Experimental Investigation on Effect of LHR in Diesel Engine Fuelled with Waste Cooking Oil Biodiesel

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Diesel-powered engines are best suitable for light and heavy-duty vehicles. Because of the high thermal efficiency, it is widely used in the transportation sector. The rapid increase in global fossil fuel demand has raised fuel prices and causes a huge demand for petroleum fuels. And the stringent Emission norms increased the need for a highly efficient engine. In this work, a low heat rejection diesel engine coated with thermal barrier coating is used to test the biodiesel obtained from waste cooking oil. The Thermal barrier coating is given for 30\,\mu m, 40\,\mu m, and 60\,\mu m with yttrium stabilized zirconia. It is observed that the thermal barrier coating with 30\,\mu m shows better results. The brake thermal efficiency of the engine with LHR and biodiesel observed an increase in its efficiency. And emission concentrations were increasing with respect to waste cooking oil biodiesel when compared with diesel. The experiment was performed in the laboratory with a single-cylinder water-cooled diesel engine. The emission concentrations are measured with a portable emission analyzer.

**Keywords:** Low heat rejection; Diesel engine; emissions; biodiesel.
1. Introduction

Biodiesel is an alternate fuel just like a standard or fossil diesel. From pure vegetable oil, animal oil and waste cooking oil biodiesel can be produced. The process wants to convert these oils to biodiesel is termed transesterification. Fuel obtained from edible fat suitable for a diesel engine as a fuel. Notwithstanding, vegetable oil is intrinsically horrendous and can't be scorched productively at surrounding temperatures in present-day over-the-street vehicles.

The protection of energy is diminishing these days and it is affirmed that it prompts energy interest [1]. Over the most recent twenty years, elective energizes have been acquired and recognized as basic [2,3]. Potential biodiesel substitutes fuel, comprising of ethyl ester of unsaturated fats created by the Transesterification response of fatty oils of vegetable oils and ethanol with the assistance of a catalyst. A great deal of examination work brought up that biodiesel has gotten critical consideration and it is a potential elective fuel. Biodiesel and its mixes with diesel were utilized as a fuel for an inside IC engine without any changes inside the existing engine. Biodiesel is an inexhaustible, biodegradable, and non-poisonous fuel for diesel motors. It is gotten from oils and fats by transesterification with alcohol. The primary obstacle to the abuse of biodiesel is that the cost of crude materials. Utilization of palatable oils as biodiesel feedstock cost with respect to 60-70% of stuff cost. Mixes of biodiesel and ordinary hydrocarbon-based diesel are items most usually conveyed for use in the retail diesel fuel commercial center. A large part of the world uses a framework known as the "B" factor to express the measure of biodiesel in any fuel mix[4,5].

- B100 is referred to as 100% biodiesel
- B50 is referred to as 50% biodiesel, 50% diesel
- B20 is referred to as 20% biodiesel, 80% biodiesel

Biodiesel has promising greasing up properties and cetane appraisals contrasted with low sulfur diesel powers. Higher lubricity fuels may build the usable lifetime of air mass mechanical framework instrumentality that relies upon the fuel for its oil. In this work biodiesel got from squander cooking oil is utilized as a fuel for fuelling in the diesel motor. Squander cooking oil got from inns and cafés is utilized to change over into biodiesel by transesterification process[6,7].

2. Materials and methods

The burning in SI engine turns over at one point and creates fire at the purpose of start spreads through the combination for the consuming of the blend, though in CI motor, the ignition happens at various focuses at the same time and the quantity of flares produced is likewise many. To consume the fluid fuel is more troublesome for what it's worth to be dissipated; it is to be raised to start temperature and afterward consume. To further enhance the combustion LHR coating is given to the engine by Yttrium Stabilized Zirconia (YSZ) [7-10]. Fig1 shows the YSZ coated diesel engine piston and cylinder head.
3. Experimental methods

The experiment is conducted in a naturally aspirated diesel engine which is a single cylinder. The engine is connected with eddy current dynamometer. Kirloskar Oil Engines Limited, India is the manufacture of the single-cylinder diesel engine. It is a single-cylinder, 4-Stroke, 1500 RPM constant speed diesel engine of 3.5KW power.

| Specifications          | Description   |
|-------------------------|---------------|
| Kirloskar               | Make          |
| 4 stroke, single cylinder, CI engine | Type          |
| 0.661 litr              | Cubic Capacity (litr) |
| 1500                    | Rated Speed (rpm) |
| Bore (mm) | Stroke (mm) | Power Rating (Hp) | Compression Ratio | Cooling | Type of Fuel Injection | Loading |
|----------|-------------|------------------|-------------------|---------|------------------------|---------|
| 87.5     | 110         | 5 hp (3.5 kw)    | 17.5:1            | Water cooled | Direct                 | Eddy current dynamometer |

**Fig 3:** Kirloskar engine with eddy-current dynamometer.

**Fig 4:** AVL Gas Analyzer.

HC is the unburned fuel that stays because of improper combustion. At the point when ignition doesn't happen or when just a portion of air/fuel combination consumes HC increases. Carbon monoxide is analyzed by a gas analyzer in percent (%). CO is a result of ignition; in this manner, if burning doesn't happen, CO won't be made. Nitrogen oxides are estimated by an emission analyzer in parts per million (ppm). NOx is a side-effect of ignition. NOx is framed in huge amounts when temperatures surpass around 2500 F. anything which makes ignition rise will likewise make NOx emanations rise.

At a consistent engine speed, experimental testing will be conducted. After stable working conditions are tentatively accomplished, the engine was exposed to comparative
stacking conditions. Beginning from 0 25%, 75% and 100% load dynamometer will be loading the engine [11]. Before beginning the experiment all the connections are checked. The emission analyzer probe is connected at the tailpipe end. Calibration of all digital equipment is carried out. During the engine test, the performance characteristics and emission characteristics are analyzed.

4. Results and discussions

In this work biodiesel obtained from waste cooking oil is used for fuel in the diesel engine. Three different blends are tested and compared with diesel fuel. The three different blends are the following

- 100% biodiesel is referred to as B100
- 50% biodiesel, 50% diesel is labeled B50
- 20% biodiesel, 80% diesel is referred B20

![Fig 5. Brake thermal efficiency with respect to brake power.](image)

![Fig 6. Hydrocarbon with respect to brake power.](image)

The brake thermal efficiency of the engine is an important parameter to find the efficiency of the engine. Fig 5 shows the brake thermal efficiency with respect to brake power for four different fuels. It is observed that for diesel fuel the thermal efficiency is high in the LHR engine[12]. For B20 blend the thermal efficiency higher compared with B50 and B100 blends. It is due to the efficient burning of B20 blend in the combustion. Fig 6 shows the hydrocarbon emissions with respect to brake power. It is observed that in LHR engine HC emission is increases for diesel fuel it is due to incomplete combustion of the diesel fuel[13]. whereas for pure biodiesel B100 the HC emission is less it is due to the complete combustion of the biodiesel.
Fig 7 shows the Carbon monoxide emissions with respect to brake power. It is observed that in LHR engine CO emission is increases for diesel fuel it is due to deficiency of oxygen during combustion for the diesel fuel. Whereas for pure biodiesel B100 the CO emission is less it is due to the complete combustion of the biodiesel. Fig 8 shows the Oxides of nitrogen emissions with respect to brake power[14]. It is observed that in LHR engine NOx emission is increases for diesel fuel it is due to high combustion temperature during combustion for the diesel fuel. Whereas for pure biodiesel B100 the CO emission is less it is due to the complete combustion of the biodiesel [15].

5. Conclusion

In this work, the experimental testing is conducted for three different biodiesel blends in the LHR coated diesel engine. The three different fuel blends are 100% biodiesel is referred to as B100, 50% biodiesel, 50% diesel is labeled B50, 20% biodiesel, 80% diesel is referred B20. The experiment was conducted in a diesel engine setup. It is observed from the results that the brake thermal efficiency of the engine high for diesel fuel and for B20 blends brake thermal efficiency is more or less equal to diesel. HC and CO emission increases with the biodiesel blends it is due to poor combustion of fuels. But for B20 blend the HC and CO emission is reduced due to betterment in combustion. NOx emission is higher for diesel for high combustion temperature. For B20 blend the NOx emission is reduced. So overall, the B20 blends have a good reduction in emission characteristics and the thermal efficiency of B20 blends is also closer to diesel.

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