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# Performance and Emission Parameters of Compression-Ignition (Ci) Engine Fuelled with Waste or used Temple Oil Biodiesel at Blends

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## Abstract

The biodiesel as a renewable fuel has been recognized as one of the best alternative fuel for diesel engine in the present world. Ignition pressure is the major influencing parameter for the performance and emission of diesel engine. Biodiesel from Waste or Used Temple Oil is mainly obtained cheaply from transesterification process as compared to biodiesel produced from various resources. Due to many mythological and religious beliefs thousands of devotees pour oil over the idols in many temples in India, such as Hanuman and Shani temples. Most of the poured oil of the temples wasted. In this study the investigation of performance and combustion characteristics of biodiesel of Used Temple Oil is focused with different blends of biodiesel like B100, B40, B30 and B20 in Compression ignition engine, operating at injection opening pressure (IOP) of 200bar.

**Keywords:** Biodiesel; Used temple oil; Ultimately wasted; Blend, Performance; Injection

## Introduction

Industrialization and population explore and also extensive use of petroleum fuels led to scarcity of petroleum fuels. This increased the importance of biodiesel fuel. Biodiesel is recommended as a renewable, sustainable efficient and cost effective fuel. It has become one of the promising alternative fuels. Due to the potentiality of a sustainable energy mix in the future and it can be produced by non edible oil feedstock [1]. There are two types of biodiesel they are edible and non edible oils. Sunflower, corn, rapeseed, palm, soybean and waste vegetable oils are edible oils. Oils from Jatropa, Jojoba, Karanja, Polanga are non edible oils. These are oxygenated, biodegradable, non-toxic and environmentally safe. Therefore

bio fuels are getting much importance and many scientific efforts to be produced in economical, available, safe and environment friendly nature [2]. Due to the easiest availability on large scale from agricultural, biodiesel from edible vegetable oils has been produced in all over the world more than 95% [3]. Currently in Canada biodiesel is produced from rapeseed, in US from soybean, in Europe from sunflower and in Southeast Asia from palm. Biodiesel from waste cooking oil is the best substitute to petroleum diesel which can solve the petroleum of environmental pollution and scarcity of energy and this would be produced with low cost, than any other edible and non edible oils [4].

Emissions of CO, smoke density and NO<sub>x</sub> reduced on average 80%, 50% and 26% respectively when karanja methyl ester with diesel [5]. The BSFC was increases with the increase of blending ratio in the blended fuel of waste cooking oil methyl ester. As compared with standard diesel and B5, B20 blend in Compression ignition engine found to be reduction in the CO. For fuel economy B20 blends were found to be good [6]. The result of experiment proved that combustion of B5 and B20 of biodiesel of waste cooking oil was same with diesel in the in the cylinder combustion pressure. Due to its properties B100 shows a large difference with diesel [7]. By using NOME (Neem Oil methyl ester) blend B20, B30 and diesel are 28.32%, 27.69% and 26.74% respectively at full load condition of brake thermal efficiency of IC engine. As compared to B30 and diesel the efficiency of B20 blend was higher. As compared to diesel exhaust emission such as CO (carbon monoxide), HC (Hydro carbon) are decreased with NOME blends. NO<sub>x</sub> emission for B30 and B20 are higher as compared to diesel. B20 blend gives better performance emission and combustion characteristics as compared to B30 and diesel [8].

It was found that BTE of waste cooking methyl ester (WCME) and its blends is slightly lower as compared with diesel. The BTE of WCME is 26% but of diesel fuel is 30%. Emission of Unburned hydrocarbon decrease when WCME blend increases [9]. For soybean methyl ester (SME) blends BSFCs were higher

than for diesel fuel and B20 SME gives the same performance compared to diesel fuel [10]. Many Indians as per their ritual and religious belief pour oils on the idols and for lamp in temples. This oil is wasted and cannot be reused. This waste temple oil from Shani Shingnapur was used to produce biodiesel. By chemical and biological method waste temple oil can be converting into biodiesel through transesterification process. Characteristics of biodiesel were studied, the yield obtained was 96%. To study the quality of biodiesel, clarity tests were conducted. Comparing with diesel fuels, it is renewable alternative fuel with low toxicity [11].

There are innumerable temples in India, counting them is puzzle. As per the tender advertisement by Department of Muzrai, Government of Karnataka, the used temple oil potential at Shree Renuka Yallamma Temple Soudatti, District Belagavi, for the year 2016-17 is 18900 kg. This is oil potential from one temple only. In this present investigation biodiesel is prepared from Used Temple Oil from Hanuman Temple near Marikamba Temple Sirasi, Uttarkannada, Karnataka. The performance and emission characteristics are evaluated on a AV1 Vertical, single cylinder, water-cooled, 4-stroke, compression ignition diesel engine.

#### Materials and Methods

Used Temple oil (crude oil), NaOH catalyst, Isopropyl methanol and Phenolphalein indicator are the main materials. Used Temple Oil was collected from Shree Maruti Temple in front of Shri Marikamba Temple, Sirsi, Uttar Kannada district of Karnataka state, India, having latitude 14° 36' 43" N and 74° 50' 22" E. The used Temple Oil is an unknown quantity mixture of ghee, edible and non-edible vegetable oils also.

The products formed during transesterification are used temple oil methyl ester and glycerin. The bottom layer consists of glycerin, excess alcohol, catalyst impurities and traces of unreacted oil. The upper layer consists of clean amber colored temple lamp oil methyl ester. After settling, the glycerol layer is removed. Esterifies oil washed with water. The washing is carried out in a separate funnel. The separated biodiesel is used for characterization. The biodiesel yield is 94.51% after purification.

**Table 1:** Physical property of UTO and UTOME.

SI No	Properties	ASTM	Diesel [7]	UTO	UTOME
1	Density (kg/m <sup>3</sup> )	870-900	846	910	870
2	Kinematic Viscosity @ 400C	1.9-6	2.60	26.6	5.1
3	Flash point °C	>130	52	202	164
4	Calorific Value (MJ/kg)	-	42.21	38.628	39.080

The physical properties of UTO (Used Temple Oil) and UOME (Used Temple Methyl ester) and different blends are determined and were compared with fossil diesel fuel as shown in the **Tables 1 and 2**. And the Values of UTOME have

almost same properties as that of the diesel fuel and shows it can be used as an alternate fuel.

**Table 2:** Physical properties of UTOME at different blends.

SI No	Properties	B20	B30	B40	B100
1	Density (kg/m <sup>3</sup> )	825	830	840	870
2	Kinematic Viscosity @ 400C cSt	2.8	3.0	3.2	5.1
3	Flash point °C	54	58	60	164
4	Calorific Value (MJ/kg)	42.881	40.231	39.423	39.080
5	Fire point °C	57	60	65	167

## Engine Performance and Emission Studies

The variations BTE with load for different fuels at 200 bar injection opening pressure is presented in **Figure 1**. The study shows that increase in BTE with increase in load for all the cases. The maximum BTE were obtained to be 29%. The BTE obtained for B30, B40 and B100 were 28%, 26% and 25% respectively. The variations BSFC with load for different blends were presented in **Figure 2**. For all the conditions BSFC decrease with increase in load. The BSFC of UTOME B20, B30 B40 and B100 and diesel at 75% load conditions are 0.25 kg/kW hr, 0.27 kg/kW/hr, 0.28 kg/kW hr, 0.29 kg/kW hr and 0.24 kg/kW hr respectively.

The variation of CO (Carbon Monoxide) produced by running the diesel engine using UTOME blend 20 to blend 100 is compared with diesel in **Figure 3**. The emission of CO increases with load. The greater the load, the richer air-fuel mixture is burnt and hence more CO is formed owing to the oxygen deficiency. Lower CO values were observed for B20 and B30 blends as compared to diesel for all load conditions. The variation of HC (Hydrocarbon) emission is shown in **Figure 4**. It is observed that the variation of HC emission with different load conditions for blends are having same trends with diesel and the values are lower than the diesel. The HC emission values of diesel, B20 and B30 at 75% load condition are observed as 31 ppm, 28 ppm and 26 ppm respectively.

The variation of NOx emissions from UTO biodiesel with respect to diesel are displayed in **Figure 5**. The NOx emissions increased with the load for all UTOME mixture. The amount of NOx produced for B20 to B100 varied between 58 ppm to 493 ppm as compared 49 and 420 for diesel. The variation of smoke produced during the test for different fuels is presented in **Figure 6**. The average smoke opacity for B20, B30, B40 and B100 were less than diesel fuel. At 75% load the smoke opacity for diesel, B20 and B30 are 82%, 76% and 70% respectively.

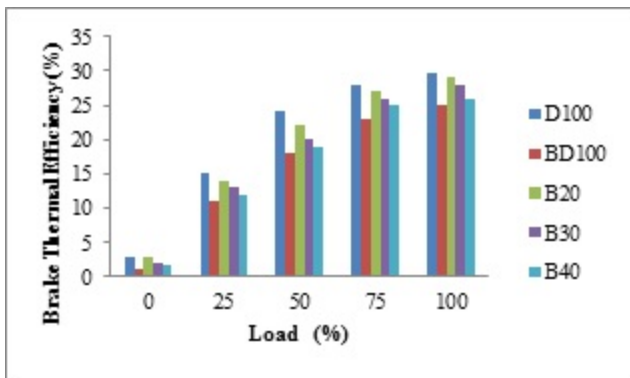


Figure 1: Variation of B.T.E vs. Load of biodiesel blends and diesel.

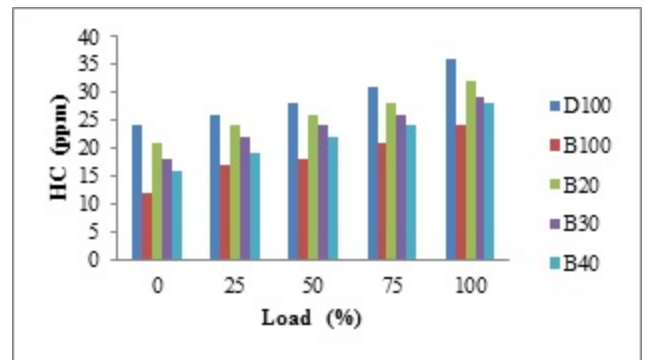


Figure 4: Variation of HC emission of biodiesel blends and diesel against load.

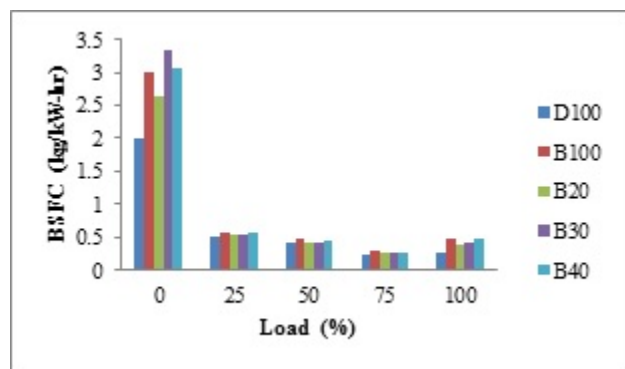


Figure 2: Variation of B S. F.C vs. Load of biodiesel blends and diesel.

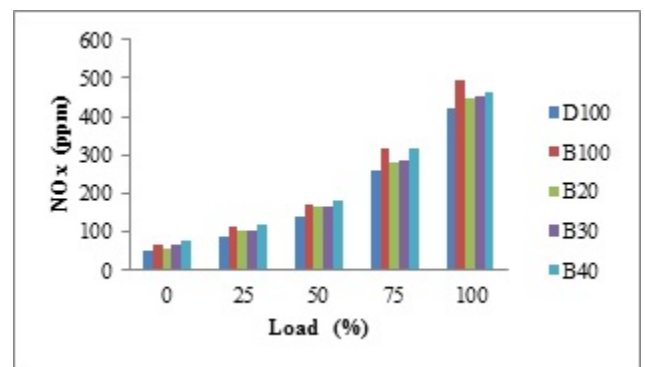


Figure 5: Variation of NOx emission with load.

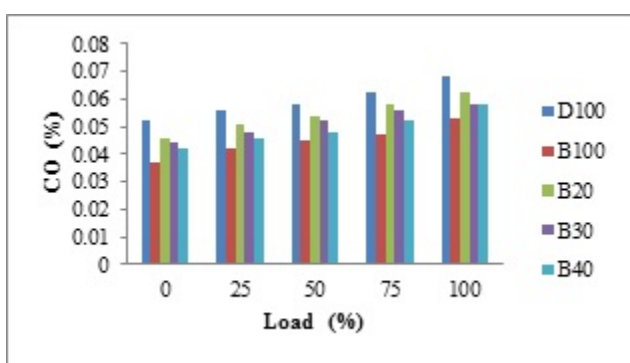


Figure 3: Variation of CO emission of biodiesel blends and diesel against load.

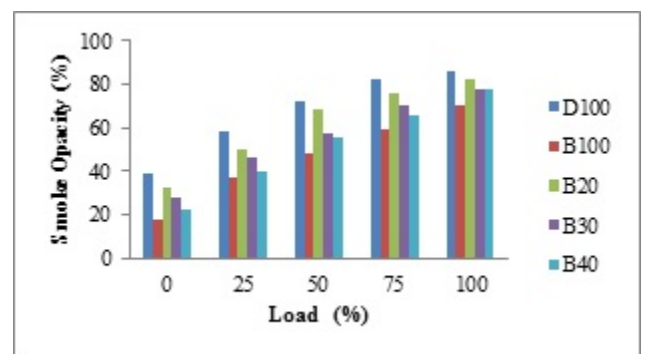


Figure 6: Variation of smoke emission of biodiesel blends and diesel against load.

## Conclusion

The main aim of the study is to evaluate the Used Temple Oil as a potential raw material for the production of biodiesel and also evaluate its possibility for the substitute to petroleum fuel. Through transesterification method, the Used Temple Oil is converted into biodiesel successfully, characteristics are also done. The physical and chemical proportions were found well with the standard limits.

The diesel engine can perform satisfactorily on UTOME blends with diesel fuel without any engine modifications. CO, HC, and NO<sub>x</sub> emissions of UTOME are decreasing than diesel. The above proportions of the UTOME are as comparable with diesel fuel hence UTOME can be effectively used as alternate fuel for diesel engine.

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