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Experimental Analysis of a Ci Engine Fueled with Waste Agricultural Biodiesel at Higher Compression Ratio

Nituraj Padmakar Hargude*
Research Scholar, Department of Mechanical Engineering, ICOER Wagholi, Pune, India

***Abstract*: Using a waste agricultural biodiesel, the performance, combustion, and emissions characteristics of a compression ignition engine were computed and examined in this study. The tests were carried out in steady state for a four-stroke single-cylinder diesel engine that was loaded at 1500 rpm. Using a BD20 biodiesel blend, the current experiment investigates the impacts of compression ratio. Biodiesel properties such as density, kinematic viscosity, cetane number, calorific value, flash point, and fire point were investigated and the results assessed in the lab. The engine was kept at varied compression ratios during actual experimental testing of a CI engine using biofuel blend, namely 18, 19, and 20. The engine load is changed between zero and full load. Taguchi method is used to design the experiment. Higher compression ratios result in higher cylinder temperatures, which increase vaporization and performance to a degree. However, because of the high operating temperature, carbon monoxide and unburned hydrocarbon emissions increase with CR, while carbon monoxide and unburned hydrocarbon emissions decrease. So, the main objective is to check the optimum compression ratio and to obtain minimum specific fuel consumption, better efficiency and lesser emission with higher compression ratio. The analysis shows optimum performance with lower emission at a CR of 20 and load 100%.**

***Keywords*: CI Engine, Biodiesel Blend, Higher Compression Ratio, Effects on Performance and Emissions.**

1. Introduction

The globe is currently experiencing a major fuel depletion and environmental degradation problem. This reduces the consumption of fuels in industries, limiting the potential for expansion. As an alternative to fossil fuels, the hunt for alternative fuels for diesel engines has accelerated in recent decades. It is demonstrated that by mixing biodiesel in diesel fuel, the dangerous gas emission can be minimized due to high percentage of oxygen contents in biodiesel. The goal of this study is to look at using a biodiesel mix (BD20) to minimize pollution emissions from diesel engines while also improving engine performance. The majority of the research was done up to compression ratio 18. This effort entails extending the CR to a maximum of 20.

2. Literature Survey

Goutam Pohit and Dipten Misra conducted research on a variable compression diesel engine to determine the performance and emission characteristics of a CI engine utilising Karanja oil methyl ester combined with diesel. Taguchi technique in combination with grey relational analysis was used to solve a multiple response optimization problem in order to discover the best process with the fewest number of experiments. A specific combination of input parameters was anticipated using grey relational grade and signal-to-noise ratio as a performance metric in order to attain the best response characteristics. The 50 percent blend was found to be the most suited for usage in a diesel engine without reducing engine performance or emissions appreciably.

Mohankumar Subramaniam investigated the use of algae as a biodiesel in CI engines. For both algae blends and diesel, he concluded that as applied load increases, SFC drops. However, as compared to diesel, algae mixes have a similar SFC under greater load circumstances. At no load and part load situations, there is a maximum of roughly 7% variance in SFC. Rinu Thomas looked at the impact of a higher compression ratio on CI engine performance. He came to the conclusion that careful application of the variable compression ratio (VCR) idea at various loading circumstances is a viable option for improved engine performance and emission characteristics.

According to Puneet Verma, key results were reached that B20, B40, and B60 had higher BTE than diesel, with 3.74 percent, 10.46 percent, and 3.27 percent at full load, respectively. As a result of the BTE comparison, the B40 blend was judged to be more appropriate. At full load, smoke opacity was found to be 50.44 percent lower when diesel was completely replaced with cotton seed biodiesel.

3. Results

1) Brake Thermal Efficiency

*Corresponding author: niturajhargude10@gmail.com

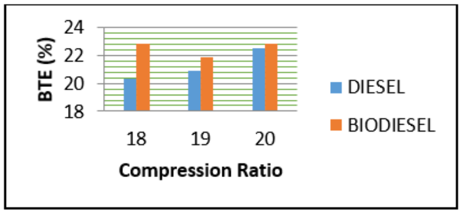

Fig. 1. Compression ratio

2) Cylinder Pressure

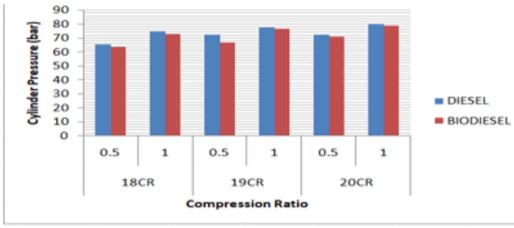

Fig. 2. Cylinder Pressure

3) Emission Characteristics

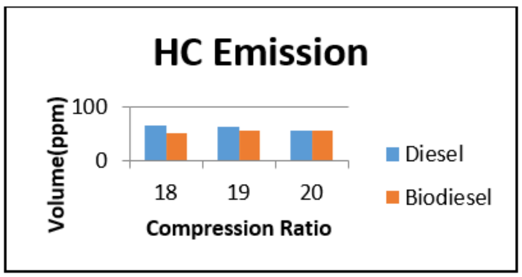

Fig. 3. HC Emission

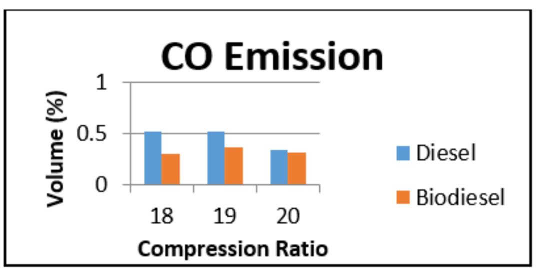

Fig. 4. CO Emission

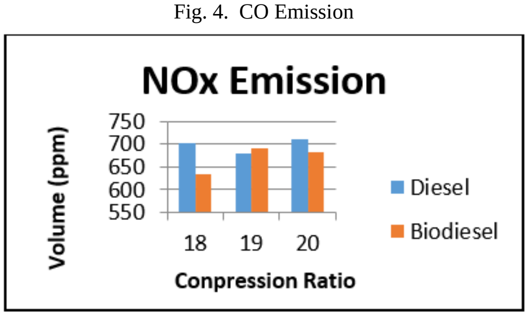

Fig. 5. NOx Emission

4. Conclusion

- As the compression ratio and load increase, the CI engine's brake thermal efficiency improves. At CR 20 and 100% load, BTE is found to be the highest.
- As the compression ratio of a CI engine is increased, the specific fuel consumption drops. At CR 20 and 100% load, the minimum SFC is reached.
- As the compression ratio of a CI engine is increased, the specific fuel consumption drops. At CR 20 and 100% load, the minimum SFC is reached.
- Hydrocarbon emissions increase with load and are observed to decrease as we progress from CR 18 to CR 20. At CR 20 and 0% load, the lowest HC emission is attained.
- Carbon monoxide emissions follow the same pattern as HC emissions, with the lowest levels occurring at high compression ratios, such as CR 20.
- The temperature of combustion in the cylinder has a big impact on nitrogen oxide emissions. As a result, NOx emissions follow the inverse trend, increasing as the compression ratio and engine load increase. NOx emissions are lowest at CR 18 and 0% load.

The study's main goal was to see how increased compression ratios affected engine performance. Experiments demonstrate that compression ratio 20 produces the best outcomes, with the exception of NOx emissions. As a result, for maximum efficiency, we can use waste agricultural biofuel in CI engines with greater compression ratios up to 20.

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