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Diesel Engine Performance on *Chlorella vulgaris* Biodiesel

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This research paper highlights the results of analyses conducted to assess performance characteristics of an unmodified CI engine fuelled by a new third-generation biodiesel derived from Chlorella *vulgaris* algae oil and its mixtures with neat diesel. A single-cylinder direct injection ignition compression engine was used to prepare and test three separate fuels at a rated speed of 1500 rpm. Parameters such as torque, net power, specific fuel consummation and thermal efficiency were evaluated for the engine output. Results from the experiment show that use of algae oil blend in diesel engine has performed better for the studied parameters.

Keywords: Algae oil, Blending, Injection, Net Power, SFC

Introduction

Concerns regarding traditional fossil fuel use, environmental degradation, and increasingly strict pollution regulations have led to research into alternative renewable, clean, and sustainable fuels.[1] Biofuels usage is a very interesting alternative option, that it decreases complete dependency on petroleum-based fuels and can be used near production sites. Biofuel doesn't just have major environmental benefits, but it also has important benefits in that of performance and exhaust emissions.[2] Biofuels, in most cases with high oxygen content helps to increase the performance from diesel engines. They are considered very suitable in the form of mixtures for diesel engine. Compared to biodiesel fuels from crops and livestock fats, algae are produced with the advantages of high fuel material, a short growth cycle and adequate growth space, not competing with food sources and having less environmental effects.[3] Algae culture had been given more focus for characterisation, photobioreactor designs, and preparation for transesterification fuel biodiesel. But previous studies on efficiency and the characteristics of combustion fuelled with algae biodiesel are few. Al-lwayzy and Yusaf (2013) tested the biodiesel / diesel 20% (vol.) microalgae blends in diesel engine. The results indicated no substantial difference in engine output in contrast to pure diesel but CO, CO_2 and NO emissions had dropped dramatically.[4] Thus, an experimental study was designed to determine the effects of this algae-based fuel on the efficiency of dual-fuel-operated engines.

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Materials and Methods & Experimental Setup

The oil extraction, biodiesel production and experimental setup were developed by following the steps which were followed in our previous study.[5]

Results and Discussion

Torque

The effects on torque at various loads for values of all blends are shown in Fig. 1a. The torque decreases with increasing engine load, respectively. This can be attributed to partial loading from the higher engine load on the cylinder during the intake stroke; while the valves are completely open. There is insufficient time for air intake and cylinder pressure rise, which contributes to a reduction in combustion pressure. As a result, the friction on the moving portions of engines increases and the torque of the engine can be lower than expected. For diesel fuel mixtures the engine torque is reduced due to the lower diesel heating value. The production torque had been reduced in earlier studies by increasing biodiesel's share in pure diesel fuel. By improving the B20 injection in the fuel blend, the production torque increases, showing that the energy provided by the combustion is much more complete and also improved the efficiency of the combustion.[6]

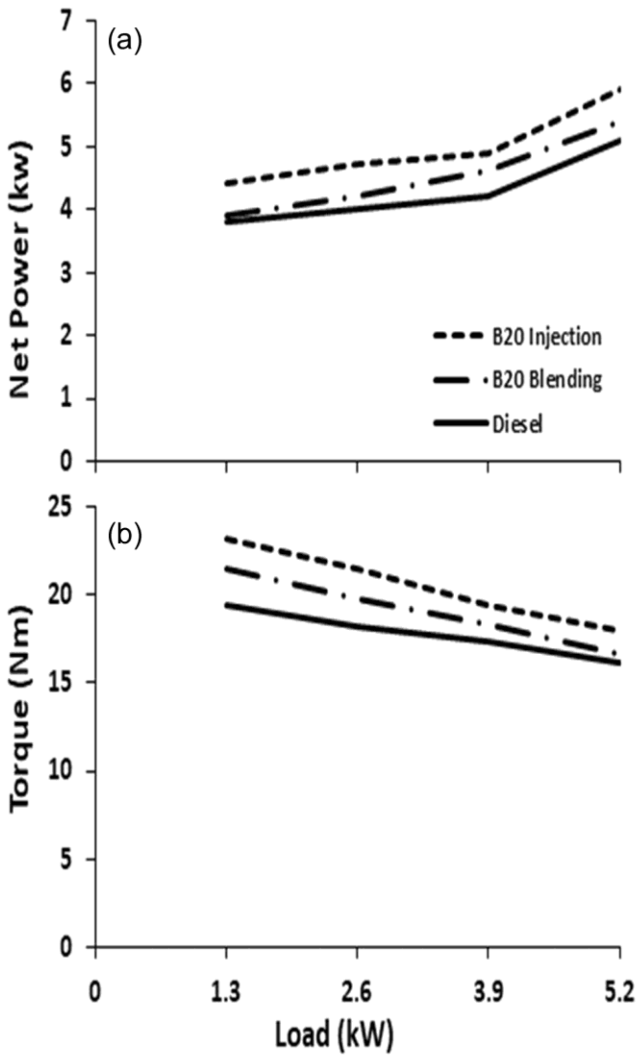

Fig. 1— (a) Variation of Net power; (b) Torque versus Load

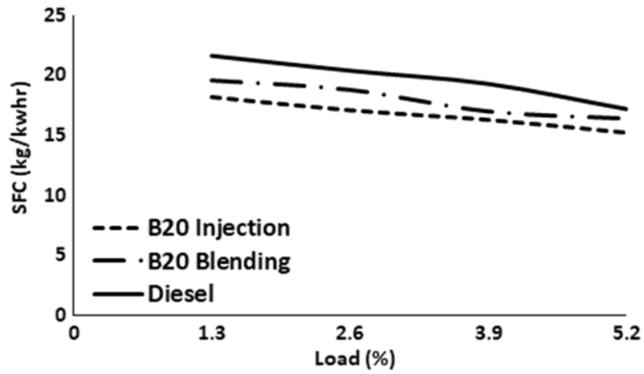

Fig. 2 — Variation of SFC versus Load

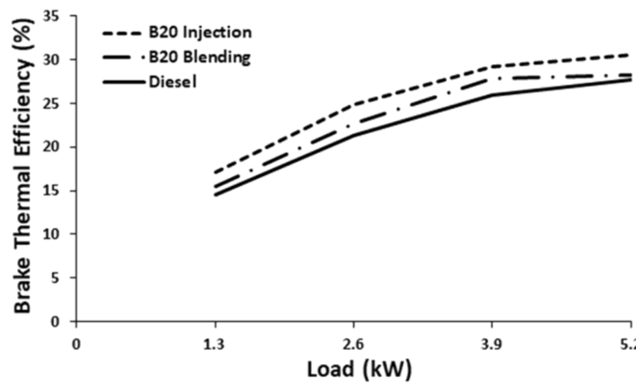

Fig. 3 — Variation of BTE versus Load

Net Power

In Fig. 1b the net power values for Diesel, B20 Blending, B20 Injection, at different charges are given. Karthikeyan and Prathima (2016) demonstrated the direct relationship between viscosity and volatility using nanoparticles.[6] They also found that the BTE had risen along with the nanoparticles concentration. In general, the combustion of fuel is incomplete at high engine speed, and the fuel content cannot be measured. For evaluating engine capacity, its pattern for all fuel blends is close to that of torque. Injection's of B20 fuel blend has the highest power while diesel has the lowest power. Overall, the brake power increases by increasing the injection share in the fuel blends, reflecting the increased combustion and the fuel's efficient energy conversion into useful work.[7]

Specific Fuel Consumption

The SFC results for Diesel, B20 Blending and B20 Injection values at various prices are Illustrated in Fig. 2. The blend of the B20 injection fuel has the lowest SFC while diesel gave the maximum SFC. This is because of the lower diesel heating expense. In this scenario, the same power generation requires more volumes of fuel. Increasing the proportion of diesel increases the density of fuel and consequently reduces the fuel blend heating value.[8] In addition to increasing the power and combustion, injection of fuel to engine also decreases the SFC. Other researchers obtained good results. Karthikeyan *et al*., 2016, investigated the impact of various dosages of ZnO nano catalyst additives on diesel engine output and SFC.[9]

Brake Thermal Efficiency

The BTE variation regarding load is shown in Fig. 3. Lowest value of BTE applies to a mix of diesel fuel. For the blend of B20 Injection fuel the full value of BTE is obtained. B20 blend injection greatly improves engine thermal brake efficiency. The BTE of the injection mixed fuels is found to be higher than that of the diesel, due to the high heat release rate at all the load conditions. As the fuel mixed with nano additives is ignited, the amount of heat release has been increased, resulting in higher BTE compared to diesel fuel.[10]

Conclusions

The empirical research for the CI engine, focused on the use of different mixing fuels injected into the cylinder. Experimental finding points towards a substantial improvement in the performance of torque, net power and brake thermal efficiency. B20 blend injection acts as an oxygen booster that increases the properties of combustion and therefore some significant improvement in performance occurs.

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