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Performance and Emission Characteristics of Diesel Engines Powered by Dual Blended Biodiesel

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Abstract:

For our daily activities, communities rely heavily on petroleum products. However, oil may be a scarce resource, which can cause environmental problems, like an increase in atmospheric greenhouse gas levels. As energy demand increases and fossil fuels decrease, research is turning to alternative fuels. Due to the rapid depletion of traditional oil supplies and anticipated shortages, alternative fuels are needed. A number of scientific studies on mixing diesel with ordinary biodiesel have been carried out. Some works have been discovered but there are a lot of works left for a mixing of two different types of biodiesel. The intention of this research to carry out the possibility of blending animal fat oil and vegetable oil with diesel or biodiesel B20. The various performance characteristics such as indicated power, thermal braking efficiency, specific fuel consumption, and effluent attributes such as carbon dioxide carbon monoxide, nitrous oxide, and hydrocarbons were measured and correlated with diesel emissions.

Keywords: *Biodiesel, Oil, Transesterification, Blends, Engine Performance, Emission*.

1. Introduction

The main energy sources in the world today are fossil fuels. Everything accounted for the quality of simple usability, accessibility, and cost-effectiveness. However, due to the rapid exhaustion of reserves due to the rise in international energy demand, the diminishing storage of fossil fuels is the main concern. In today's world, petroleum products are the primary cause of air contamination. Attempts are therefore underway to find alternate sources for this exhausting supply of energy. Although cutting-edge technology has arisen, which has provided only usable solar, wind, or tidal energy resources, still they are not widespread because of integration problems with prevailing technologies and processes. Initiatives are often aimed at discovering sources of energy so that they can be used in much the same way as existing fuels that could be utilized as direct substitutes. The foremost energy source in carriage industry is diesel fuel. During the year 1900, Rudolf Diesel worked on an engine with 100% peanut oil and exhibited at Paris. In 1911, he asserted that the internal combustion engine is also served with vegetable oils which would increase the manufacturing of agriculture in the world. Most of the studies shown that animal and vegetable oils are also utilized in diesel engine due to fuel related properties. It is considered a milestone due to the availability of

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varied kinds of oil seeds in large quantities. Vegetable oils and fatty animal oils are sustainable sources of natural resources, and large-scale use can create opportunities for rural workers. The vegetable oil has extracted from crops such as karanja, soybeans, sunflowers, peanuts, rapeseed, neem, cotton, mustard, linseed, and castor have been cultivated in various regions of the world. Animal fatty oils are also only obtained from chickens, goats, buffaloes, and pork around the world. The oils have high viscosity and various problems making it impossible to use, so it was used before converted into its compound of methyl ester, which modified all the features to satisfy the suitable energy demand for substitute fuel. Throughout this job, 10 percent chicken oil methyl ester and 10 percent sunflower oil methyl ester are combined with the normal mass-based gasoline.

2. Materials and Methods

It extracts the chicken oil by heating the chicken fat. To the same degree, chicken oil and sunflower seed oil are mixed. Titration is done in order to verify the amount of catalyst needed for transesterification. The oil mixture was transformed into methyl esters by base-catalyzed transesterification by methanol in the occurrence of NaOH as a catalyst. One hour before transesterification, the oil mixture is heated approximately 60°C and then the precipitate and impurities are filtered with a fine filter. With the aid of separating funnel during transesterification, two layers, namely ester and glycerol, were formed and separated. Finally, the mixture of methyl ester with chicken oil and sunflower seed oil was purified with distilled water. Table 1 shows the properties of dual mingled fuel.

Table 1: Properties of fuel

Property	Diesel	B20 biodiesel
Density (kg/m^3)	860	830
Calorific value (KJ/kg)	46500	28136
Viscosity (mm^2/s)	3.52	1.49

3. Experimental Setup

A single-cylinder four-stroke having direct injection diesel engine has chosen for accessing the efficiency and emission characteristics of diesel and compared with biodiesel. The specification of the selected engine has tabulated in Table 2. By using biodiesel blend, there is no need for any special arrangements to the exiting diesel engine. An eddy current dynamometer combined with varying engine compression ratio to carry out the experiments. The motor power supply is given to the dynamometer to be utilized by the load. For various load conditions ranging from zero with the incremental of 2.5 kg upto 10 kg under constant engine speed, the test is extended to 1500 revolutions per minute. Here, the data collection method is used to collect equipment information and keep the

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data in the storage unit for analyzing the characteristics of the motor. By the use of piezoelectric pressure sensor, the engine cylinder pressure was reckoned and angle of crank is calculated with crank angle encoder. The various range of load can be measured with the aid of the load cell which is connected to the eddy current dynamometer. The inlet and exhaust temperature was measured by using a K-type thermometer. Then, an intake air flow was calculated by utilizing the airflow sensor and double infrared optical detectors with a desktop computer for monitoring fuel flow. The amount of smoke exhausted by the engine was measured by the AVL smoke meter and the various constituents of exhaust gas such as CO, CO_2, NO, and HC were analyzed by AVL DIGAS analyzer. The experiments were carried out at a uniform compression of 17.5:1 and corresponding results have been recorded. The B20 gives the blending of 20% biodiesel and remaining 80% pure diesel. Initially, the test was carried out using pure diesel under various load conditions. Then, under the same loading conditions, the D100 pure diesel experiment was carried out using the biodiesel blend (Figure 1).

Table 2: Test engine specifications

Parameter	Details
Type of engine	Single-cylinder four-stroke diesel engine
Speed	1500 rpm
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5

Fig.1. Experimental setup

4. Results and Discussion

4.1 Performance characteristics: Indicated power

Figure 2 shows the difference between the motor power value and the load. For operation with

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biodiesel fuel, the measured power value is lower than the usual value for diesel fuel.

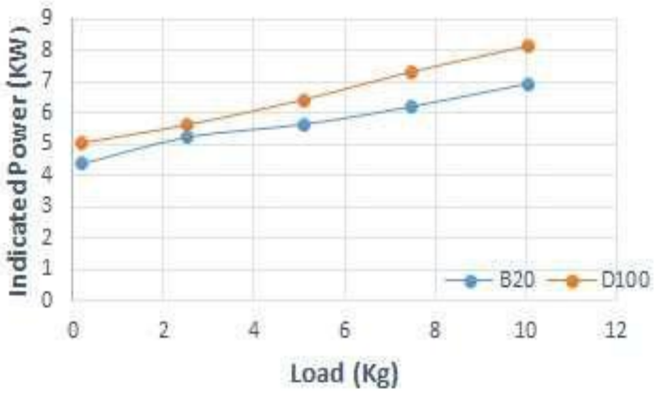

Fig.2. Changes in indicated power with load

4.2. Brake thermal efficiency (BTE)

BTE is a crucial parameter in IC engine performance testing as it denotes what amount of energy is converted inside an engine into useful work. The variations in engine brake thermal efficiency with regard to load are shown in Figure 3. It demonstrates that the BTE can increase with increasing loads on the engine. For B20 petrol, the BTE is slightly higher than for diesel.

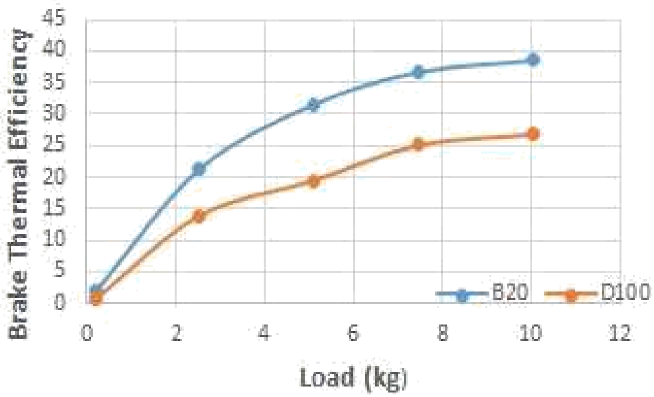

Fig.3. Changes in brake thermal efficiency with load

4.3. Specific fuel consumption (SFC)

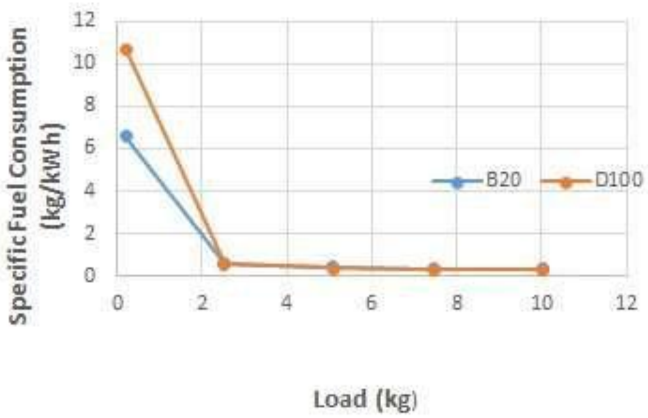

Fig.4. Changes in specific fuel consumption with load

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Figure 4 shows the effect of loading on the brakes for the specific fuel consumption of the two mixed fuels. For all fuels with higher loads, a sharp drop in brake-specific fuel consumption is observed. The important explanation for this may be that the percentage increment in fuel necessary to run the engine is due to the relatively low heat loss at higher loads, which is less than the percentage increase in stopping power. This means that for compression ignition, the engine runs more efficiently at higher loads than at part-load conditions. The graph shows that the exact fuel consumption of each blend of pure diesel and B20 turned out to be almost the same.

4.4 Emission characteristics

Figure 5 shows the difference in CO emissions between diesel and biodiesel. For low-load biodiesel blends, CO emissions are lesser than diesel, but because of higher viscosity, it will increase under higher load conditions. Under high load, the carbon monoxide emissions of the mixture were not found to be varied from that of ordinary diesel. However, associated with standard diesel, the carbon monoxide emissions of biodiesel are significantly reduced at low loads. The greater oxygen ingredients in biodiesel are also due to this reason.

The difference in diesel and biodiesel HC charge emissions is shown in Figure 6 by six estimated values. After adding biodiesel to traditional diesel fuel, unburned hydrocarbons are greatly reduced. The HC emissions of the B20 mixture are lower when installed in conjunction with a diesel engine with low to medium loads. This is also because of greater combustion temperature that oxidizes hydrocarbon emissions and oxygen in biodiesel.

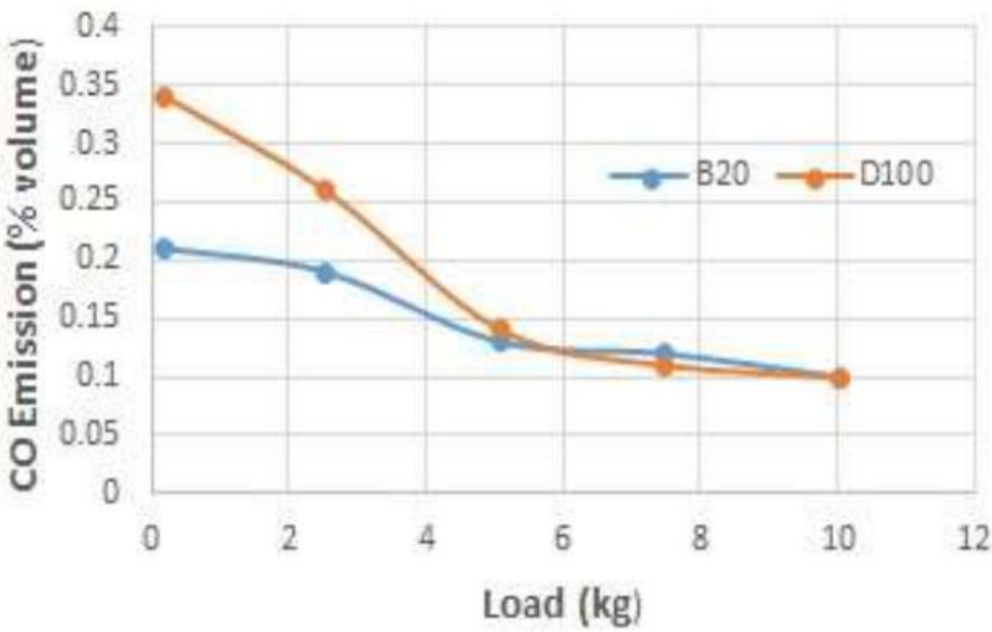

Fig.5. Changes of carbon monoxide

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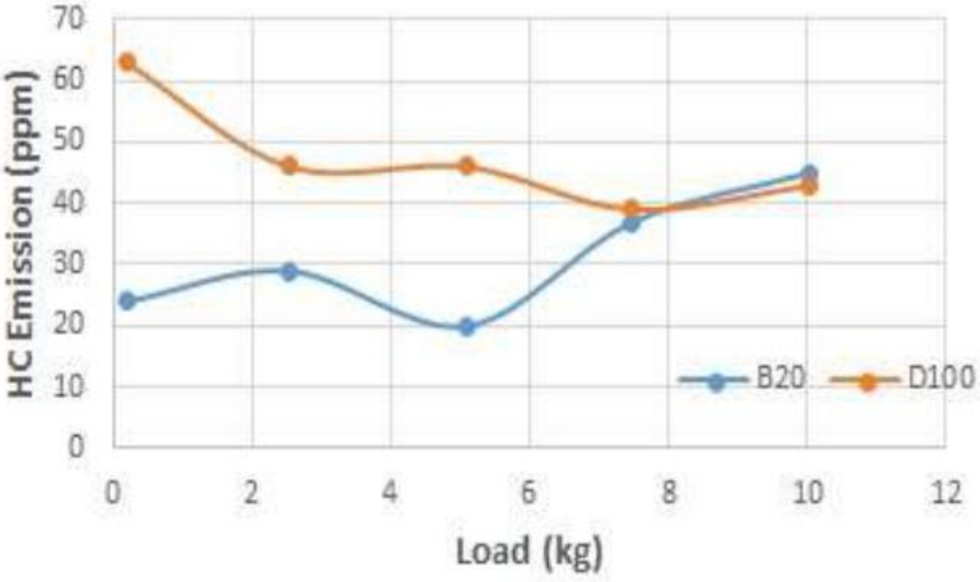

Fig.6. Changes of hydrocarbon emission

Figure 7 shows the difference in NOx emissions between gasoline and biodiesel. Under high load conditions, the NOx emissions of B20 biodiesel are slightly higher. The reason behind is because of greater viscosity of the mixture fuel and increased rate of heat release compared to fuel. According to many researchers, the findings of many researchers indicate about the cetane number distribution will cause nitrogen oxide effluents from diesel engines.

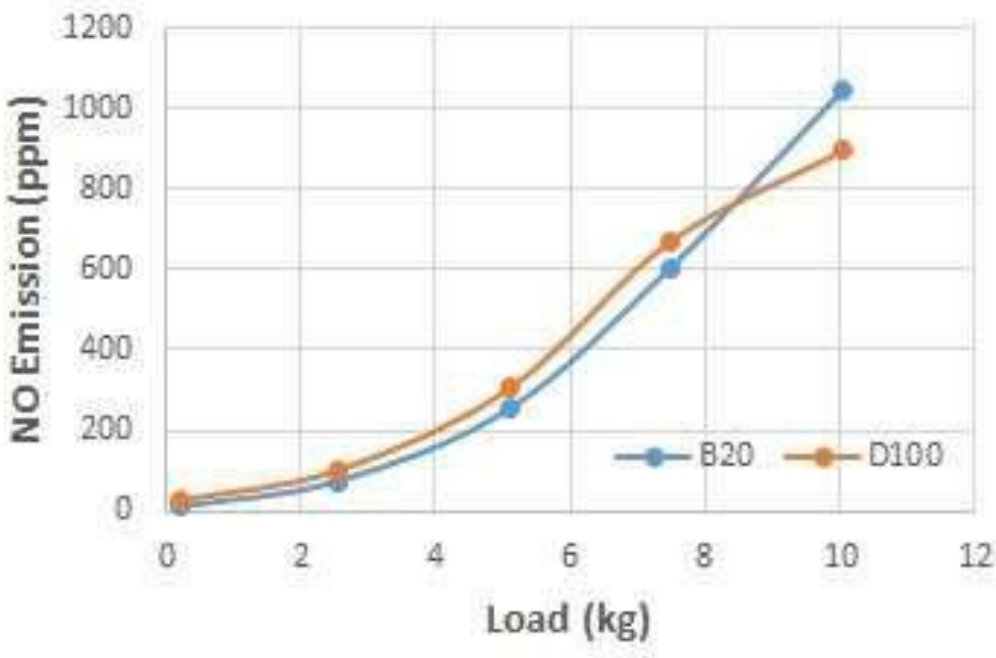

Fig.7. Changes of nitrous oxides emission

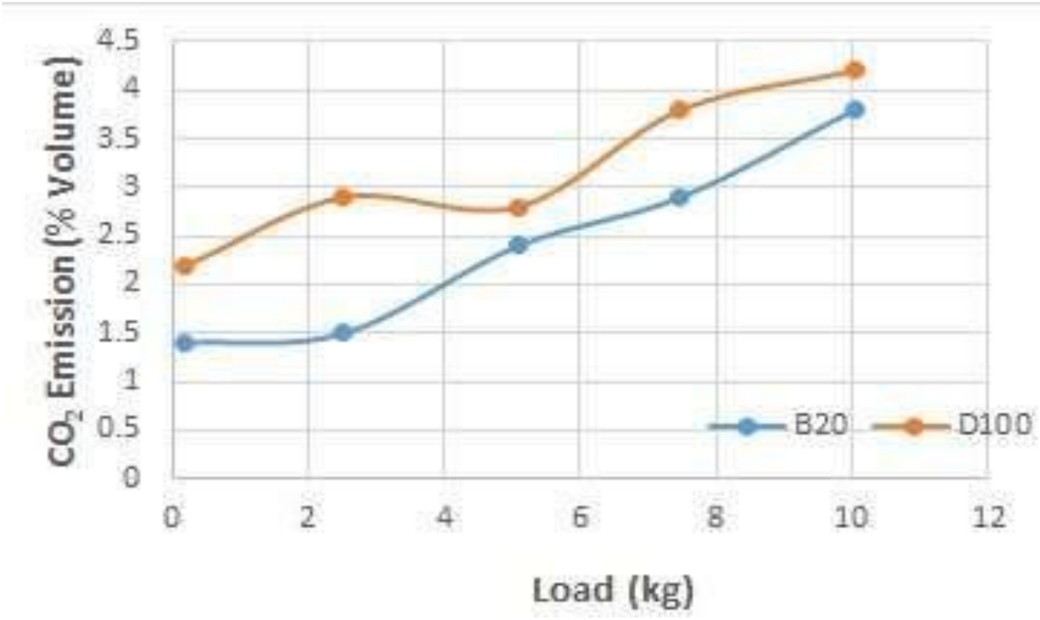

Fig.8. Changes of carbon dioxide emission

The decreased cetane index range shows a longer ignition delay and additional build-up of the fuel/air mixture, resulting in a sudden release of heat at the commencement of combustion, leading to high temperatures and higher levels of nitrogen oxide. Figure 8 shows the difference in greenhouse gas emissions from gasoline and biodiesel. The greenhouse gas emissions of B20 biodiesel are significantly lesser than those of pure diesel under all load conditions.

5. Conclusion

Compared with diesel, the characteristics of dual-blended biodiesel have been studied and changed according to the load. The blended biodiesel (B20) was good in performance characteristics of brake thermal efficiency and specific fuel consumption. However, the energy produced is slightly lower than pure diesel. The emission characteristics of CO, CO_2, NOx, and HC emissions are higher than those of pure diesel. Since there is no need to modify the engine, this biodiesel can also be directly adopted in any type of diesel engine. Long-term testing can better show engine performance and life. Only short-term tests were conducted.

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