Effects of Aloe Vera biodiesel blends with TiO_2 on the emission and performance characteristics of a DI diesel engine

Abstract

Concerns about the effect of activities that need the use of alternative fuels, as well as a growth in demand for clean energy, have made biofuels research more well-known, and so began the search for oilseed plants that can be used to make biodiesel.Present research was carried out the aloe vera oil is used as a biodiesel in diesel engine. Because aloe vera oil having higher calorific value compare to other sources. Potassium hydroxide catalyst was used for transesterification process, which has lesser cost and more availability. And also, in this work conducted diesel engine experiments using four different biodiesel blends (B20, B40, B60, B100) and diesel fuel. Additionally, to reduce the emission nano particles (TiO_2) was blended with optimal biodiesel blend (B20). The performance and emission characteristics were conducted with different biodiesel blends. In this blends, B20+ TiO_2 blend gives good performance and reduction in emissions compared to other biodiesel blends.

Key words:

Biodiesel, Biodiesel blends, Performance, combustion, Emission

1. Introduction

The global knowledge of the energy and environmental consequences of burning fossil fuels has grown. Many academics are looking at the prospect of replacing crude oil and its derivatives with alternative energy sources. Biodiesel appears to be the most appealing of the three for numerous reasons: it is highly biodegradable and has low toxicity, and it may be used to replace diesel fossil fuels in a variety of applications, such as boilers and internal combustion engines, without requiring large system adjustments. The benefits of biodiesel include lower emissions of sulphates, aromatic compounds, and other environmentally harmful chemicals, as well as a tiny net contribution of carbon dioxide (CO2) during its whole life cycle, which appears to result in a major boost in rural economic potential. The demerit is brake thermal efficiency is less compare to diesel fuel. Recently, Ranganathaet.alhas conducted experimental investigation on a four-stroke compression ignition engine with Mahua biodiesel blends with diesel at numerous proportions (20%, 40%, hour and 80%) at a constant engine speed of 1500 rpm. According to these findings, the braking thermal efficiency of biodiesel mix B20 is comparable to diesel fuel, and the thermal

efficiency of diesel fuel is greater by 12% at full load when compared to plain biodiesel (100%) When comparing biodiesel and its mixes with diesel to diesel, CO emissions are lower, but NOx emissions are higher. Shahid.et.al has carried out experiments with the blends of diesel and Karanja biodiesel with completely different ratios, to analyze the performance characteristics of engine and exhaust emissions. The experimental results showed that the engine running with pure biodiesel that is B100, leading to higher brake specific fuel consumption and lower brake thermal efficiency as compared to the diesel. The CO and HC emissions were reduced, however higher quantity of NO_x was observed when B100 was used as fuel.

The experiments conducted with short and long-run engine test with neat soya bean vegetable oil in a small CI engine. Short-run tests with this vegetable oil indicated that the performance is similar to that of diesel fuel and long-run testing couldn't be carried out due to power loss and carbon build-up on the injectors. They ended that the vegetable oil may be used for short-run operation solely **[Proysis**]. A single cylinder four stroke Cl engine was accustomed to evaluate the performance and emission characteristics of Mahua biodiesel and its blends with diesel by Shiva Kumar, B et al. The experiment is conducted with neat (100%) Mahua Biodiesel, a neat (100%) diesel and its blends of 20, 40, 60 and 80 percent of biodiesel by volume within the diesel fuel. The experimental results indicates that the rise in biodiesel concentration within the blends reduces the CO and HC emission considerably whereas fuel consumption and NOx emission will increase as compared with pure diesel. The brake thermal efficiency and brake specific fuel consumption for B20 is nears to the diesel fuel. To reduce the emission nano particles was used, because nano particles high surface area-to-volume ratio and greater reactive surface area, nanoparticles cause fuel mixes to oxidize quickly. Nano fluid fuels have a rapid evaporation rate, greater atomization, fluent air-fuel mixing, and higher flame sustainability. Shortening premixing and diffusion time reduces ignite delay significantly.

A one cylinder four stroke CI engine was accustomed to evaluate the performance and emission characteristics of jatropha biodiesel and its blends with diesel by venkatsunaik j et al. The experiment is conducted with neat (100%) jatropha Biodiesel, a neat (100%) diesel and its blends of 20, 40, 60 and 80 percent of biodiesel by volume within the diesel fuel. The experimental results indicates that the rise in biodiesel concentration within the blends reduces the CO and HC emission considerably whereas fuel consumption and NOx emission will increase as compared with pure diesel. The brake thermal efficiency and brake specific fuel consumption for B20 is nears to the diesel fuel.

VenkatesuNaik j etal.Single cylinder 4 strokeCI engine experimentally investigated effect on emission & performance characteristics with Al_2O_3 and Cuonano particles added.using of Al_2O_3 given the better performance and emission comparison of the other nano particles.

According to the literature review, many researchers have used a variety of biodiesel coupled with diesel fuel in the performance, combustion, and emission investigation of a

wide range of diesel engines with modest changes. As an alternative bio-diesel, aloe vera oil is not widely used. Biodiesel blends generated from aloe vera oil and Nano-particle (TiO2) are explored for combustion, performance, and emissions in a single-cylinder diesel engine, as well as to develop an alternative fuel by comparing the blended fuel results to the pure diesel results in this research.

2. Experimental procedure

The experiments were conducted on a single-cylinder four-stroke diesel engine. The experiment was done with constant speed to evaluate the performance and emission characteristics of the blended aloe vera oil, as shown in Fig. 1. The diesel engine results are measured under various engine load conditions with the different blends of biodiesel blend like; B10, B20, B30 and diesel fuel. Based on initial experiments and obtained results the B20 blend is optimal. Further experiments were carried out B20 with titanium oxide (TiO_2) blends.Theinvestigational diesel engine was straight linked to an eddy current dynamometer, allowing the load to be changed from zero to full (100%). The engine loads are physically changed using an eddy current dynamometer. An AVL gas analyzer and smoke meter were used to analyze the smoke density and exhaust gas temperatures. The AVL five gas analyzer was used to determine the emission parameters of the exhaust gas, including HC, CO_2, CO, and NOx levels. Figure 1 depicts the experimental process.

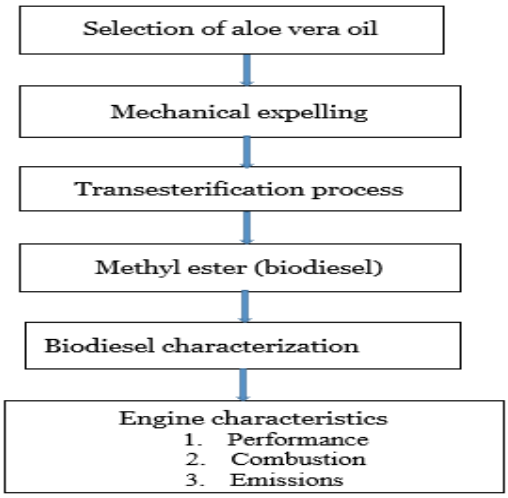

Fig.1 Experimental procedure

The engine, complete with dynamometer, fuel delivery unit, and rectifier, is shown in Figure 2. The Eddy current dynamometer is used to load this engine in order to determine braking torque. Both the engine and the dynamometer are water cooled. The dynamometer is equipped with load and speed sensors. The engine controller controls the engine load. The controller keeps track of the fuel use. The output of the engine sensor is likewise linked to the controller. The emission analyzer device is linked to cylinder calibration gases. The emission analyzer device is also connected to an air drier. The performance and emission values are shown on a monitor near the emission unit.

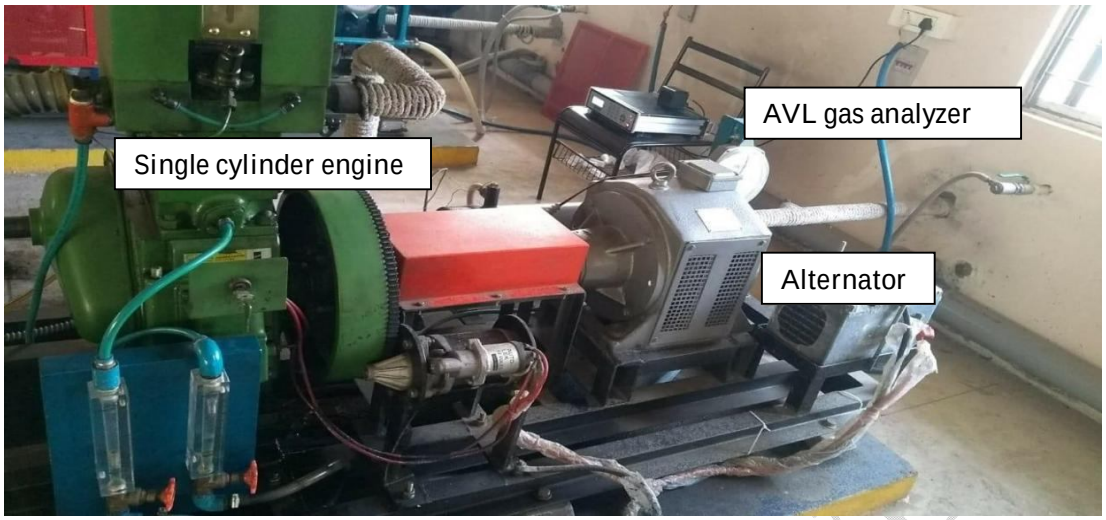

Fig.2 Single cylinder diesel Engine Setup

2.1 Titanium oxide nanoparticles approach

To increase the characteristics of biodiesel fuel Because of its high oxidation concentration, TiO_2 was utilized as an additive. They're utilized in a wide range of products, including paints, polymers, textiles, cosmetics, and coatings.In comparison to pentanol and other additives, TiO_2 has a high dispersion quality, which allows the nanoparticle to be blended with biodiesel without changing the fuel's viscosity. Few publications claim that the dispersion rate in organic solvents and vegetable oil is 99%[Nithya]. They also have the capacity to resist corrosion and have higher thermal properties. The sol–gel process was used to create this TiO_2 nanoparticle. The combustion, performance, and emission properties of aloe vera oil biodiesel that has been doped with titanium oxide (TiO_2) nanoparticle mixes have been evaluated in an experimental study. The fuel characteristics are as follows

B10 = 1350ml (pure diesel) + 150ml (aloe vera oil) + 0.15gm (TiO_2)
B20 = 800ml (pure diesel) + 200ml (aloe vera oil) + 0.1gm (TiO_2)
B30 = 700ml (pure diesel) + 300ml (aloe vera) + 0.1 gm (TiO_2)

3. Result and Discussion

3.1 Performance analysis

Fig. 3 shows the test results of the specific fuel consumptions (SFC) with the engine power outputs, when the engine fuelled by different fuel blends and diesel. The variation of SFC with engine brake power outputs, when the engine fueled by different fuel blends and diesel. The results show that engine power can be maintained at the same level while using alternative fuel mixes, albeit with modest increases in fuel consumption. From fig it’s clear that increasing aloe vera blend ratio with diesel SFC is increasing at all engine load due to its higher density and lower calorific value, when compared to that of diesel fuel.

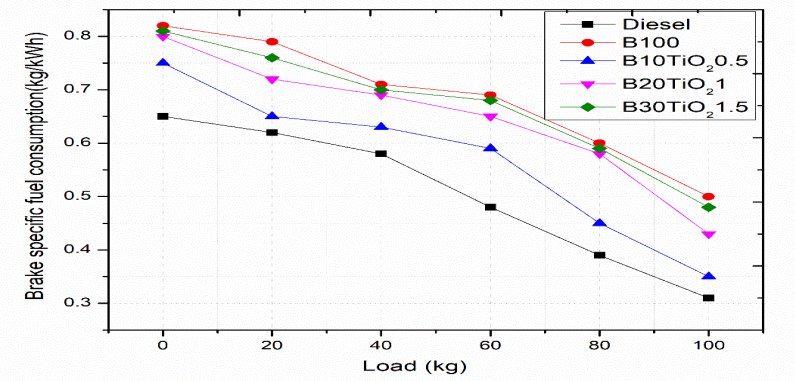

Fig .3Specific Fuel Consumption Vs Load

Figure 4 depicts the change in brake thermal efficiency as a function of engine load. Internal combustion engines' brake thermal efficiency is a measure of their fuel efficiency. The BTE is calculated by dividing real braking effort per cycle by the quantity of fuel chemical energy indicated by a fuel's lower heating value [Hoang, T. A]. The BTE was found to decrease when the quantity of biodiesel was increased. This is due to the reduced calorific value of biodiesel. For diesel (25.35%), the better the brake thermal efficiency, and B10 blend has BTE that is close to diesel fuel (24.9%). On the other hand, if the amount of biodiesel blended increases, the mechanical efficiency decreases, as illustrated in Figure 5.The mechanical efficiency was observed decrement with increasing blend ratio. The predicted decrement percentages clearly show that castor biodiesel blends have a minor mechanical efficiency loss. However, biodiesel's lower mechanical efficiency is mostly due to the ester's low volatility and high density, which hampers atomization and, as a result, results in poor combustion.

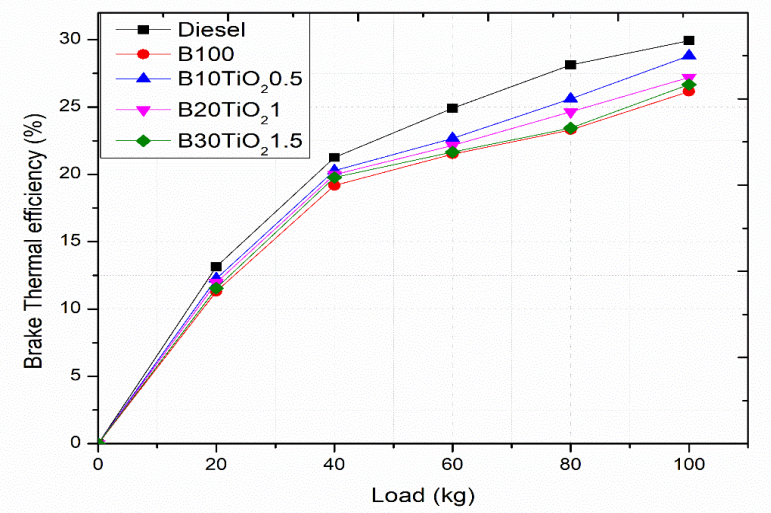

Fig. 4Brake thermal efficiency Vs Load

3.2 Emission analysis

The Fig.5 shows the variation of nitrogen oxide emission with different engine loads. NOx is a collective term for toxic gas molecules that are chemical compounds between nitrogen and oxygen. When compared to pure diesel fuel, all mixed fuels emit more nitrogen oxide. The

impact of increasing the combustion fuel creates greater exhaust gas temperatures and, as a result, increased NOx emissions. One of the causes for increased NOx emissions is the presence of oxygen molecules in biodiesel.Because B20 contains TiO2, its combustion temperature is somewhat lower than diesel, resulting in fewer NOx emissions. NOx emissions are lower than with other fuels since there is no ignition delay and the gasoline flows easily.

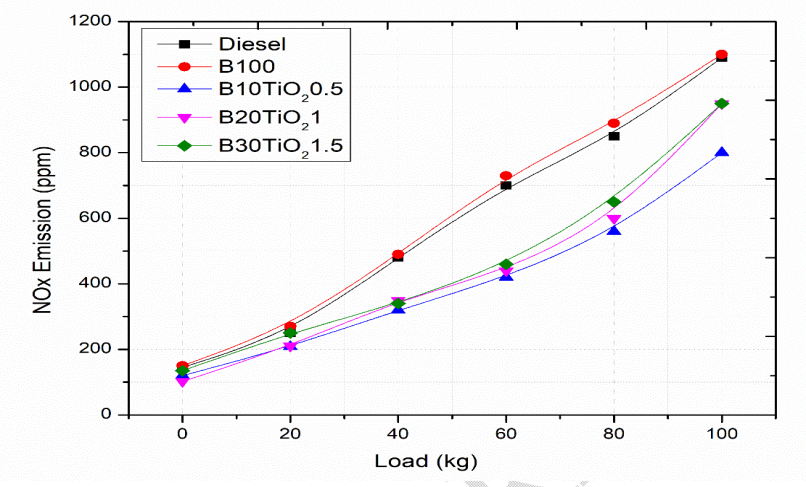

Fig.5 Nitrogen oxides Vs Load

The Fig.6 shows the variation of carbon dioxide emission with different loads. The biofuels are made from plants, it doesn't mean that the emission of carbon will be neutral. The biofuels also contain the carbon content but compared to fossil fuels the biofuels will produce less carbon content. Biofuels will reduce the consumption of fossil fuels to reduce the emission of carbon dioxide. When compared to biodiesel and diesel, the CO emissions of the B20 fuel are lower. Because of the shorter ignition delay effect, using nanofluids reduces emissions by roughly 10% at full engine load. The oxygen content of the nanoparticle (TiO_2) contributes to full combustion. As a result, CO emissions for B20 are lowered.

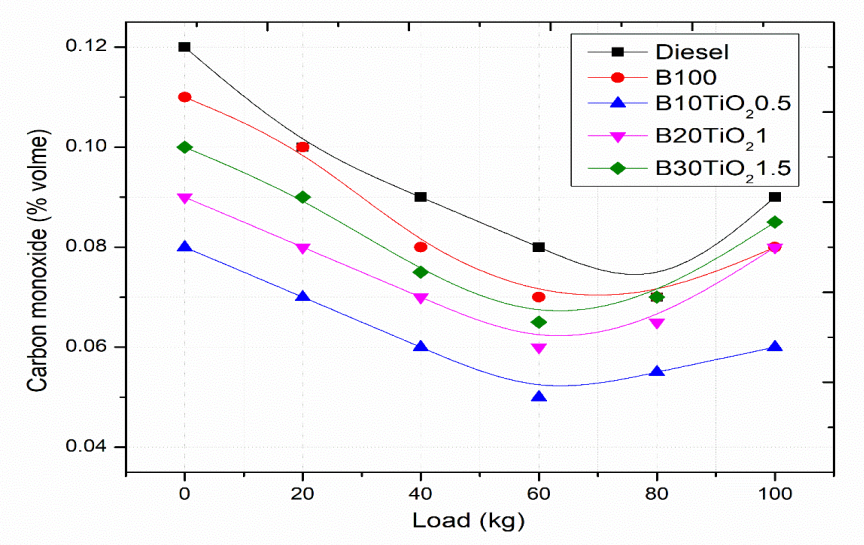

Fig.6. Carbon dioxide(CO)Vs Load

The Fig.7 shows the variation of hydrocarbon emissions with different load. Hydrocarbons are produced products of incomplete combustion process which can be during operation of the internal combustion engines. With Titanium dioxide to the B20 blend also leads to low HC Emissions. With B20 there is lot of spikes in the HC emissions. With B20 there is more emissions compared to all the blends. In comparison to other fuels evaluated, B20 produces less HC. The presence of TiO_2 nanoparticles is the major cause of this because of TiO_2 has a high activity, a high area to ratio of volume, and a high fatty acid content, HC emissions is minimized.

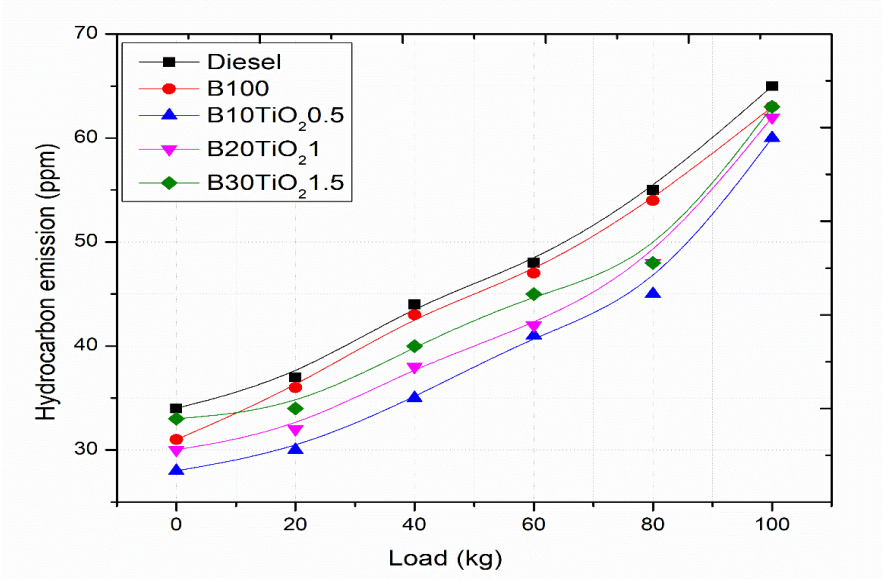

Fig.7. Hydrocarbon Vs Load

Conclusion

An alternative fuel that is cleaner than petroleum diesel is biodiesel.Its great biodegradability, strong lubricity, and lack of sulphur content are its three main benefits. Aloe vera oil having good calorific value compare to diesel. Examined and compared with diesel fuel were exhaust pollutants such as CO, NOx, and HC.For reduction the engine emissionthe Nano particles (TiO_2) was blended with optimal biodiesel blend (B20). CO, HC and NOx emissions were lower for the tested biodiesel with TiO2 (B20) as compared to diesel fuel. The acquired outcomes were compared with earlier outcomes of other research authors. This comparison showed accepted conformity.

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