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Topic of Research: SOME STUDIES ON PERFORMANCE, COMBUSTION AND EMISSION CHARACTERISTICS OF CI ENGINE USING BIODIESEL-BLENDED FUELS

Findings

As the world's energy demand has risen significantly in the last few decades, concern about energy security, unstable energy prices, environmental pollution, and human health has grown. The insufficient reserves, limited supplies, and increasing demand for energy are concerns that could have severe consequences for the world, especially for India, and must be addressed. The rapid progress in energy demands, the decade-old environmental impact, climate change, and air contamination have encouraged research on clean and sustainable energy sources that are technically feasible, readily available, and globally acceptable. One way to address this issue is to use alternative fuels as a permanent solution to overcome this challenge, which can run existing diesel engines without modification. Biodiesel is a well-known renewable and sustainable substitute for Compression Ignition (CI) engines compared to commercial diesel.

Biodiesel is a non-toxic, biodegradable fuel from vegetable oils, animal fats, or algae. Producing biodiesel involves transesterification with a lower alcohol in the presence of a catalyst. The production and commercialization of biodiesel face challenges due to the high cost of oils. To overcome this problem, Waste Cooking Oil (WCO) emerges as a promising feedstock and feasible solution for biodiesel production. The total cost of biodiesel production is associated with approximately 70–80% of feedstock cost, so if WCO is used as feedstock, biodiesel production could be reduced to 60–70%. The increasing production of WCO, with an increasing population, presents a significant environmental challenge and contributes to problems in sewage and wastewater systems. Utilizing WCO as a feedstock for biodiesel production can

address challenges such as water pollution and clogging of drainage systems, which require additional cleaning. Therefore, the current research focused on converting waste cooking oil to biodiesel and blending with nanoparticles to enhance performance and combustion characteristics and reduce emissions.

This study was conducted in four phases:

The studies contain a comprehensive literature review of the existing work related to biodiesel as an alternative fuel. After a thorough literature review of the various types of feedstock and nanoparticles available, the gaps for this research were identified, and based on these gaps, the expected objectives of this study were formulated. After that selecting feedstock and the biodiesel production approach. The optimized parameters for the transesterification were conducted at 62.5 °C with a 0.9% KOH concentration for 80 minutes, resulting in a high production yield of 95.5% using a molar ratio of 6:1. WCO biodiesel and diesel blends and selecting nanoparticles that address the shortcomings associated with biodiesel. Graphene oxide (GO) is utilized to achieve desired fuel properties, enhance the performance characteristics of diesel engines, and achieve effective emission control, all without requiring any engine modifications. A biodiesel blend named B20 was prepared by combining 20% WCO biodiesel by volume with 80% diesel fuel. After that, the B20 and GO mixture was prepared using an ultrasonic device operated at a frequency of 40 kHz. The ratio was adopted as the standard for preparing fuel blends with 20, 40, and 60 parts per million (ppm) concentrations, denoted as B20GO20, B20GO40, and B20GO60, respectively.

The last phase of the study tested the physiochemical properties of all fuel blends and obtained values within the range of ASTM standards. Further, the work focused on the experimental investigation of all prepared fuel blends (B20, B20GO20, B20GO40, and B20GO60) and used diesel as a reference fuel. The experiment was carried out on Kirloskar, TV1, using a computerised variable compression ratio (VCR), four-stroke, single-cylinder, and water-cooled engine. The tests were conducted with a constant speed of 1500 rpm at 20%, 40%, 60%,80%, and 100% load conditions for diesel, and each blend was tested. The peak cylinder pressure was increased by 3.88%, 12.52%, and 19.40%, and the heat release rate (HRR) was enhanced by 5.96%, 12.76%, 17.82%, for B20GO20, B20GO40, and B20GO60 fuels, respectively, compared to B20. This is due to adding GO nanoparticles into fuel blends, which enhanced combustion rates and reduced ignition delay. Compared to the B20 blend, brake thermal efficiency

(BTE) at 80% of engine load increased by 4.41%, 11.20%, and 8.45%, while brake-specific fuel consumption (BSFC) was reduced by 6.39%, 10.67%, and 13.87% for B20GO20, B20GO40, and B20GO60, respectively, at peak load.

The CO emissions were reduced by 9.52%, 26.28%, 28.58%, and 29.65%, and UHC emissions were decreased by 7.25%, 39.48%, 33.16%, and 27.32%, respectively, for B20, B20GO20, B20GO40, and B20GO60, with reference fuel diesel at maximum loading conditions. The NOx emissions demonstrated increments of (17.82%, 18.43%, and 19.32%) for the B20GO20, B20GO40, and B20GO60 fuel compositions, respectively, compared to B20 fuel. The results showed that adding GO nanoparticles improved the fuel properties, enhancing the performance and combustion characteristics and reducing the emissions parameters.