Investigation of ignition characteristics of biodiesel and nano particles blends on engine performance and emission in 4-Stroke C.I. Engine - A Review Paper

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Abstract: The preference given to biodiesel in a diesel engine has gained importance over the past two decades, due to its various environmental and economic benefits. There exists a lot of scope for further improvement in the performance and emission reduction with biodiesel. In recent years the use of nanoparticles (such as carbon nanotubes, alumina, cobalt oxides, cerium oxides), as additives in diesel improves flash point, fire point, kinematic viscosity, shorten ignition delay depending upon the dosage of the nanofluids. New combustion regimes are being observed that are affected by very short ignition delays combined with very high metal combustion temperatures.

Index Terms **– Alternate Source of Energy, Internal Combustion Engine, Nanoparticles, Nanofluids**

I. INTRODUCTION

Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. The process used to convert these oils to Biodiesel is called transesterification.

The largest possible source of suitable oil comes from oil crops such as rapeseed, palm or soybean. Most biodiesel produced at present is produced from waste vegetable oil sourced from restaurants, chip shops, industrial food producers. Though oil straight from the agricultural industry represents the greatest potential source it is not being produced commercially simply because the raw oil is too expensive. After the cost of converting it to biodiesel has been added on it is simply too expensive to compete with fossil diesel. Waste vegetable oil can often be sourced for free or sourced already treated for a small price. (The waste oil must be treated before conversion to biodiesel to remove impurities). The result is Biodiesel produced from waste vegetable oil can compete with fossil diesel.

Carbon nanotubes (CNTs) are an allotrope of carbon. They take the form of cylindrical carbon molecules and have novel properties that make them potentially useful in a wide variety of applications in nanotechnology, electronics, optics and other fields of materials science.

Nanotubes are members of the fullerene structural family, which also includes buckyballs.Whereas buckyballs are spherical in shape, a nanotube is cylindrical, with at least one end typically capped with a hemisphere of the buckyball structure. Their name is derived from their size, since the diameter of a nanotube is on the order of a few nanometers (approximately 50,000 times smaller than the width of a human hair), while they can be up to several millimeters in length. There are two main types of nanotubes: single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs).

These cylindrical carbon molecules have unusual properties, which are valuable for nanotechnology, electronics, optics and other fields of materials science and technology. Owing to the material's exceptional strength and stiffness, nanotubes have been constructed with length-to-diameter ratio of up to 132,000,000:1, significantly larger than for any other material. In addition, owing to their extraordinary thermal conductivity, mechanical, and electrical properties, carbon nanotubes find applications as additives to various structural materials. For instance, nanotubes form a tiny portion of the material(s) in some (primarily carbon fiber) baseball bats, golf clubs, car parts or Damascus steel.

Nanotubes are members of the fullerene structural family. Their name is derived from their long, hollow structure with the walls formed by one-atom-thick sheets of carbon, called graphene. These sheets are rolled at specific and discrete ("chiral") angles, and the combination of the rolling angle and radius decides the nanotube properties; for example, whether the individual nanotube shell is a metal or semiconductor. Nanotubes are categorized as single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs). Individual nanotubes naturally align themselves into "ropes" held together by van der Waals forces, more specifically, stacking. Applied quantum chemistry, specifically, orbital hybridization best describes chemical bonding in nanotubes. The chemical bonding of nanotubes involves entirely sp2-hybrid carbon atoms. These bonds, which are similar to those of graphite and stronger than those found in alkenes and diamond (which employ sp3-hybrid carbon atoms), provide nanotubes with their unique strength.

II. PERFORMANCE, EMISSION AND COMBUSTION CHARACTERISTICS OF A DIESEL ENGINE USING CARBON NANOTUBES BLENDED JATROPHA METHYL ESTER EMULSIONS

J. Sadhik Basha , R.B. Anand (2014) conducted Experimental examination in a single cylinder constant speed diesel engine to establish the effects of Carbon Nanotubes (CNT) with the Jatropha Methyl Esters (JME) emulsion fuel. The JME was produced from the Jatropha oil by transesterification process, and subsequently the JME emulsion fuel was prepared in the proportion of 93% of JME,5% of water and 2% of surfactants with a hydrophilic-lipophilic balance of 10. The Carbon Nanotubes are blended with the JME emulsion fuel in the various dosages systematically. The whole investigation was conducted in the diesel engine using the following fuels: neat JME, neat JME emulsion fuel and CNT blended JME emulsion fuels accordingly. The experimental results revealed an appreciable enhancement in the brake thermal efficiency for the CNT blended JME emulsion fuels compared to that of neat JME and neat JME emulsion fuel. At the full load, the brake thermal efficiency for the JME fuel observed was 24.80%, whereas it was 26.34% and 28.45% for the JME2S5W and JME2S5W100CNT fuels respectively. Further, due to the combined effect of micro explosion and secondary explosion phenomena associated with the CNT blended JME emulsion fuels, the level of harmful pollutants in the exhaust gases. From the experimental investigation the following conclusions were drawn:

The Brake Thermal Efficiency Of CNT Blended JME Emulsion Fuels Was Appreciably Enhanced Owing To Their Improved Combustion Characteristics When Compared To That Of Neat JME And Neat JME Emulsion Fuel. At The full load, the magnitude of NOx and smoke opacity for the neat JME was 1282 ppm and 69%, whereas it was 910 ppm and 49% for the JME2S5W100CNT fuel respectively.[1]

III. REDUCTION OF EMISSIONS AND FUEL CONSUMPTION IN A COMPRESSION IGNITION ENGINE USING NANOPARTICLES

H. Soukht Saraee S.Jafarmadar H. Taghavifar S. J. Ashrafi (2015) the effect of adding nanoparticles on the performance characteristics of diesel engine was investigated. Up to now, several metallic nanoadditives including cerium and aluminium have been applied in this area. However, the possibility of using some other metals or modification in the additive structures as well as improving or changing the basic fluid is among factors manifesting a broad scope of work in this area. For this purpose, the silver nanoparticles were used as additives to the net diesel fuel. The results are indicative of significant alteration in the engine power, oil temperature, and the proportion of the released pollutants. The presence of the metallic nanoparticles inside the combustion chamber augments the heat transfer to fuel and shortens the ignition delay through an acceleration of the burning process. Meanwhile, these particles can aid fuel particles further penetrate in the compressed air during the spraying stage. Having all of these features altogether will improve combustion and hence the unburned carbons and other pollutants will decrease. Based on these observations, the rate of CO and NOx would be reduced significantly up to 20.5 and 13 %, respectively, noting that the net diesel and HC would undergo the highest change (up to 28 %). The results also indicate a 3 % fuel consumption reduction accompanied with 6 % improvement in the engine power, utilizing nanoparticles in most cases.

Based on the obtained results from the experiments and diagrams, it was observed that adding silver nanoparticles to the diesel fuel will improve the fuel consumption and the extent of emitted pollution. Adding the metallic particles will increase the fuel infiltration and mixing with air, that this improves the combustion process.Also, these metallic particles will accelerate the fuel evaporation and will reduce the ignition delay in the combustion process. [2]

IV. EFFECT OF DISPERSION OF VARIOUS NANO ADDITIVES ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF A CI ENGINE FUELLED WITH DIESEL , BIODIESEL AND BLENDS

T.Shaafi, K.Sairam, A.Gopinath,G.Kumaresan,R.Velraj (2014) The preference given to biodiesel in a diesel engine has gained importance over the past two decades, due to its various environmental and economic benefits. There exists a lot of scope for further improvement in the performance and emission reduction with biodiesel as the fuel. Fuel adulteration is one of the important techniques for performance enhancement and emission reduction, compared to other techniques such as engine modification and exhaust gas treatment. In recent years, the use of nanoparticles as additives in diesel improves the thermo physical properties, such as high surface area-to-volume ratio, thermal conductivity, and mass diffusivity, when dispersed in any base fluid medium. Based on the results available in the literature, it has been found that nanoadditives with diesel, biodiesel and blends improve the flash point, fire point, kinematic viscosity and other properties, depending upon the dosage of the nanofluid additives. In the present work are view has been made to study the effect of dispersion of various nanoadditives on the enhancement of the performance and emission reduction characteristics of a CI engine fuelled with diesel, biodiesel, and its blends and a summary of the observation made from the literatures are reported in the conclusion.

It is evident from all the studies that the diesel engine performance improves appreciably with nano additives for all the cases of diesel, biodiesel and emulsified fuels. Some of the studies carried out with various nano additive concentrations showed that increasing the concentration of the nano additives does not increase the performance proportionately, and in some cases, it is insensitive beyond a certain concentration level..Hence, the estimation of the optimum dosage is essential for every nano additives. It is understood from the emission characteristics [3]

V. INFLUENCE OF ALUMINA NANOPARTICLES, ETHANOL AND ISOPROPANOL BLEND AS ADDITIVE WITH DIESEL SOYBEAN BIODIESEL BLEND FUEL: COMBUSTION, ENGINE PERFORMANCE AND EMISSIONS

T. Shaafi, R. Velraj (2015) Experimental investigation was carried out to study the combustion, engine performance and emission characteristics of a single cylinder, naturally aspirated, air cooled, constant speed compression ignition engine, fuelled with two modified fuel blends B20(diesel-soybean biodiesel) and diesel-soybean-biodiesel-ethanol, with alumina as a nanoadditiveve (D80SBD15E4S1+alumina) and the results are compared with neat diesel . The nanoadditive was mixed in the fuel blend along with a suitable surfactant by means of an ultrasonicator to achieve stable suspension. The properties of B20, D80SBD15E4S1+alumina fuel blend are changed due to the mixing of soybean biodiesel and the incorporation of the alumina nanoadditives. Some of the measured properties are compared with those of neat diesel, and presented. The cylinder pressure during the combustion and the heat release rate, are higher in the D80SBD15E4S1+ alumina fuel blend, compared to neat diesel. Further, the exhaust gas temperature is reduced in the case of the D80SBD15E4S1 þ alumina fuel blend, which shows that higher temperature difference prevailing during the expansion stroke could be the major reason for the higher brake thermal efficiency in the case of D80SBD15E4S1+alumina fuel blend. The presence of oxygen in the soybean biodiesel, and the better mixing capabilities of the nanoparticles, reduces the CO and UBHC appreciably, though there is a small increase in NOx at full load condition.

The cylinder pressure at full load condition is higher for all the crank angles during the combustion process, in the case of alumina fuel blend, which is due to the higher surface area exposure of the alumina nanoparticle supported by the inherent oxygen present in the soybean biodiesel that helps in rapid combustion.The brake specific energy consumption is higher for the B20 and alumina fuel blends compared to neat diesel at 25% and 50% load. However, at higher loads of 75% and full load, the BSEC is minimum compared to the neat diesel. Pressure starts increasing appreciably from 7 degree before TDC for all the fuels, and a sharp increase is observed up to 7 degree after TDC in the case of the D80SBD15E4S1 + alumina fuel blend and up to 8 degree, after TDC in the case of pure diesel and B20 blend.Due to the complete combustion that occurred in the B20, due to the presence of higher oxygen in the fuel, and the further increase in efficiency in the case of D80SBD15E4S1 + alumina fuel blend is due to the micro explosion of the primary droplet, and higher evaporation rate due to the presence of the alumina nanoparticle. Hence there is a full release of thermal energy that leads to higher brake thermal efficiency. [4]

VI. NANOFUELS: COMBUSTION, ENGINE PERFORMANCE AND EMISSIONS

Rakhi N. Mehta, Mousumi Chakraborty, Parimal A. Parikh (2014 Experimental investigation was carried out to study the burning characteristics, engine performance and emission parameters of a single-cylinder Compression Ignition (CI) engine using nanofuels which were formulated by sonicating nanoparticles of aluminium (A1), iron (F1) and boron (B1) in base diesel. These fuels showed reduced ignition delay, longer flame sustenance and agglomerate ignition. Study of engine performance at higher loads revealed drop in peak cylinder pressures and reduction of 7% in specific fuel consumption for A1 as compared to diesel.

Improved combustion rates raised exhaust gas temperatures by 8%, 7% and 5% leading to increased brake thermal efficiencies by 9%, 4%, and 2% for A1, F1, and B1 respectively, as compared to diesel at maximum loading conditions. Volumetric reduction of 25–40% in CO emission, 8% and 4% in hydrocarbon emission was measured when the engine was fuelled with A1 and F1 respectively as compared to emissions from diesel. However, elevated temperatures resulted into marginal rise in NOx emission.

Nanofuels A1, B1 and F1 showed increased evaporation rates with early ignition at 0.2 s as compared to diesel (1.2 s), suggesting reduced ignition delay. On ignition of A1 and F1 droplets, flame sustained for longer period of time followed by ignition of agglomerates coated with un-burnt nanoparticles which was not observed during the burning of diesel and B1 droplets.Peak cylinder pressures decreased at full load conditions and were registered as 55, 59, 60 and 62 bars for A1, B1, F1 and diesel respectively. Engine performance parameter study revealed a noticeable reduction of 7% in specific fuel consumption with A1 in comparison to diesel for generating equivalent brake power. Exhaust gas temperatures of A1, F1, and B1 rose by 9%, 7% and 5% respectively, resulting into increase in brake thermal efficiencies by 9%, 4%, and 2% as compared to diesel at higher loads. [5]

VII. CONCLUSION

- Enhance surface to volume ratio is found for the blends due to addition of nano particles.
- Ignition delay time is reduced.
- Higher Heat Release Rate is found, but peak pressure increased.
- Better combustion occurred due to increment in Cetane number.
- Performance parameter like Specific Fuel Consumption decreased and improvement in Brake Thermal Efficiency is found for the blends of nanoparticles.
- For the emission, it is found that the CO increased and HC is decreased, marginally.
- Smoke is reduced.
- But $NO_x$is increased due to increased temperature because of the thermal conductivity of the nano particles addition.

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