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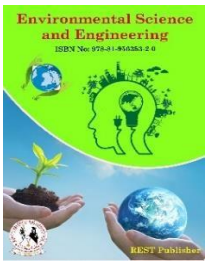

A Comparative Study of Injection Pressure Effects on Performance and Emission Traits of Algae Biodiesel-Powered Four Stroke CI Engine

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Abstract: *The demand for conventional fuels is on the rise, and as a result, conventional fuel reserves are depleting. Furthermore, the extraction and use of fossil fuels is occurring on an unsustainable scale, so these fuels will become scarce in the not-too-distant future. Diesel-powered vehicles emit a wide range of pollutants into the air, including carbon monoxide, nitrogen oxides, carbon dioxide, smog-forming particulate matter, and more. We owe it to future generations to keep the planet habitable. That means cutting back on pollution from cars. However, the introduction of bio-fuels as an alternative fuel in the field of IC engines is helping to alleviate this issue. Clean renewable fuels like algal biodiesel are the best alternative to the conventional fuels used in today's internal combustion engines, hence they are seen as a promising option. Algal biodiesel's primary benefits lie in the improved quality of exhaust gas emissions and its renewability. Algae can have a high percentage of lipids or carbohydrates that can be easily turned into a wide variety of biofuels such as biodiesel or bioethanol, depending on the species and growth circumstances. The primary goal of this research is to replace conventional fuels in a single-cylinder, four-stroke, water-cooled, light-duty, injection-compression-ignition (CI) engine with algal oil, which is injected directly into the combustion chamber and also blended with non-renewable fuels at 20% by volume. Both regular diesel and B20 algal oil were put through their paces in a diesel engine at a constant speed of 1500 rpm while the weights were changed. At mix pressures between 180 and 190 bars, performance is extremely comparable to that of pure diesel. At 180 bars, the emissions of UHC, CO, and CO2 are significantly lower than those of pure diesel. When compared to 100% diesel, NOx emissions are lower at 200 bars. At both 180 and 190 bars, overall performance is satisfactory. However, boosting injection pressure reduces emissions.*
Keywords: *Algae oil, BTE- Brake thermal efficiency, CI engine, Engine emissions and performance, Fuel injection pressures, Noxemissions and UHC-Unburnthydrocarbons*.

1. INTRODUCTION

An engine is defined as a device that can transform thermal energy into mechanical work. In this case, work represents high-quality energy and heat represents low-quality energy. There are two main categories of IC engines, the external and internal combustion engines. Internal combustion engines are more efficient than their external combustion engine counterparts. Emissions from IC engines are also lower in volume than those from EC engines. Alternative fuels are a great idea for the transportation sector as a whole because of the many positive social and economic effects they will have, in addition to helping the environment. Since the turn of the century, numerous researchers have suggested that bio-fuels can successfully replace fossil fuels. We propose algae oil as a new type of fuel in this study. Shree Kumarasamy Poly Chemicals Ltd in panruti supplied the algae oil used in the current experimentation. It's in Tamil Nadu, specifically the Cuddalore district. Oil extracted from algae is a low-cost, readily available alternative fuel source. These include unburned hydrocarbons (UHC), nitrous oxides (NOx), carbon monoxide (CO), sulfur compounds, lead compounds, and particulates. There are a total of 7,000,000 people in the globe. We currently have 1 billion autos, or roughly one car for every seven people on the planet. There will be 4% annual growth in the number of people alive today. While the United States uses half of the world's petroleum-based energy, the number of vehicles on the road is growing by 24%. 4% of the global population lives there. While our population is 121 crore, only 1.5% of our income goes toward consumption. While just using 1.5%

of the world's petroleum, the Indian population claims that the country's air quality is terrible. Presently, 15% of the Indian population owns a car. In contrast, every single person in the United States owns a car. The average Indian family makes $1,000 per year. In India, 40% of the population lives on less than $1 a day, while 10% of the population is wealthier than the entire United States of America. Diesel engines are 30–35% more efficient than their gasoline counterparts, while gasoline engines are just 11% efficient. The vast majority of vehicles in India are powered by two-stroke motorcycle engines. Because they produce so much pollution, these cars are illegal in many nations. One of the writers ran experiments on an internal combustion engine (I.C) using Cashew nut shell oil blended with Diesel in proportions of 20:1, 40:1, 60:1, 80:1, and 100:1. Among the other options, he discovered that the B20 blend of cashew nut shell bio diesel yielded the best results in terms of emissions and performance. In order to improve performance, modern diesel engines use fuel injectors that are built to withstand significantly higher injection pressures. Reduced emissions and improved engine efficiency are the primary goals of this layout. The smaller the fuel droplets, the higher the injection pressure may be. When injection pressures are lowered, fuel droplet sizes grow, resulting in a longer delay before ignite. Because of this, the injection pressure must be raised even higher. If the combustion process in the engine deteriorates, the engine's performance will suffer. Smaller fuel particles were produced as injection pressure was raised. Complete combustion in the cylinder at the time of ignition improves the quality of the air-fuel mixture formed. The time it takes for the engine to start is decreased when the injection pressure is high. A better combustion efficiency is the result of a more uniform mixture.

2.ENGINE ANDFUELPROPERTIES

TABLE 1. Properties of Diesel and Algae Oil

Properties	Diesel	Algaeoil	B20
Density(Kg/M^3)	850	990	875
KinematicViscosity@45^{0}C	2.82	18.3	4.7
CalorificValue (KJ/Kg)	42570	40455	42100
FirePoint (^{0}C)	87	208	98
FlashPoint(^{0}C)	81	200	88
CetaneNumber	46	58	53
LowerHeatingValue	42.3	39.9	42.9

TABLE 2. Engine Specifications

Make	KIRLOSKAR
Type	Single Cylinder, Four Stroke, Water Cooled
Capacity	5HP
BoreDiameter	80mm
StrokeLength	110mm
Speed	1500rpm

The tests were conducted on a water-cooled, single-cylinder, direct-injection diesel engine with a naturally aspirated combustion chamber. Table 2 displays engine data, whereas table 1 details fuel characteristicsintable1.

3. VARIATION OF INJECTION PRESSURES

The fuel injection system needs to take into account the engine's load and speed in order to inject the correct amount of fuel at the correct time. The specific combustion space will dictate the optimal fuel particle shape and size. The fuel injection pressure in the current experimental research ranged from 180 to 200 bars. For high-velocity diesel engines, the standard injection pressure is 180 bars. By turning the screw on top of the injector, the user can adjust the pressure of the injection. A fuel injector pressure tester is used to determine the injection pressure in a vehicle's fuel injector system.

4. ENGINEPROCEDURE

The 4-stroke diesel engine was used in the experiments. Diesel engines use four strokes (intake, compression, power, and exhaust) to complete a cycle. The inlet and exhaust valves are the only two valves of a four-stroke diesel engine. At the beginning of the suction stroke, the inlet valve is used to draw fuel charge or pure air into the

chamber, and at the end of the combustion stroke, the exhaust valve is used to release exhaust gases from the engine cylinder. Piston is travelling from TDC to BDC at the beginning of the cycle. As the piston moves from top dead center (TDC) to bottom dead center (BDC) during the suction stroke, the inlet valve opens and fuel is sucked into the combustion chamber, where it is compressed during the compression stroke between the cylinder head and the piston. During the power stroke, which follows the end of the compression phase, fuel is sprayed into the cylinder. The exhaust gases are released at the end of the power stroke. Exhaust stroke is the time when the exhaust gases are released into the atmosphere. The 4-stroke diesel engine cycle is similar.

5. EXPERIMENTALPROCEDURE

A. Allowthewatertoflowtotheengineandcalorimeterandadjusttheflowrateto6lpm&3lpm.
B. Release the loading yon the dynamometer.
C. Open the three-way cocksothatfuelcan flowintotheengine.
D. Starttheengine by ranking.
E. Allow to Atta in the study state.
F. Load the engine by switching on the loading switches.
G. Note the following readings for particular condition.
H. Engine speed
I. Timetakenfor5ccoffuel consumption
J. Rotameter reading
K. Manometer readings, in cm of water
L. Temperature sat different locations
M. Readings of Voltmeter and Ammeter
N. Not pollution values from the pollutionsetupi.e., multigasanalyzersystem
O. Repeat the same procedure for different loads at various fuel injection pressures i.e., 180,190 and 200 bars respectively and note down the above readings.
P. A fret the completion, release the load and the switch of the engine.

6. RESULTS

Hydro car bon Emissions: Because the right amount of spray is produced at the beginning of injection at higher injection pressures, HC emissions decrease as injection pressure rises. Using B20 Algae oil, which has a high viscosity, will boost efficiency. Most likely, this is the result of advancements in fuel spray, which allow for shorter delay times. Better combustion and thermal efficiency are additional benefits of the enhanced spray. At 180 bars, the emissions of unburned HC are substantial, while at 200 bars, they are significantly lower. The burning of biodiesel at 200bar thanks to proper diffusion results in minimal emissions. Emissions are greater at pressures of 180 and 200 bars because there is so little time for fuel to diffuse. Due to the high oxygen content of biodiesel, the UHCs drop as the percentage of biodiesel in the blend rises, resulting in complete combustible mixture in the cylinder.

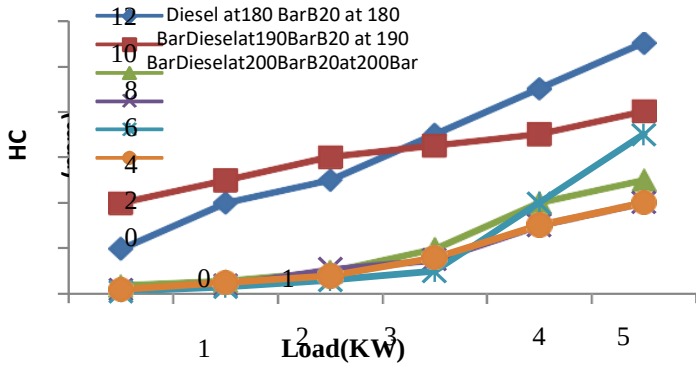

FIGURE1. Comparison of HC Emissions

Effect on Exhaust Gas Temperature (EGT): Figure 2 depicts the tested variations in diesel and B20 algae oil exhaust gas temperature as a function of applied load. It shows that the temperatures of the exhaust gases produced by burning algae oil are lower than those produced by burning plain diesel. As a result, raising the injection pressure from 180 to 200 bars causes a small increase in the exhaust gas temperature for both fuels. The fuel atomization increases during the combustion process, leading to more thorough combustion. Up to an injection pressure of 200 bars, complete combustion was achieved; beyond that point, however, the rate of combustion began to drop. Injection pressures above 200 bars reduce scavenging effectiveness and cause knocking in the combustion chamber. As a result of gasoline pre-ignition, the compression stroke will occur early. Finally, it is seen that at 200 bars of injection pressure, the exhaust gas temperatures are higher for both fuels.

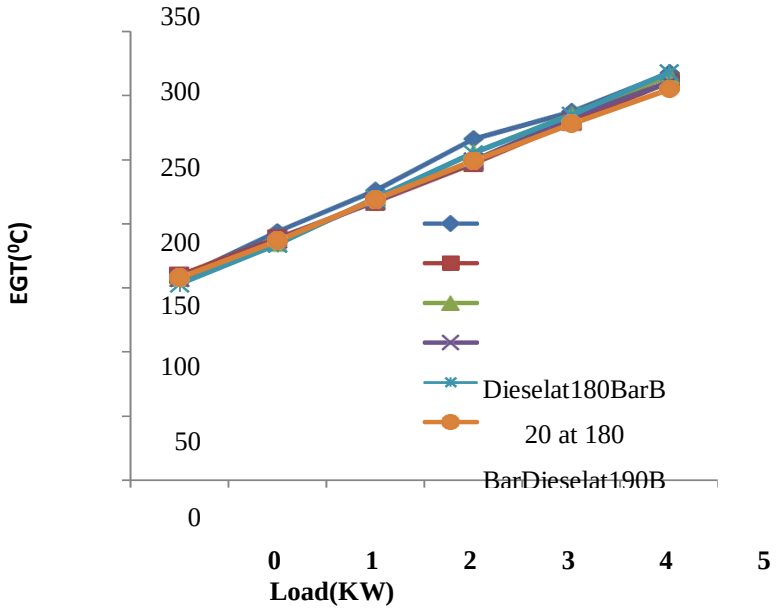

FIGURE 2. Comparison Exhaust Gas Temperature

Carbon Monoxide(CO)Emissions: The atomization and mixing process of B20 Algae oil are enhanced at full load as a result of the higher injection pressure. High injection pressures are needed to improve atomization and better mix the air and fuel, which results in reduced CO emissions, however algae oil is much more viscous than diesel. Increasing loads result in lower CO emissions across all pressures. When comparing B20 algae oil to 100% diesel, the former produces lower CO emissions. Burning algae oil more efficiently results in less carbon monoxide gas being released. At 180 bars, B20 Blend's CO emissions are significantly lower than those of diesel (which are greater at all pressures).

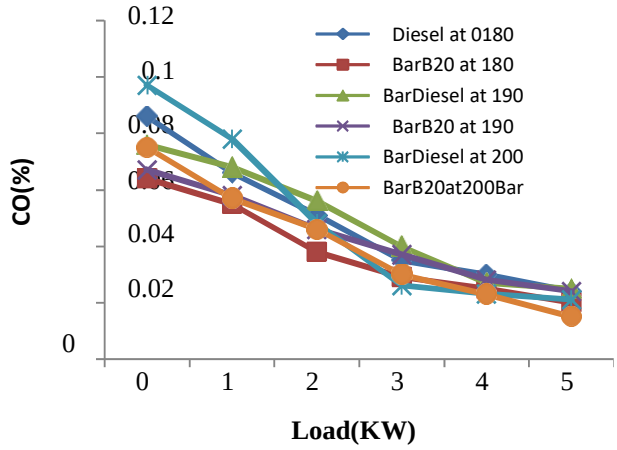

FIGURE 3. Comparison of COE missions

Effecton Indicated Mean Effective Pressure(IMEP): The relationship between load and the Indicated Mean Effective Pressure is depicted in Fig. 4. What we're really measuring is the mean effective pressure. Indicated mean effective pressure dropped from 180 to 190 bar and then increased slightly to 200 bar, as seen in the figure. As the frictional power reduces, the IMEP also drops. Diesel has somewhat greater injection pressures across the board compared to B20.

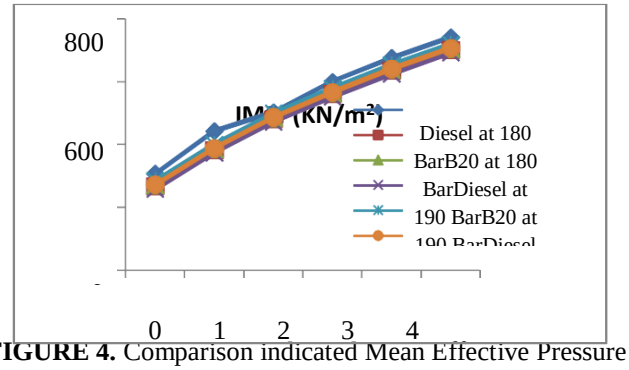

FIGURE 4. Comparison indicated Mean Effective Pressure

Effect on Mechanical Efficiency: Figure 5 demonstrates an improvement in mechanical efficiency from 180 to 190 bar, followed by a minor reduction to 200 bar as indicated power is reduced. This is because a higher mechanical efficiency is achieved by using a lower indicated power. B20 has somewhat greater injection pressures across the board compared to Diesel. B20 at 190 bar yields a mechanical efficiency of 62.79 percent, the highest possible.

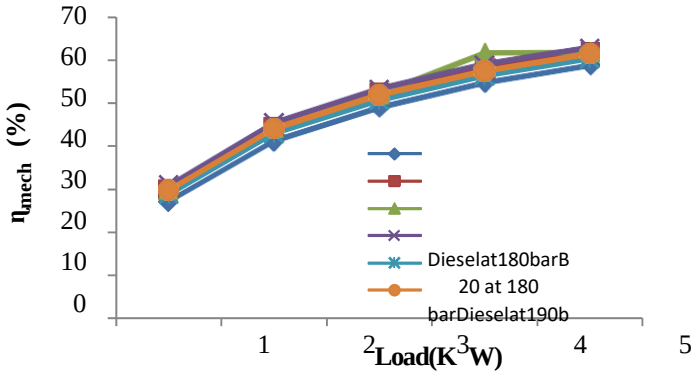

FIGURE 5. Comparison of ME

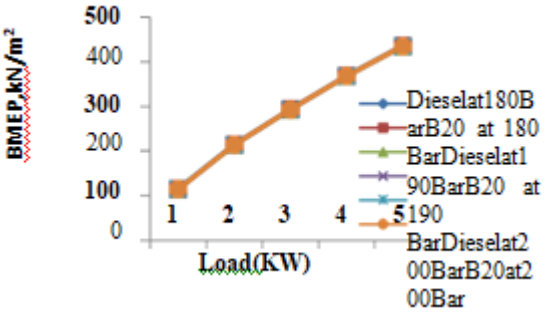

FIGURE 6. Comparison of BMEP

*Effect on Brake Mean Effective Pressure(BMEP):*As can be seen in the picture, the decrease in brake power from 180 to 190 bar and the subsequent increase to 200 bar resulted in a modest decrease in brake mean effective pressure. Diesel has somewhat greater injection pressures across the board compared to B-20. However, the BMEP variation is negligible.

7. CONCLUSION

The engine may operate on either diesel fuel alone or a combination of algae oil and diesel fuel. The fuel injection pressures used in the studies ranged from 180 bar to 190 bar to 200 bar. At maximum power, the engine's performance and emissions were studied. The subsequent findings emerged. Diesel fuel mode and a diesel/Algae oil blend allowed the engine to function at fuel injection pressures of 180, 190, and 200 bars. The HC emission ofB20 is lessatallload compared to diesel. TheCOemissionsarelowforB20at200barsthan diesel. Lowered haunt temperature swerve observe dathigherinjecti on pressures. B20havehighermechanical efficiency than dieselatallinjecti on pressures. Based on the experimental investigation it can be concluded that B20 of Algae oil can be adopted as an alternative fuel for Clinginess.

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