THE EFFECT OF NANOPARTICLE BLENDED BIO-DIESEL ON THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF BIODIESEL

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Abstract –

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Abstract— Renewable fuels are very important when we consider the environment. The overuse of fossil fuels is affecting the environment of water, land, and air and even increasing the global warming effect too. Hence, overcoming these issues and also strict limits on pollutant emissions has encouraged the use of alternative fuels like biodiesel. Biodiesel is one of the most used fuels in compression ignition (CI) engines, as it has many advantages compared to other renewable fuels. Many works have been carried out for the production of biodiesel. The blended biodiesel, when used in CI engines showed promising results. The emission parameters were lower when compared to conventional diesel fuel. Many research papers showed that Carbon Monoxide (CO), Particulate Matter (PM), and Total Hydrocarbons (THC) were reduced. The presence of oxygen which leads to complete combustion a with cleaner combustion process is one of the important reasons for less emission. The combustion of biodiesel also showed lesser emission of PM when compare the diesel fuel, this was due to the absence of aromatic compounds in biodiesel.

In this paper, biodiesel was produced from madhuca indica seeds and also an attempt is made to add the nanoparticles in biodiesel and check its effect on basic properties and combustion properties. The addition of nanoparticles showed an improvement in ignition properties and better performance with lesser emission.

Key Words: BioDiesel, Nano-Particles

1. INTRODUCTION

All countries are interested in using alternative fuels in IC engines to address the increasing energy demand. This is mainly due to the effect of fossil fuels on the environment and the increase in petroleum prices worldwide. For many decades, a lot of efforts are being made to reduce the dependence on petroleum fuels. Developing countries like India are looking for alternative fuels and want to depend less on petroleum fuels and other fossil fuels. Many alternative fuels are getting highlighted and being used, among them biodiesel has received much attention in recent years, for its advantages for diesel engines. It also can be a great solution for many countries to reduce their oil imports. Another important benefit of going with biodiesel is that it is made from waste products and even its end product glycerin also has great value.

1.1 Scope of biodiesel as an alternative fuel

Biodiesels are “mono-alkyl esters with long chain fatty acids resulting from lipid feedstock, like animal fats and vegetables, for its usage in diesel engines.” Crude vegetable oils that may be obtained from edible or non-edible are not suitable for CI engines. The main reason for this is operational and durability issues with biodiesel. Under durability, the focus is mainly on the engine injector coking, carbon deposits on injector tip and injector nozzle, corrosion, and wear and tear of engine parts. Under operational, the focus is mainly on combustion, ignition, and starting engines with crude vegetable oils [1-2]. The above issues discussed on durability and operation are due to viscosity and density. Since, biodiesel has higher density and viscosity it leads to larger droplets, this larger droplet leads to poor atomization with the longer jet spray penetration and lower volatilities. Many research works are being carried out to overcome the issues related to the use of crude vegetable oils. Based on the work carried out two major approaches can be adapted first is going for engine modification like duel fueling with different tanks or changing the properties of fuel by heating the fuel or modifying the injection systems. The second approach is fuel modification by blending, pyrolysis process, and microemulsion.

Biodiesel is biodegradable fuel and it can be mixed with any diesel at any ratio as per our requirements. It emits no sulfur oxides, a pollutant that causes acid rain and burns the lungs, eyes, and throat. Global warming can be reduced by reducing carbon dioxide emissions by using biodiesel. Some of the advantages of using biodiesel are the absence of sulfur, absence of aromatics, lower hydrocarbon emissions, reduction of smoke and soot, and reduction in carbon monoxide [2-3].

The biodiesel obtained is blended with diesel fuels in any proportion which can remain in good stable conditions in cold weather i.e at lower temperatures too with some basic precautions. If biodiesel is exposed to lower temperatures, then it separates from diesel fuel and clogs the fuel flow line. To bring back to its original property it needs a bit of warm-up. The biodiesel should be stored in a closed container so that air does not mix with it and it should be used before six months. It

should be protected from sunlight, moisture, and cold weather [4].

As biodiesel has got many advantages, it has also got disadvantages too, as it can't be directly used alone in CI engines. It is less volatile and has a lesser heating value with higher emissions of NOx when used in diesel engines [5], which is due to higher exhaust gas temperature. As biodiesel has a lower calorific value, the engine's efficiency reduces [5-6].

1.2 Scope of nanoparticles as a catalyst

The blending of fuel process is commonly acknowledged and used by researchers during their work, to obtain the required fuel characteristics. This is mainly done to make the performance parameters better and reduce the emission in the diesel engine without any alteration of the present engine [7-10], by using additives, catalysts, or blending fuels. The main purpose of using the catalysts as fuel additives to conventional fuels is:

The presence of catalysts must reduce emissions and also it should help to increase the oxidation intensity in diesel engines.

- It should not affect the operational properties of engines and also fuel should combust at a lower temperature and burn for a longer rate.
- Whenever the catalyst mixes with fuel, it should alter its chemical stability under all conditions.
- The performance and effectiveness of the particulate filters should not be changed under all conditions.
- The presence of catalytic additives used must assist to reduce emissions of the substance which directly or indirectly affect the environment [7].

Risha et al. experimented with the combustion of nano-aluminum, at a different range of particle sizes, pressures, and mixture compositions. It was found that the Ignition gap and high temperature are the major important factors that affected the working of a diesel engine. It was noted that the performance and emission factors of a diesel engine can be boosted by enhancing the ignition gap and temperature of the engine.

Tyagi et al. tried to investigate the properties of fuel by adding nanoparticles to diesel. It was found that the addition of nanoparticles to the diesel fuel improved its radiative and also the properties of heat and mass transfer. Due to the presence of nanoparticles droplets ignited at a lesser temperature compared to D100 when tested on diesel engines. The combustion properties were also investigated in the presence of nanoparticles which also showed better results when compared to pure diesel.

2 LITERATURE SURVEY

Tayfun M et al [2015] The author got better results by using nanoparticles. The author determined fuel properties after the addition of Nanoparticles to biodiesel and the efficiency, performance, and emission characteristics are examined on a four-stroke, single-cylinder, direct injection engine. It was also noticed that there was a little bit of reduction in the emission properties for NOx, PM, and CO addition of the nanoparticles.

M. Ghafoori et al [2015] Blending process of biodiesel was carried out using the ultrasonicator with the carbon nanotubes CNT. The test was carried out on diesel engines for all the different blends including neat diesel fuel including the CNT blends. The conducted experiment showed clearly the advantages of using CNT. There was a substantial boost in the performance by the use of CNT biodiesel blended fuels when it was compared to the B100 and D100 fuel, the power, and torque increased up to 17%, and 18% respectively, but the BSFC was reduced by 38.5%. By using the CNT the emission parameters showed an improvement as there was some decrease in emissions when compared to D100 and B100 fuels. The HC and CO decreased by up to 23%, and 13% respectively with the use of nanoparticles CNT.

M. Naveen Kumar et al [2016] investigation was carried out for different Nano-additives in the fuel. An experiment was carried out at different injection pressure by using TiO2, Al2O3, and nano-additives to compare the effects on the performance and emission of Waste Vegetable Oils. Among TiO2 and Al2O3, the Al2O3 blends had the least NOx emissions compared to TiO2. Performance parameters for both blends were found to be similar.

Gangadhara Rao et al [2016] investigation was carried out for different additives that improved the biodiesel and diesel combined basic properties like viscosity, calorific value, fire, flash, cloud and pour points, etc. The author found that by using the nanoparticle there was not much improvement in performance characteristics but the combustion characteristics showed improvements with the use of additives. The emissions of hydrocarbons (HC) and PM emissions were less but NOx emission in some cases was found to increase due to the high-temperature effect of the biodiesel. The author has mentioned that NOx emission was reduced to some extent by using NOx inhibitor additives

Chockalingam S R et al [2016] The work is carried out with papaya seed oil methyl ester (PSME) biodiesel under different blends. For the study purpose, the additive Di-Tera-Butyl Peroxide (DTBP) is used as an additive. The test is carried out with the blends and additives on the single-cylinder direct injection diesel engine for performance, exhaust emissions, and combustion characteristics fueled with PSME. They found that with nanoparticles the performance increased and emission also reduced.

Shiva Kumar et al [2017] The author got better results by using nanoparticles with liquid fuels like diesel or biodiesel as by using the biodiesel as fuel, engine performance was reduced to a small extent but the NOx emissions increased due to the high temperature. Adding the nanoparticles to the fuel blend of diesel and biodiesel resulted in better performance and also the presence of nanoparticles reduced emissions also.

Annamalai Asokan et al [2018] The author tried to increase fuel efficiency by integrating the nanoparticles with various blends of biodiesel. The metal oxide formed by the reactions of nanoparticles will increase the calorific value of the blend as the carbon monoxide CO donates the oxygen atoms to aid complete combustion.

Prabu Arockiasamy et al [2018] The author studied the consequence of nanoparticles on Jatropha biodiesel. The experiment was carried out on a diesel engine. During the experiment, the author found that there were fewer pollutants in the exhaust. It was also found that there was an improvement in engine performance also. By using the nanoparticles It had the advantage of a higher surface area to volume ratio. The nanoparticles act as a catalyst for improved combustion which results in good performance results with the lesser pollutants.

M. Norhafana et al [2019] According to the work and analysis, the author determined that some variety of nanofluids can be used as additives in biodiesel and diesel. The main purpose of adding the additives is to increase the surface area to volume ratio and also increased the catalytic activity in nano-size metal oxides and metals. Adding of nanofluids gave better combustion than the normal blends used in diesel engines, which was mainly due to the micro explosion phenomenon.

Meshack Hawi et al [2019] The main investigation was to reduce the harmful emissions coming out of diesel engines including (NOx) oxides of nitrogen which is one of the major emission issues while using biodiesel, caused due to high temperature. For reducing the emission issues the nanoparticles of iron-doped cerium oxide (FeCeO2) were used as an additive in the fuel. The experiment was carried out in a single-cylinder, four-stroke, direct injection diesel engine with Waste Cooking Oil Methyl Ester (WCOME).

3 PROPERTIES OF FUELS

Production of biodiesel is carried out in the laboratory by the transesterification process from the Machuca Indica seeds. The fuel properties are the important properties. As the fuel properties are going to affect the engine combustion, its performance, and also the emission characteristics. The basic important fuel properties are determined according to the ASTM protocol in (BTH) Bangalore Test House - Bangalore and the Indian Institute of Science, (IISC) Bangalore. Table 4.1 shows basic fuel properties of D100, BD100, BD15, BD20, BD15A50, BD20A50, BD15A100 and BD20A100. The basic fuel properties are given below in table 1:

TABLE 1: BASIC FUEL PROPERTIES OF DIFFERENT BIODIESEL BLENDS.

Sl.No	Density at 15 °C	Viscosity at 40 °C	Calorific value kJ/kg	Flash Point °C
D100	815.5	3.3	42005	58
BD100	870	4.91	39955	135
B15	826.5	3.61	41625	75
B20	827	3.42	41660	70
B15A50	825.5	3.36	41620	70
B20A50	829	3.34	41720	65
B15A100	828	3.56	41640	71
B20A100	825	3.1	41700	61

CONCLUSIONS:

The waste seeds can be converted to value-added alternative fuels. Madhuca indica seeds were used for the production of biodiesel, and a nanoparticle (Al_2O_3) aluminium oxide was used.

The production of alternative fuel i.e Biodiesel is carried out in the laboratory by the transesterification process. The biodiesel produced is mixed with diesel for making different bends and different blends of fuel were prepared and examined to know the basic fuel properties as per ASTM methods. The blends had similar properties to diesel.

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