Control of Carbondioxide Emission in Automobile Vehicles using co 2 Scrubber

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Investigation of Momordica charantia seed biodiesel with cerium oxide nanoparticle on CI engine

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ABSTRACT
The main fuel for transport is diesel. It adds to the success of overall economy, as it is widely used due to its high efficiency in combustion, versatility, unwavering quality and cost-effectiveness. One of the major sources of air pollution on the Earth is emission from diesel engines. Over the years, the need for biofuels has enabled Momordica charantia seed oil to become biodiesels. Momordica charantia seed oil having low calorific value than other biodiesels made it an alternative for diesel which shows lower emission and improvement in performance characteristics. In this exploration work, to study the emission and performance characteristics of biodiesel, four blends of Momordica charantia seed oil with cerium oxide added substance are investigated. The results showed that B30 (69% diesel, 30% biodiesel and 1% cerium oxide) performs better than different blends.

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KEYWORDS
Momordica charantia seed; cerium oxide; biodiesel; emission characteristics; additive

1. Introduction

One of the most efficient prime movers is diesel engine, from the perspective of ensuring worldwide condition and worries for long-haul energy security it winds up important to properties of alternative fuels practically identical to conventional fuels. India's interest in diesel power is multiple times that of petrol, so seeking an alternative to conventional diesel is a characteristic choice. Alternative fuels should be easily accessible without much effort, be neighbourly condition and fulfil energy security requirements deprived of giving up engine operational performance. Waste is converted into energy is the ongoing pattern in the determination of alternative fuels. Fuels like liquor, biodiesel, plastic fuel and so on are part of the alternative IC engines fuels.

Silva et al. (2015) examined the biodiesel obtained from aloe vera. With the upgrades offered in each biodiesel procedure resulting from the production of aloe vera, it shows that aloe vera should be a feasible source for the biodiesel production. Venkatesan and Kadiresh (2016) utilised aqueous cerium oxide biodiesel to compare with the diesel engine emissions and performance characteristics. Cerium oxide additives are used as oxygen buffers that produce oxidation of hydrocarbon (HCs) whereas nitrogen oxides are reduced. Furthermore, the brake thermal efficiency (BTE) greatly improved, and also brake specific fuel consumption is increased. Sajith, Sobhan, and Peterson (2010) conducted an impact test on biodiesel using cerium oxide additive, used the techniques to change the hydrocarbon combustion characteristics, evaluated the use of additives and physicochemical properties that are particularly effective in the structure of nanoparticles, due to the surface area being upgraded to the volume proportion. In each B20 blend test, Karthikeyan, Elango, and Prathima (2016) examined a cerium oxide additive at 50 and 100 ppm with an ultra sonicator guide in rice bran oil biodiesel. The test results show that a significant enhancement in performance characteristics and emission reduction due to the use of CeO_2 mixed biodiesel in the CI engine.

Anderson (2017) researched about the use of ceramic thermal barrier coatings in diesel engines. In stainless steel ceramic, the plasma spraying method was used and the results showed that the ceria mixed yttria-stabilised zirconia had a higher resistance to corrosion. Jayaprabakar, Karthikeyan, and Rameshkumar (2017) examined the characteristics of combustion in two biodiesels extracted oil from rice bran and algae with three different injection timings. The cylinder pressure and the discharge rate for heat release differ from the injection change. Desirable results have been found in the performance characteristics of rice bran oil over algae.

Shaisundaram et al. (2018a, 2018b) examined the emission characteristics and engine performance of a single cylinder diesel engine with a stabilised zirconia coating of ceria and yttria on the piston head and cylinder liner. Differential dosing levels are added to diesel in both coated and uncoated engines. The examination showed discernible variations in certain levels of cerium oxide nanoparticle additives in diesel thermal barrier coating and dosing. There was also a significant decline in the emissions of carbon monoxide, nitrogen oxide and hydrocarbon. In contrast to conventional diesel mode in the uncoated engine, a 2.1% increase in BTE and a 3% reduction in brake-SFC

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Figure 1. Momordica charantia.

Table 1. Momordica charantia seed biodiesel properties.

S.No	Properties	Results
1	Acid value	0.120 mg NaOH/g of Oil
2	Kinematic viscosity @ 40°C	5.046 cSt
3	Density	0.910 g/cc
4	Moisture content	0.78%
5	Cloud point	7°C
6	Pour point	5°C
7	Flash point	260°C
8	Fire point	270°C
9	Calorific value	72.15 cal/g

Table 2. Cerium oxide nanoadditive properties.

Properties	Values
Molecular formula	CeO_2
Molar mass	168.26 g/mol
Appearance	Pale yellow solid
Density	7.242 g/cm^3
Melting point	2400°C (4350°F; 2670 K)
Boiling point	3550°C
Solubility in water	Insoluble
Crystal structure	Cubic–fluorite

were perceived. Karikalan and Chandrasekaran (2017) show that the BTE of a mixture of 20% mineral turpentine and 80% Jatropha biodiesel is close to diesel fuel at 75% load. Carbon monoxides and hydrocarbon emissions have been reduced to a significant amount, although nitrogen oxides increase with a limited load increase and decrease with 75% in full load conditions. Padmanabhan et al. (2018a) conducted its performance tests in a single cylinder, water-cooled diesel engine powered by diesel, waste oil nanoemulsions and waste oil emulsions. The test outcomes demonstrate that significant enhancement in BTE and decreased oxides of nitrogen and SFC for waste cooking oil nanoemulsion when contrasted with the waste cooking oil emulsion. Padmanabhan et al. (2018a, 2018b) carried out an investigation into bio-seeded biodiesel in order to assess the performance analysis and emission characteristics of cerium oxide nanoparticles, and the outcomes were compared to the base results.

In this paper, Beemkumar et al. (2018), researched with fins to improve the rate of heat exchange in thermal energy storage systems. The outcomes are analysed for both discharge and charging methods for their performance characteristics. Sivaganesan et al. (2018) evaluated the performance and outflow parameters of Jatropha biodiesel blended with bio-added substance in three unique proportions as the blending ratio increases and the thermal efficiency upsurges. Biodiesel blend is closer to diesel, but emissions are lowered in all diesel blends. The collected study shows that many analysts used a range of biodiesels in combination with conventional fuel in the performance analysis, combustion and emission characteristics of a varied range of diesel engines with little or no change. Momordica charantia seed oil has not been researched elaborately as a biodiesel option. It tends to be macerated into biodiesel and could be used as fuel for diesel engines. The mission and performance characteristics of biodiesel mixtures and mixtures from Momordica charantia seed oil with cerium oxide added substance in a single cylinder diesel engine are investigated in order to observe a replacement fuel by comparing the results of the blended fuel and diesel.

2. Experimental procedure and details

2.1. Momordica charantia–biodiesel

Momordica charantia is a Momordica class plant type. It grows wild throughout the world in tropical atmospheres and is cultivated for agricultural and medicinal purposes. The oil from the seed of Momordica charantia is also used as a medicine for diabetes (Figure 1).

It is used for laxative purposes and to cure cough as an anthelmintic agent. Other studies often contradict studies that find positive evidence as given in Table 1.

Momordica charantia seed oil is collected and prepared by expelling free fatty acids by separating glycerol and biodiesel. The isolated biodiesel is kept far away from glycerol. Biodiesel is mixed with conventional diesel adequately, such as B10, B20, B30 and B40, where B is biodiesel. The combustion performance and emission characteristics of momordica charantia biodiesel seed oil and its doped nanoparticle blends of cerium oxide (CeO_2) are evaluated. Cerium oxide additives are used to stimulate the carbon monoxide oxidation and to ingest oxygen to reduce oxides of nitrogen. The impact of additives of CeO_2 nanoparticles on blend subsidises good combustion and meaningfully reduces dangerous emissions of exhaust gases. Modified fuel performs on par with conventional diesel.

The addition of cerium oxide to diesel results in a significant reduction in the number of weighted conveyor belts and light-off temperature and a significant increase in the oxidation rate. Cerium oxide, which is an unusual earth metal with a double valance state, has incomparable catalytic activity due to its ability to buffer oxygen, specifically in the structure estimated by the nano. Henceforth, in diesel fuel biodiesel is used as an additive, nitrogen dioxide and hydrocarbon emissions are reduced and oxidised separately from the diesel engine (Table 2).

Biodiesel can be found in various blends. It tends to be used as a fuel (B100) or mixed in B5, B10 and so on with petro diesel. B10, B20, B30 and B40 are the blends used here. The mixture of Momordica charantia seed biodiesel is mainly carried out by sonicating for the production of biodiesel, Hielscher offers reactors for ultrasonic blending on any scale. The ultrasonic blend increases mass exchange and response energy leads to quicker transesterification and higher yields. It reduces usage of methanol and catalyst.

A single cylinder engine with constant speed and direct injection was used to examine the performance of the engine and emission characteristics of the blended Momordica charantia

Figure 2. The photographic view of experimental set-up.

Table 3. Engine specifications.

Parameters	Specification
Engine type	4 Stroke, single cylinder, Water-cooled engine Bore 87.5 mm, Stoke 110 mm, 661 cc
Power	5.20 KW @ 1500 rpm
Compression ratio	17.5
Injection variation	0–30° before TDC
Dynamometer	Water-cooled and Eddy current, with loading unit

biofuel. The CI engine was examined at different loading conditions with various blends of Momordica charantia. To change the zero load to full load, the test diesel engine was specifically combined with an eddy current dynamometer. The engine load extension is fluctuated from the zero load state to (0%, 25%, 50%, 75% and 100%) to full load state in view of the engine power generated. With the help of an eddy current dynamometer, the engine loads are physically changed. The AVL gas analyser and smoke meter were added to estimate the smoke density and exhaust gas temperatures. To evaluate emission from hydrocarbon, carbon monoxide, carbon dioxide and nitrogen oxides from the exhaust gas, AVL five gas analysers were used.

The test was completed for various mixtures of Momordica charantia biofuel blended with pure diesel fuel. The engine performance analysis at various rated power levels was assessed in terms of SFC, BTE and emissions, for example HC, CO, CO_2 and NO_x. Figure 2 depicts the X experimental set-up photographic view as given in Table 3.

3. Results and discussions

3.1. Specific fuel consumption

The emission and engine performance test diesel and Momor dica charantia seed biodiesel with various blends with an additive were tried at various load conditions. SFC and BTE for various mixtures (KW) related to the engine for various proportions of Momordica charantia seed biodiesel mixtures with cerium oxide as additives and results are compared with those of diesel fuel (Figure 3).

In Momordica charantia seed oil, SFC is high as a result of low oxygen. For B40, the SFC is high and reduces the combustion efficiency due to its higher viscosity. SFC for B30 is not less than other blends. This is because of the production of oxygen

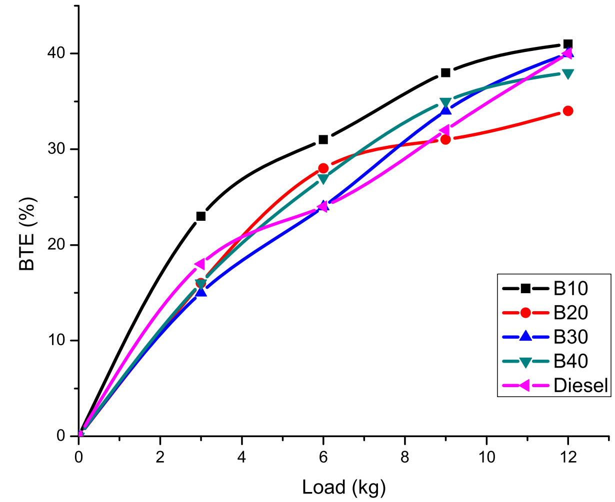

Figure 3. SFC vs engine loads.

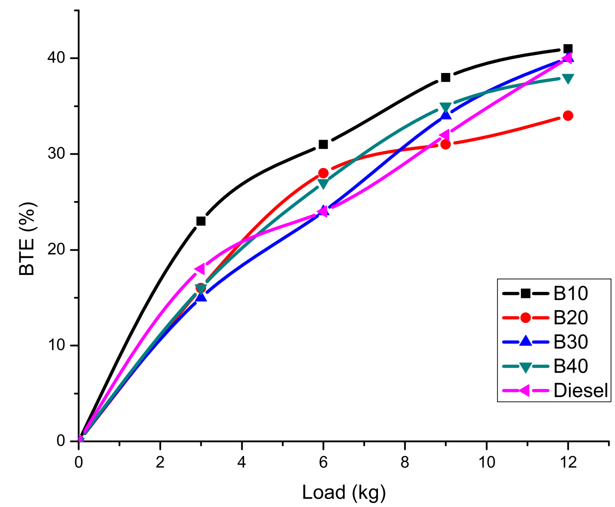

Figure 4. BTE vs engine loads.

in seed oil from Momordica charantia. Due to the better blending of fuel and air, fuel combustion is enhanced at high engine speed. Although combustion is increased at high engine load because of higher cylinder temperature after progressive engine operation at this load, it could increase evaporation and fuel atomisation and to some extent increase the fuel air blending process. The addition of cerium oxide to the blends, however, contributed to an increase in oxygen content. The oxygen is used as a base of combustion, which improves the combustion process and increases the combustion chamber temperature.

3.2. Brake thermal efficiency

A variety of the brake thermal efficiencies are depicted in Figure 4 for various loads regarding distinctive proportions of Momordica charantia seed biodiesel blends with cerium oxide as additives.

Due to lower fuel consumption, the BTE for B30 is increased. For B10 and B20, the BTE is lower due to increased fuel consumption. For B40, the lower heat value reduces the BTE.

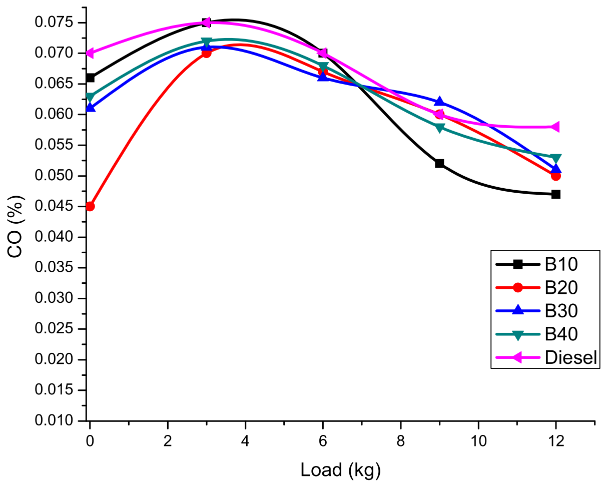

Figure 5. CO vs engine loads.

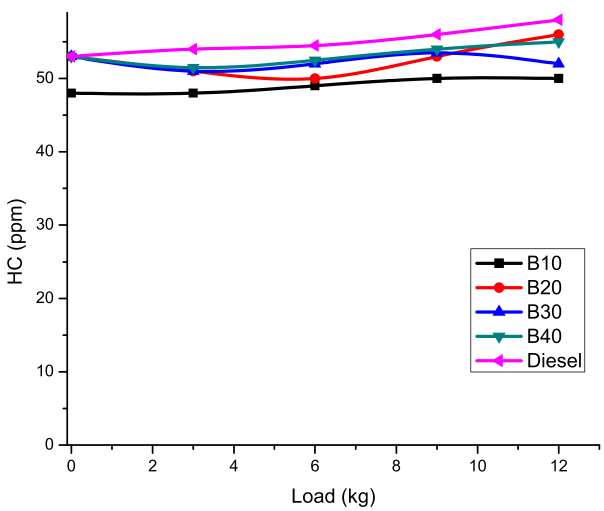

Figure 6. HC vs engine loads.

3.3. Carbon monoxide

Figure 5 shows the distinction between carbon monoxide emissions for different loads and different proportions of Momordica charantia biodiesel seed blends with cerium oxide as an additive.

The levels of CO are reduced when compared to diesel. With the blends, CO emissions are raised. It is low for B10 and subsequently increases with the increase in blends for B20. From the result, emissions for all blends are low compared to diesel.

3.4. Hydrocarbon

Figure 6 shows the distinction between hydrocarbon emissions for different loads and different proportions of Momordica charantia seed biodiesel blends with cerium oxide as an additive.

In contrast to diesel, HC levels are reduced while the composition of Momordica charantia blends is increased due to the higher oxygen content of biodiesel. The HC for B30 is then seen to be low at the estimated load. HC is reduced for B10. For B20, B40 compared to B30 the HC is increased.

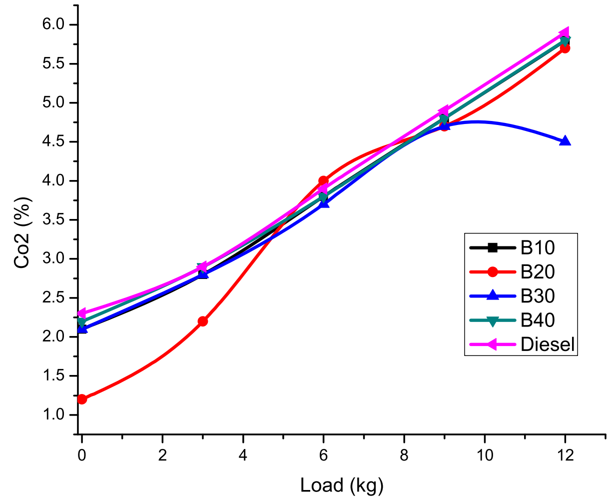

Figure 7. CO_2 vs engine loads.

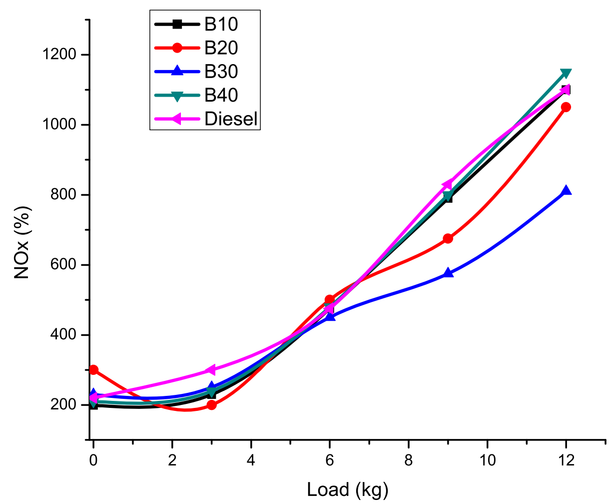

Figure 8. NO_X vs engine loads.

3.5. Carbon dioxide

Figure 7 shows the distinction between the carbon dioxide emissions for different loads as for different proportions of Momordica charantia seed biodiesel blends with cerium oxide as an additive.

Compared to diesel, CO_2 is greatly reduced with the increase in seed mixtures from Momordica charantia. During the combustion process, CO_2 is a byproduct produced when the fuel carbon is fully oxidised. It is now seen that CO_2 for B30 is low at the rated load. Compared to B30, CO_2 is increased for B10, B20 and B40.

3.6. NO_X emission

Figure 8 depicts the distinction between the NO_X emissions for different loads as for different proportions of Momordica charantia seed biodiesel blends with cerium oxide as an additive.

The NO_X is seen to be reduced compared to diesel, while the composition of Momordica charantia seed biodiesel blends is increased by increasing the specific heat in the engine cylinder. At the rated load, the higher flame temperatures are reduced. The NO_x for B30 is now seen to be low at the rated load. NO_X is increased for B10, B20 and B40 compared to B30.

4. Conclusion

- Cerium oxide can be used to oxygenate diesel-Momordica charantia biodiesel seeds and additives from collective research on diesel-Momordica charantia biodiesel seed blends and increase the cetane number as an incentive for enhanced combustion. These blends can improve the performance and emission characteristics.
- Additives can increase viscosity to confirm adequate lubrication of the injection pump and balance the mixture in view of the high water content to confirm the homogeneity of the fuel in all conditions. To ensure cleanliness of fuel injection equipment and good atomisation, it has better detergent properties.
- To achieve homogeneity and prevent phase separation, the tests were carried out without modifying the engine and adding additives to all blends. Several performance tests are performed using the engine with different blend proportions and the combination of additives and blends has been studied.
- The Momordica charantia seed biodiesel blend is a better alternative fuel that provides better emission characteristics and good performance based on the engine performance and emission test. The B30 blend (30% biodiesel, 1% nanoadditive and 68% diesel) offers good performance and combustion compared to another mixture. This experimental investigation also led to another new environment-friendly alternative in the biodiesel category.

Disclosure statement

No potential conflict of interest was reported by the authors.

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