Performance and Emissions Characteristics of Diesel Engine Run on Citrullus Colocynthis Biodiesel with Zinc Oxide Additive

K. Logesh, M. Karthick, S. Baskar, and Abhishek Sharma

1 Introduction

In the past, wood was the primary source of energy due to the frequent deforestation; however, wood as fuel was deeply concerned about its durability. An alternative to timber, namely coal, was then discovered. Later oil goods, such as petrol and diesel, were established [1]. It appears that the energy dilemma was completely solved in the initial process. However, global energy demand is intensified by population growth and shifts in lifestyle [2]. It became evident later that the opportunities for fossil fuels were also minimal. One of the biggest energy users in the automotive industry, because 600 million vehicles are used globally and are mainly used in diesel engines [3]. The second approach appears to be easier because a vast number of existing engines already exist. The cost of shipping and pollution for biofuels are also lowered.

Biodiesel is one of the most sustainable and environmentally friendly renewable fuels for CI engines. Biodiesel is capable of replacing diesel, and much of its properties are closer to diesel [4–6]. The decline of fossil fuel prices raises day-by-day demand for renewable fuel exploration to satisfy the world's energy demands. In contemporary times, biodiesel provides the largest energy alternative. Fossil fuel can be substituted by biodiesel. The Citrullus Colocynthis oil (CCO) is converted into biodiesel by transesterification process which in the presence of catalyst, which

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decreases on the dependency on fossil fuel improves in the contributions towards the use of renewable fuels. Many research reports are available on the use of CCO as substitute fuel with low moisture content and durability [5, 7–9]. Many recommended a maximum yield of pancreatic lipase-based vegetable oil. The mixture of 20% biodiesel in diesel was more effective. They researched brake thermal performance and the addition of diesel-like additives for non-edible waste and bio-seeding crude.

Many studies were carried out on the use of biodiesel derived through non-edible seed to determine the effects on performance and emission properties of oxygen-additive nanoparticles, followed by a comparison of experimental results with base pure diesel [10–12]. The efficiency and emissions properties of waste oil with nano-emulsions were investigated. In another study, they evaluated nano-added bio-seed oil that results in lower oil viscosity and density. For a beneficial result, the emissions of an engine may be minimized with bio-seed such as seed oil. The efficiency and emission characteristics of various proportions of cerium oxide cotton oil and diesel with nanoparticles have been investigated by Sujesh et al. [13]. The present paper incorporates diesel for the efficiency and emission characteristics study of the various loads of a single-cylinder diesel engine with a 10% increase in the Citrullus Colocynthis oil at three different proportions.

2 Experimental Details

Conversion of oil into biodiesel is done through transesterification process. In our current research, Na–OH, the basic catalyst, is obtained in a pallet shape on the market and is polished very finely and combined with and well stirred to create a homogenous methanoxide mixture. Methanolysis is called this method of preparation of methanoxide. The next step is the simple catalytic raw oil transesterification. To eliminate the impurities, present in the oil the raw oil collected from the market is first filtered and then preheated to about 60 °C for about 10–15 min to remove the humidity present in the oil.

The preheated oil and the homogeneous methanoxide are then blended to a limit of 150 ml of methanol per 600 ml of oil. Then using the hot plate magnetic mixer, the mixture is mixed at 1200 rpm and the mixture is held at 65 °C for an hour. Through this one-hour method of transesterification, the triglycerides in the raw oil have been converted to glycerine. Then the glycerine produced in the transesterification phase is transferred to the separating beaker and can be positioned on top of the glycerine during the six-hour term and then extracted by the transesterified oil (Table 1).

Test fuels were produced by mixing with diesel at various percentages by volume the CCO. The preferred mixing ratio was B10, B20, B30, i.e. 10% CCO with 90% diesel, 20% CCO with 80% diesel and 30% CCO with 70% diesel to provide evidence for a broad spectrum of biodiesel. The composition of the exhaust gas has been determined using the gas analyzer. In the exhaust gases, it tests NO_X, CO_2, HC, CO. By checking the engine powered from the formulated test fuels for the output of each

Table 1 Properties of Citrullus Colocynthis oil blends

Property	Pure diesel (PD)	CCO	CCOB10	CCOB20	CCOB30
Calorific value (kJ/kg)	44,800	41,250	44,780	44,730	44,680
Density (kg/m$^{3)}$	850	885	862	870	874
Cetane number	53	57	41	45	46.8
Kinematic viscosity (mm^2/s)	2.12	4.45	1.56	1.87	2.21

fuel at the same engine load conditions, the short-term performance and the emission features were assessed.

3 Results and Discussion

3.1 Performance Parameters

The improvement in thermal brake performance in load-related test diesel. Thermal brake output of all combustibles improved as load increases as shown in Fig. 1. This could be clarified because the load raises the suction pressure, which could have contributed to the engine's efficient combustion. At 75% load, diesel thermal brake performance, CCOB10, CCOB20 and CCOB30, respectively, was 33, 31, 30 and 29%. If the mixing rate rises to 75% of load, the brake thermal efficiency decreases. However, the thermal brake performance of the combination of CCOB20 and CCOB30 was improved by more than 20% in a load of fuel, due to the higher oxygen content in biodiesel mixtures than diesel, resulting in total combustion [14]. The CCOB20 and CCOB30 mix with higher latent vaporization heat, at 75% load,

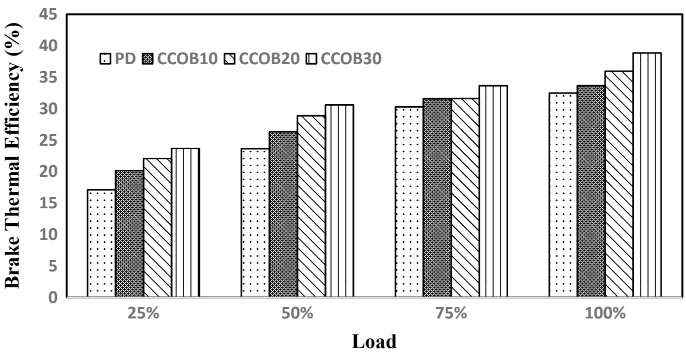

Fig. 1 Brake thermal efficiency of CCO blends

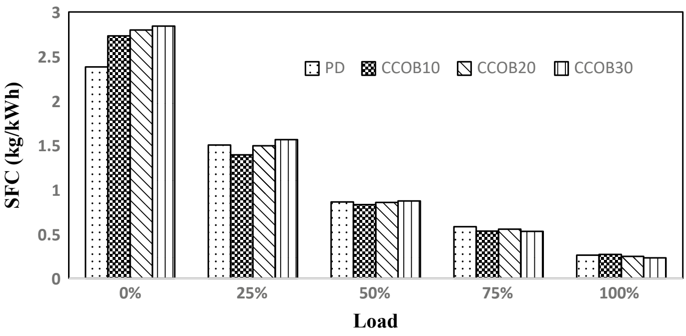

Fig. 2 Brake-specific fuel consumption of CCO blends

contributes to incomplete combustion, thus reducing the thermal performance of the brakes.

The brake-specific fuel consumption (BSFC) diesel and CCO mixtures of diesel at varying loads as shown in Fig. 2. For CCOB10, because of the lower heat quality of the blend, the BSFC is more than gasoline. At 25% load in CCOB20 and CCOB30, the oxygen content is lower than diesel as the combustion results in stronger combustion. But the BSFC of all blends was 75% higher than diesel as the burden rose.

The lower the heat value of the blend, and nonsensical combustion, lead to an increase in the amount of fuel that is injecting to retain the same engine capacity, and the lower heat value of the fuel blending is absorbed [15]. These variables would also contribute to a rise in BSFC loads.

3.2 Emission Parameters

Figure 3 shows the emissions of hydrocarbons from types of diesel and Citrullus Colocynthis oil combinations of gasoline. The increased pollution is noted for the

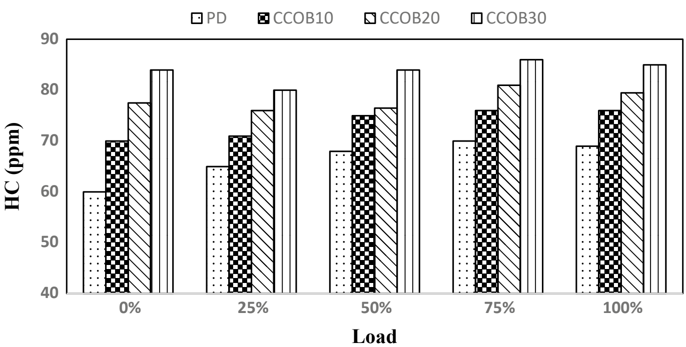

Fig. 3 Hydrocarbon emission of CCO blends

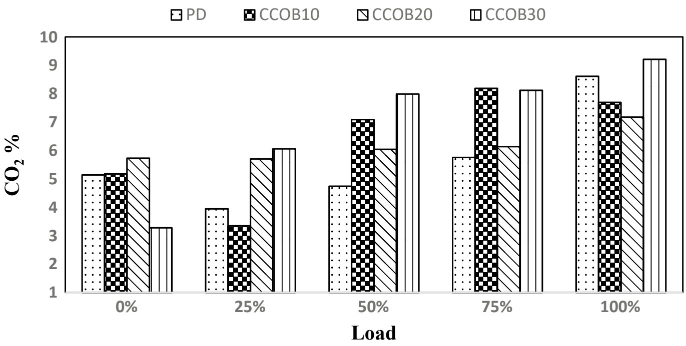

Fig. 4 Carbon dioxide emission of CCO blends

mixtures of CCOB10, CCOB20 and CCOB30 since the unburned mixture of fuel emitted into the exhaust system is not consumed. The blend of CCOB20 emits more hydrocarbon than other blends, as the unused oxygen reveals that oxygen is more emitted without combustion and additional hydrocarbon emissions. Due to the lower calorific value and delays in fuel ignition, a lot of fuel molecules are not homogenous, and combustion happens after the energy stroke resulting in a high hydrocarbon release [16, 17]. It is noted from the literature that with the higher gas temperature and cetane number, CCO mixtures, more than 50%, show lower emissions of hydrocarbons than diesel [18].

Shift in the emission of carbon dioxide from the CI engine as shown in Fig. 4. The CCO blends' CO_2 emissions from petrol are nearly equal to minor percentage differences, with mixtures displaying an increase of up to 0.3% of CO_2 emissions relative to diesel [19]. The increase in charge raises the CO_2 emission ratio because of the consumption of additional petrol. The combustion of the fuel is easier, because of the oxygen molecules in the palm oil methyl ester blend. These concerns total fuel combustion and oxidation with the oxygen of carbon molecules by lowering CO levels of CCO blends to the atmosphere as diesel.

Figure 5 indicates the change in CO emissions for test fuels at different loads. Carbon monoxide is commonly formed if the gasoline is not oxidized by enough oxygen. Diesel is commonly run-in excess air since the diesel engine's carbon monoxide emissions are smaller than those of the petrol engine [20, 21]. At a load of 25% and a load of 75%, the CO emission of Citrullus Colocynthis oil decreased considerably relative to diesel. CCOB10, CCOB20 and CCOB30 have lower CO emissions than the represented diesel for 25%. With rising load, CO emission decreases when excess oxygen molecules oxidize CO into carbon dioxide as a result of full combustion [22].

When the engine load has stepped up to 100%, the load for mixed fuels has been lowered by marginal changes in NO_x emissions in Fig. 6. In the case of mixtures, the CCOB20 has a closer NO_x degree than the basic diesel emission. The lower fuel heat value leads to lower temperatures in the combustion chamber and lower emissions

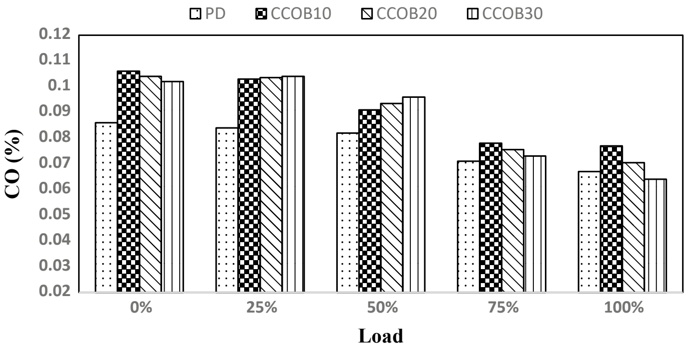

Fig. 5 Carbon monoxide emission of CCO blends

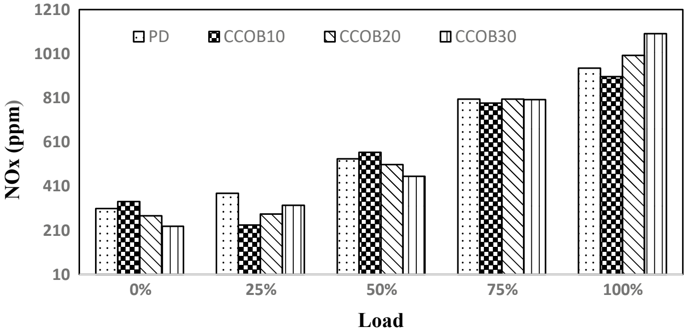

Fig. 6 Oxide of nitrogen emission of CCO blends

of NO_x in blends like CCOB20 and CCOB30. The effect of biodiesel on emissions is more obvious. The various emissions are significantly reduced due to the addition of biodiesel, but NO_x increases. The increase in the residence time and the temperature of the mixture in the cylinder may lead to raise in NO_x emission [23]. In future, the bio-diesel is playing a major role in terms of improving the performance.

4 Conclusion

The energy demand is continually increasing because of the vast number of businesses and automobiles induced by the detonation of residents. Fossil fuels, including oil, gas, coal, hydrocarbons and nuclear energy, are the available sources of energy. Greenhouse emissions are the main risks of using oil-based oils. A variety of greenhouse gases are released from the diesel ignition. This is one of the key sources of gas pollution derived from fossil fuels, including NO_x, CO and particulate substances and volatile compounds. The experimental investigations on a compression ignition engine were carried out to test the output of Citrullus Colocynthis seed oil-based biodiesel and blended with zinc oxide nanoparticle diesel blends. The efficiency of the engine parameters and emissions are evaluated, and the property of biodiesel blends is checked in the laboratory. In general, we have found that the Citrullus Colocynthis oil, which is combined with diesel fuel, offers top quality and a major CO_2 emission reduction, making it ideal for Citrullus Colocynthis oil mixes CCOB20 and CCOB30.

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