions

Fig.7 shows the variatin of NO_x emission with varying load. Nitrogen responds with oxygen only at high instantaneous increase in temperature and and pressure, the high temperature in cylinder brings about response of nitrogen with oxygen, NO_x discharge increments with the moment temperature raise. From the graph the greatest and least NO_x discharges were displayed for B20WCO+AL_2O_3 and diesel respectively. This is because of higher surface to volume proportion of AL_2O_3 nanoparticles which works on the ignition there by expanding the cylinder temperature, which brings about higher NO_x emissions.

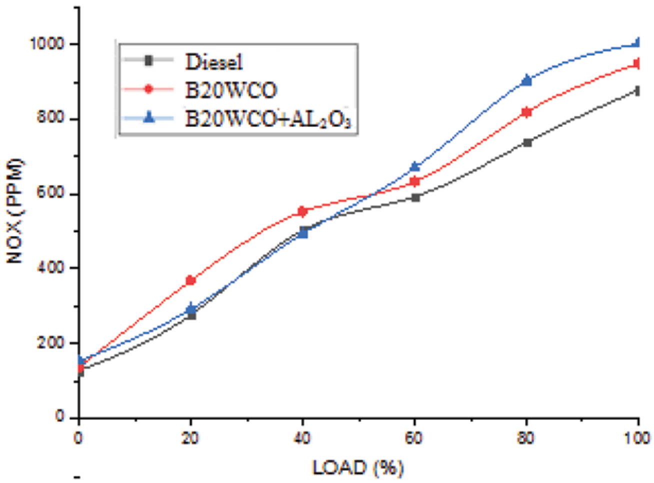

Fig.7: NO_x vs. load

3.3.3 UBHC emission

Fig.8 shows the variation of UBHC with load. At all heaps the UBHC emissions is low for all the test fuels contrasted with diesel. The greatest and least UBHC discharges are noticed for diesel and B20WCO+AL_2O_3 respectively. UBHC emissions are 50% lower than diesel because of high synergist property of AL_2O_3 nanoparticles which give oxygen to finish ignition there by decreasing UBHC.

4.0 Conclusions

In view of the explored different attributes like combustion, performance and emanation of CI engine with test fuels, the accompanying conclusions were made.

- The maximum BTE is represented B20WCO+AL_2O_3 and least is noticed for diesel. This shows that there is increase

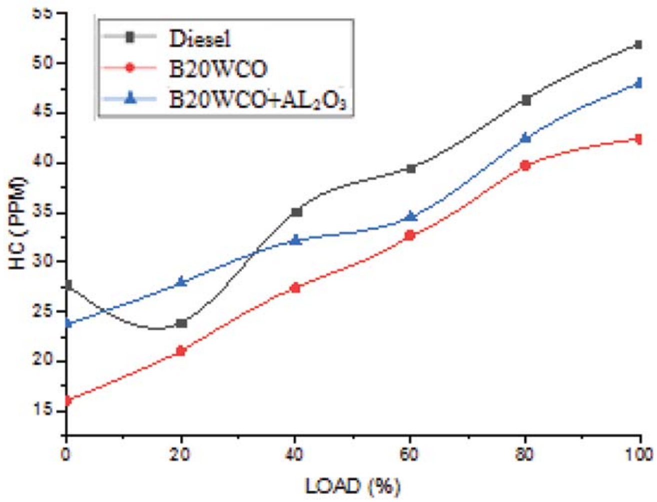

Fig.8: UBHC vs. load

  in BTE for B20WCO compared to diesel. We can see there is decrease in SFC for biodiesel compared to diesel.
- The AL_2O_3 nanoparticles which give oxygen for combustion and reduce the CO and UBHC emissions. NO_x is expanded for B20WCO+AL_2O_3 because of oxygen content presents in biodiesel and nanoparticles and increase the cylinder pressure.

After result analysis we can conclude adding metal additives in biodiesel plays important role in reduction of emissions and increase in performance.

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