JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Experimental Investigation of Performance Characteristics of soyabean Biodiesel in Single Cylinder Compression Ignition Engine

Amit Kumar Bhagat[1] Abhishek Saxena[2] Dr. Shrihar Pandey[3]

[1, 2] M.Tech. Research Scholar, Department of Mechanical Engineering, Eklavya University Damoh, (Madhya Pradesh)

[3] Associate Professor and Head, Department of Mechanical Engineering, Eklavya University Damoh (Madhya Pradesh)

Abstract:

The depletion of fossil fuels and increasing environmental concerns have led to a growing interest in alternative and sustainable energy sources for internal combustion engines (ICEs). Biodiesel, a renewable and environmentally friendly fuel, has gained significant attention due to its potential to replace or supplement conventional diesel fuel. This research paper aims to explore the utilization of Soyabean biodiesel as a viable alternative fuel in single-cylinder compression ignition internal combustion engines. The study focuses on evaluating the performance characteristics of Soyabean biodiesel and its blends in comparison to conventional diesel fuel. Performance test were also carried out when fuelled with petroleum diesel and diesel-biodiesel blends. The engine experimental result shows that the performance of the engine is 16.93% higher in terms of brake thermal efficiency. The BSFC decrease with increase in load and it is found that for B20, B50 and B100. BSFC of B100 is 18.28% higher than D100.

Keywords: Soya bean Biodiesel, Biodiesel blend, Conventional diesel, Diesel engine, fuel properties, engine performance characteristics.

1. Introduction:

The escalating demand for energy coupled with the adverse environmental effects of fossil fuel combustion has driven researchers to investigate alternative fuels. Biodiesel, derived from renewable feedstocks such as vegetable oils, animal fats, and microalgae, presents a promising solution. Soyabean oil, extracted from the Soyabean seeds, offers the potential to serve as a sustainable feedstock for biodiesel production due to its edible nature and ability to grow in marginal lands. Diesel fuel, in particular, which is made from soybean oil, can be replaced by the renewable and environmentally friendly biodiesel produced from soybeans. A type of biofuel known as biodiesel is generally produced from renewable resources including vegetable oils, animal fats, and used cooking oils. Due to the abundance of soybean crops and the relatively high oil content of soybeans, soybean biodiesel is one of the most produced and consumed types of biodiesels.

2. Literature Review:

Previous research on biodiesel utilization in internal combustion engines has shown varying effects on engine performance and emissions. Several studies have explored the combustion characteristics, emission profiles, and thermal efficiencies of biodiesel and its blends in diesel engines. However, limited research has focused specifically on the utilization of Soyabean biodiesel in single-cylinder compression ignition engines.

Rehman, A et al., (2008) carried out experimental work on Karanja oil as fuel for compression ignition engine and performance was tested. The fuel performance analysed for esters of karanja oils, blends of karanja oil and the diesel oil as baseline at varying load performed at governor-controlled speed. The injection pressure is changed in this experiment. The experimental result shows that diesel engine gives poor performance at low injection pressure when esterified karanja oil and its blends with diesel. The specific energy consumption is higher for pure karanja methyl ester as well as for its diesel blends. Smoke emission increases with increase in engine load due to overall richer combustion longer duration of diffusion combustion phase and reduced oxygen concentration. Advancing injection timing increases combustion temperatures and allow more time for oxidation of soot in the expansion stroke thereby reducing smoke emission.

Yogesh PALANI et al., (2022) Many researchers delve for an alternative fuel to overcome the fossil fuel crisis. Developed countries have embarked focus on renewable energy like wind energy, geothermal, biofuel, ocean energy and solar energy. Biodiesel is considered to be one of the most felicitous one kinds of renewable energy with similar properties of diesel fuel. Biodiesel is gaining prominence due to the global fossil fuel crisis and emission control challenges. Biodiesel blends are formulated in numerous proportions with diesel to run the diesel engine and it has significantly reduced the harmful pollutants from contaminating the environment. This review paper summarizes the outcome of biodiesel blends on properties, performance and emission-quality of a diesel engine under different operating conditions.

3. Experimental Setup:

In this study, a single-cylinder compression ignition internal combustion engine was employed for experimental investigations. The engine was modified to accommodate different fuel injection strategies and equipped with sensors to measure key performance parameters such as brake thermal efficiency, specific fuel consumption.

Figure 1: Experimental Setup

4. Methodology:

A series of experiments were conducted using varying blends of Jatropha biodiesel and conventional diesel fuel, ranging from B10 (10% biodiesel, 90% diesel) to B100 (100% biodiesel). The engine was operated at different load conditions and constant speed. Performance parameters were recorded and analysed to assess the impact of biodiesel on engine efficiency.

5. Results and Discussion:

The results of the experiments revealed important insights into the performance and emission characteristics of soyabean biodiesel. As the biodiesel blend ratio increased, there were observable changes in brake thermal efficiency, specific fuel consumption. The performance characteristics of soyabean biodiesel were compared to those of conventional diesel fuel.

5.1 Performance Characteristics

The performance characteristics of test engine on standard diesel and biodiesel-diesel blends are discussed below.

5.1.1 Brake Specific Fuel Consumption

It is observed that for all the fuels, the BSFC decreases with increase in load. This is due to higher percentage increase in brake power with load as compared to increase in the fuel consumption. For B100 the BSFC is slightly higher than diesel fuel, while B50, and B20 the BSFC is similar to the Standard diesel. As brake specific fuel consumption is exactly inverse of brake thermal efficiency, it follows opposite trend of efficiency variation. This is due to lower calorific value with increase in biodiesel percentage in the blends.

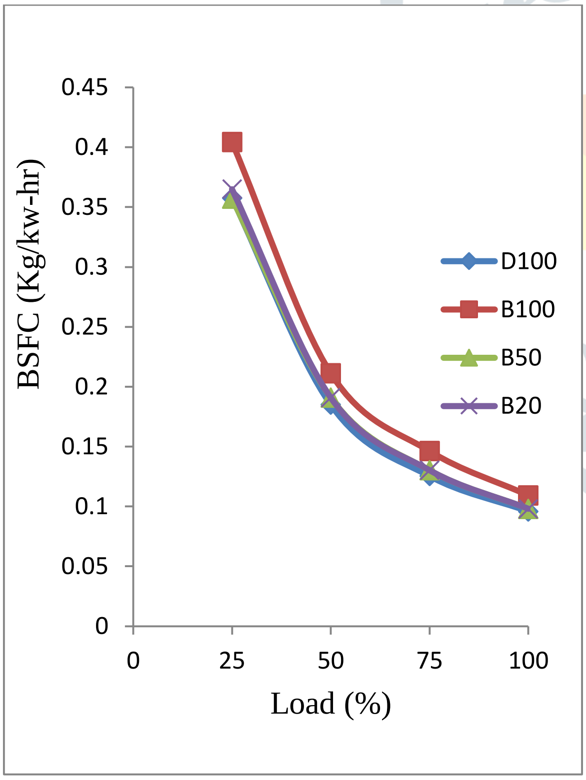

Figure 2: BSFC Vs Load

5.1.2 Brake Thermal Efficiency

Brake thermal has the tendency to increase with increase in applied load reaching a maximum somewhere at 75% load and then decreases. The reason for increase in brake thermal efficiency up to a maximum is the reduction in heat loss and increase in power developed with increase in load. This rise is limited by production of undesirable quantity of smoke. The peak brake thermal efficiency in case of D100, B100, B50 and B20 are 30.77%, 25.56% 29.21% and 29.54% respectively. It can be seen that brake thermal efficiency with biodiesel blend was little lower than standard diesel fuel.

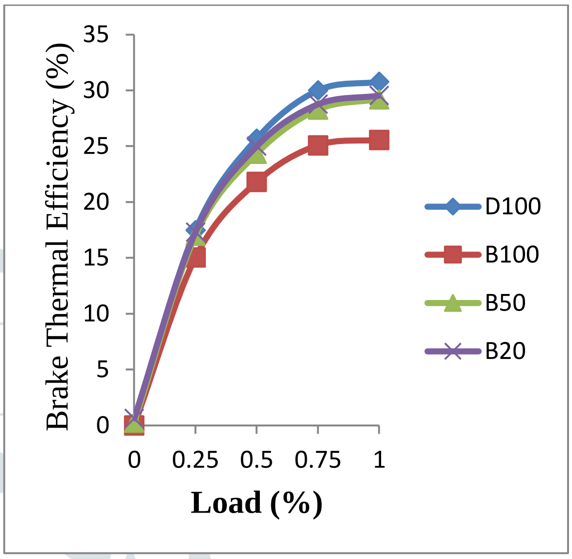

Figure 3: Brake Thermal Efficiency Vs Load

5.1.3 Exhaust Gas Temperature

It shows the variation of exhaust gas temperature with Load for diesel and biodiesel- diesel blends. The results show that the exhaust gas temperature increases with the increase in load for all the test fuels. The amount of fuel injected increases with the engine load in order to maintain the power output and hence the heat release and the exhaust gas temperature rise with increase in load. Exhaust gas temperature is an indicative of the quality of combustion in the combustion chamber. At all loads, diesel was found to have the lowest temperature and the temperature for the different blends showed the upward trend with increasing concentration of biodiesel in the blends.

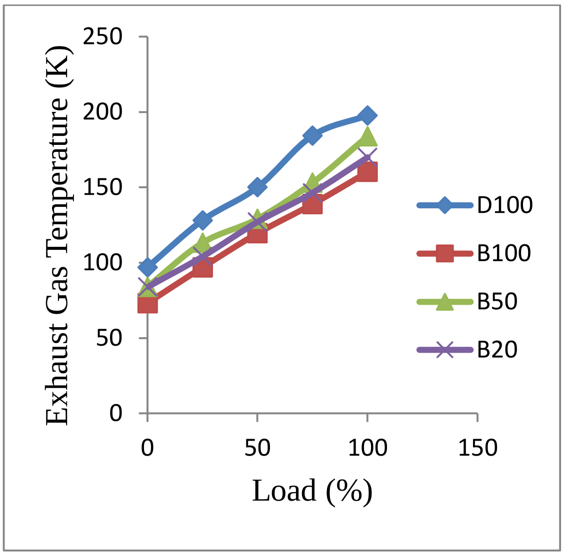

Figure 4: Exhaust Gas Temperature Vs Load

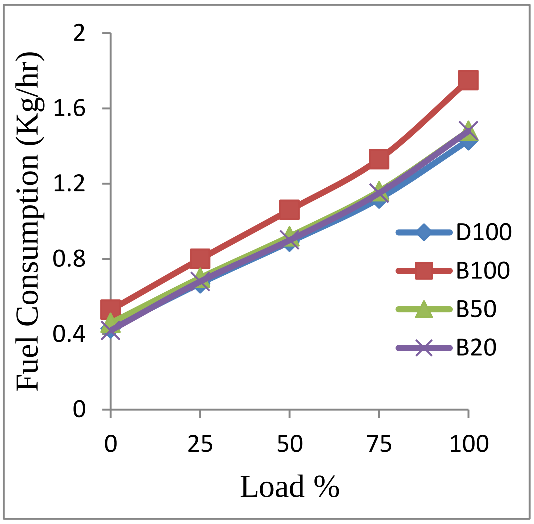

Figure 5: Fuel Consumption Vs Load

5.1.4 Fuel Consumption

Fuel consumption is increasing at load increases. B100 is more fuel consumption in comparison to the B50, B20 and D100.There are slightly more fuel consumption of B50 and B20 in comparison to the diesel fuel. At 100% load B100 is18.28%, higher fuel consumption than standard diesel while B50 and B20 is 3.37% and 3.37 % respectively higher fuel consumption than D100. The fuel flow is consistently higher with the soyabean biodiesel (B100) than the B50, B20 and standard diesel at high load. At low load, the fuel flow is low for the B20 as a result of the high viscosity of the fuel at low temperature. The diesel uses much less fuel across all loads. The B20 fuel flow does not increase like the other fuels at high load, therefore the engine is running lean which explains the drop in horse power.

6. Conclusions:

The research paper presents a comprehensive analysis of the performance characteristics of Soyabean biodiesel in a single-cylinder compression ignition internal combustion engine. The study contributes to the understanding of the potential benefits and challenges associated with using Soyabean biodiesel as an alternative fuel source. The results indicate that Soyabean biodiesel has the potential to be a viable substitute for conventional diesel fuel, with implications for reducing greenhouse gas emissions and enhancing energy sustainability.

The performance characteristics of a 5.2 kW DI compression ignition engine fuelled with soyabean biodiesel and its blends have been analysed and are compared to that of pure diesel fuel. The result of present work is summarized as follows.

- Brake specific fuel consumption decreases with increase in load, bsfc of B20 and B50 is closer than that of pure diesel. The bsfc for pure soyabean biodiesel, B50, B20 and pure diesel are 340, 290, 290 and 280 g/kWh respectively at full load.

- Brake thermal efficiency increased as load increases. Maximum BTE of pure diesel, pure soyabean biodiesel, B50, and B20 is 30.77%, 27.20%, 29.89%, and 30.45% respectively. BTE of pure soyabean biodiesel, B50 and B20 is 11.60%, 2.86%, 1.03% less compared to pure diesel.

- Exhaust gas temperature increased as load increases. Exhaust gas temperature of pure diesel, pure soyabean biodiesel, B50 and B20 are 160.21K, 197.68K, 183.83K and 169.80K respectively at full load. EGT of pure diesel is 18.96% lower than pure soyabean biodiesel at full load.

7. Future Recommendations:

Based on the findings of this study, further research is recommended to explore optimization strategies for engine parameters and fuel injection techniques to maximize the benefits of Soyabean biodiesel. Long-term durability and compatibility assessments are also essential to understand the long-term effects of using biodiesel in internal combustion engines.

8. Acknowledgments:

The authors would like to acknowledge Eklavya University Damoh, Madhya Pradesh for providing the necessary resources and facilities to conduct this research.

9. References:

1. Fangyuan ZHENG, Haeng Muk CHO* and Changchun XU (2022) Effect of biodiesel blended fuel on the performance and emission characteristics of diesel engines – a review, *vol.27, No.1, pp.215-231.*
2. Junxing Hou, Zhenghe Wang, Shuanghui Xi, Shuhao Li, and Xiaokui Xu (2022) comparative analysis of combustion behaviors and emission characteristics of diesel engines fueled with biodiesel or biodiesel Blends Vol.7, pp. 33461−33469.
3. Yogesh P., Chandramohan D., Dhanashekar M., Sathish T., (2022) Performance and emission characteristics of biodiesel-blend in diesel engine: a review 27(1): 200338 pISSN 1226-1025.
4. SAMUELRAJ Daniel, Jaichandar Sriramulu, Harish Venu, (2022), Regulated and unregulated emission analysis in a lhr engine powered by diesel/soyabean biodiesel blends DOI: https://doi.org/10.21203/rs.3.rs-1487684/v1.
5. Fayaz Hussain, Manzoore Elahi M. Soudagar, Asif Afzal, M.A. Mujtaba, (2020), Enhancement in combustion, performance, and emission characteristics of a diesel engine fueled with ce-zno nanoparticle additive added to soybean biodiesel blends vol.13, pp. 4578.
6. Akash K. Ingole, Achuat S. Deo, Ajay K. Ledade, Kunal R. Dhote and Amol D. Pitale (2016), Study of performance and emission characteristics of biodiesel blends of soybean and karanja oil on twin-cylinder diesel engine test rig. E-ISSN 2277 – 4106, P-ISSN 2347 – 5161.
7. Akbar Emil, Yaakob Zahira, Kartom Siti, Ismail Kamarudin Manal, and Salimon Jumat, 2009, "Characteristic and Composition of Jatropha Curcas Oil Seed from Malaysia and its Potential as Biodiesel Feedstock," European Journal of Scientific Research, vol. 29, pp:396-403.
8. Ali Yusuf, Hanna Milford A. and Leviticus Louis I., 1995, "Emission and Power Characteristics of Diesel Engines on Methyl Soyate and Diesel Fuel Blends," Bioresources Technology, vol. 11, pp: 185-195.
9. Banapurmath, N.R., Tewari, P.G., and Hosmath, R.S., 2008, "Performance and Emission Characteristics of a DI Compression Ignition Engine Operated on Honge, Jatropha and Sesame Oil Methyl Ester," Renewable Energy, vol. 33, pp. 1982-1988.
10. Benjamin Bol, M., Dr Bhattacharya, T. K., and Dr Mishra, T. N., 2004, "Studies on Fuel Properties of Refined Soybean Oil, Soybean Ethyl Ester and their Blends with Diesel to Assess Usefulness as CI Engine Fuel", vol. 85,
11. Berglund, D.R., McKay, K., and Knodel, J., 2007, "Canola Production," North Dakota State University, A-686.
12. Biodiesel Magazine, 2008, "Biodiesel Industry Directory, BBI International, Grand Forks," New Delhi.
13. BP Statistical Review of World Energy-2008, accessed on May, 2010.
14. Pramanik, K., 2003, "Properties and Use of Jatropha Curcas Oil and Diesel Fuel Blends in Compression Ignition Engine," Renewable Energy, vol. 28, pp: 239-248.
15. Rehman, A., Pandey, R.K., Dixit, S. and Sarviya, R.M., 2009, "Performance and

Emission Evaluation of Diesel Engine Fueled with Vegetable Oil," International Journal of Environment, pp: 463-470.

16. Senthil Kumar, M., Ramesh, A., Nagalingam, B., 2003, "An Experimental Comparison of Methods to Use Methanol and Jatropha Oil in a Compression Ignition Engine," Biomass and Bioenergy, vol. 25, pp: 309-318.

- **Corresponding Author:** shriharpandey@gmail.com