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Experimental Study The Tamarind Seed Biodiesel Blend Characteristics Combustion Emissions In A Compression Ignition Engine

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Abstract
The present experimental investigation research work are convergences on the depreciating qualitative tamarind seed oil with additive and its blends in a single cylinder, 4-stroke CI engine to evaluate the combustion, performance and emission characteristics. Five blend, namely Diesel, B20 (20% Biodiesel, 80% Diesel), B40 (40% Biodiesel, 60% Die sel), B60 (60% Biodiesel, 40% Diesel), B80 (80% Biodiesel, 20% Diesel), and B100 (100% Biodiesel), were utilized during the trials. The biodiesel synthesized using tamarind seed oil blended with the additive dimethyl carbonate is used in this work as an alternative fuel using CI engines, which is a novel technique. According to experimental foundthat, B20 as a little increased cylinder pressure than diesel whereas B40, B60, B80, and B100 have significantly higher heat rate of dissolution. In terms of performance, and emissions break BTE, BSEC, and NO_X levels marginally increased whereas CO2, CO, and HC emissions were significantly reduced. All fuel blends demonstrated lower smoke emissions for all engine load settings, with the exception of B20 fuel blend. the new oil extraction the non editablesources.

***Keywords**: tamarind seed oil, combustion, dimetheyl carbonate, performance, brakethermal efficiency*

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I. Introduction

In the present trends reduction of crude oil resources, higher the environment pollution affair contains day by day and fastens the fuel price. The search for appropriate interchange fuel in agriculture, transportation, and industry is expected to increase as fossil fuel reserves are depleted. Furthermore, harmful emissions from hydrocarbon-based fuels in diesel engines cause global temperature changes and other unnatural effects [1].the biodiesels are being given a lot of attention around the world as a potential inexhaustible fuel source for diesel engines. Recent trends in fuel prices, environmental pollution concerns, and the rapid depletion of crude oil resources have made it more important than ever to use biodiesel as a desirable renewable feedstock for diesel engines [2]. Needless to say, biodiesel is widely regarded as an environmentally friendly, cost-effective, and abundant resource. Over the years, researchers have studied various feed stocks for biodiesel production, such as corn seed oil, mahua seed oil, Jatropha curcas, Pongamia pinnata, soybean, sunflower, and others conducted extensive studies on their effect on the performance parameters in a diesel engine [3]. Significant research has been conducted over the last two decades with a variety of biodiesels in diesel engines, both on and off the road. Many literature studies on various types of biodiesels have been conducted around the world [4].

Uyumaz [5] have investigated at various concentration the impact of mustard oil methyl ester on diesel engine characteristic was researched. In this biodiesel are blends with diesel at 10%, 20%, and 30% by the volume. The indicated thermal efficiency of diesel is significantly depletion by 10% diesel-biodiesel blends operation and when 30% diesel- biodiesel blends used the NO_X emission is increased by 22.1%. In another researcher the biodiesel obtained cooking oil servers as fuel for marine diesel engine application with various at different engine load condition. Wei et al., [6]. They pointed out that the higher the concentration of biodiesel in the blends, the higher the BSFC, with little penalty in BTE.

The combustion characteristics of biodiesel-diesel fuel operations have revealed that combustion begins very early for higher biodiesel fractions in the fuel, with a significant improvement in peak heat release rate. A compared of diesel properties for various biodiesels at various concentrations. Harish et al., [7] canola, corn, hazelnut, soybean, and seed oils have been utilized as biomass resources for biodiesel esterification. They contended that the diesel engine powered by a 20% hazelnut biodiesel blend performed better than other biodiesels and blend ratios.

Rizwanul Fattah IM et al.,[8] ewer scientists reported that biodiesel ageing can be easily avoided by combining a small amount of an anti-oxidant additive with biodiesel, which reduces biodiesel degradation and oxide formation. Furthermore, doping an antioxidant additive with biodiesel results in significant NOX reduction without any additional treatment. Dhana Raju et al.,[9] the investigation of novel tamarind seed methyl ester of nana particle blend with diesel based on volume are 10%, 20%, 30% concentration and two type of nano particle using multi walled carbon nano tube, alumina oxide doping with tamarind seed methyl ester blends of 30ppm, 60ppm concentration comparing diesel fuel. In the result are BTE are improve by 1.6% more higher in alumina oxide at 30 ppm level to 60 ppm and emission are 15-51% and 24-68% in NOX and HC are reduced.

Dhana Raju et al.,[10] the study tests are run at constant speed using diesel and a TSME 20 biodiesel blend under various weights. Looks at the effect of exhaust gas recirculation on the characteristics of a diesel engine running on 20% tamarind seed methyl ester (TSME 20) as a renewable fuel. TSME 20 biofuels produced increased nitrogenous oxide (NOX) emissions under all operating circumstances. When compared to diesel and TSME 20, the test findings demonstrated that TSME 20 with such a 20% EGR rate decreases NOX emissions by 45.67% and 52.69%, the thermal efficiency of the absorbers is substantially decreased. As a consequence, using a 20% EGR rate to TSME 20 is the best approach for better NOX emission control. Yemieni Siva Shankar Rao et al., [11] experimental investigation runs by a diesel engine fuelled by jatropha with Tamarind Seed Oil Methylester (TSOME) mixed biodiesel. The biodiesel (B10) contains 5% of jatropha, 5% tamarind seed oil, and the remaining 90% of diesel by volume. Here, noted higher Brake Thermal Efficiency (BTE) for biofuel than neat diesel by the effect enhanced combustion rate. Further, change the standard compression ratio (CR) of 17.5 to 19.5 and 21. However, higher BTE reported at CR21, followed by lower CR conditions. CO emissions showed lower for the compression ratio 21 than the other CR conditions and higher for the diesel. But, it emits higher CO2and HC emissions for the CR 21 and lower for the diesel.

Mahalingam etal., [12] maha oil biodiesel was blends with pentanol at various ratios such as 10% and 20% by volume, and its performance and emission were measure at 10% and 20% EGR rates. They saw good performance and low emission as the blends was increase from 10% to 20%. The use of EGR is demonstrated to provide an additional benefit, decreasing NOX and smoke emission by 5.1 and 7.8 at a 20% concentration.

This article novelty is development of new oil that is tamarind seed oil with additive Dimetheyl Carbonate (TSDC) and the additive is constants proportion used in different load condition, maximum speed are 1500 Rpm. Reduce the emission and improve the performance in CI engine.

The Present Study The Motivation

The tamarind seed is the types of non editable seed which is producing the tamarind fruit from tamarind tree. These trees are available in different place in India. The tamarind seed contain oil 35-40% of 350-450 grams per one kg of tamarind fruit. This type of oil extraction no one literature and not using in CI engine, not founding the emission and performance levels. The biodiesel production for these seed by using pyrolysis process. To finding the psychochemical properties of this biodiesel with help of some mechanical device. Zivkovicet al., [12] studied how biodiesel affects the environment. According to their analysis, biodiesel might be considered a feasible and alluring alternative fuel in diesel engines for environmental sustainability because of its low toxicity and biodegradability, among other factors. They came to the conclusion that the environmental benefits of biodiesel may be increased with proper control of production elements such the technology used, the type of natural resources used, and operational procedures[13].

The proposed work seeks to build a systematic technique using different fuel IPs of tamarind seed dimetheyl carbonate-diesel blend, and it will be the first of its kind in the literature. Furthermore, the usage of EGR at the five levels is primarily intended to reduce nitrogen oxide emissions[14]. In this regard, the current work investigates the performance, combustion, and emission characteristics of a tamarind seed Dimetheyl carbonate blend under operation.

Biodiesel Preparation And Availability

Tamarind tree, or Tamarindus indica, is primarily an African plant. Since many years ago, it has also been grown in India and other subcontinents. Due to the tamarind's central role in Indian sub continental cooking, its uses are virtually limitless[15]. The tamarind seeds used in the current investigation to produce biodiesel were collected from readily available trees in the area. The states of Andhra Pradesh, Tamil Nadu, Madhya Pradesh, , west Bengal, and Karnataka have the most accessibility to it. A by-product of the tamarind fruit's processing is tamarind seed. It might have a 35–40% oil yield. Coarse seeds with ruby to purple shades are found. Per kg of fruit, there is a total of 250 and 450 g of seeds produced. About 30% of the weight of tamarind is made up of seeds. It has more unsaturated fatty acids than some other foods.

The transesterification process for biodiesel production is shown in Fig. 1. Unrefined tamarind seed oil has a higher viscosity, a lesser percentage of unstable, and a higher density as its main drawbacks. The most common approach to decreasing viscosity and enhancing the flavour of biodiesel is transesterification. Our transesterification process used 5 litres of tamarind seed oil, 0.5 litres of dimetheyl carbonate as the solvent, and 50 g of potassium hydroxide (KOH) as the catalyst. The transesterification method is meant to use sodium hydroxide as the catalyst, 700 C for the reaction, 180 minutes of response time, and consistent stirring at 500 rpm. The full picture is put away in the closed vessel for 12 hours. The mixture is then separated, and the tamarind seed methyl ester is then extracted using water. With these stages of the transesterification process, the methyl ester extraction from seeds is about 82%. As per ASME standards, the different characteristics of the biodiesel samples are evaluated experimentally and contrasted with those of diesel[16].

The tamarind seed biodiesel produced by the preceding method is mixed with diesel in a volume ratio of 20:80 to produce TSDC20. According to the literature, TSME20 is mostly regarded as the best blend since it has greater performance and low emission properties.

Table.1 lists the physicochemical parameters of diesel, and TSDC with blends of biodiesel produced from them. Furthermore, according to ASTM guidelines, the concentration of biodiesel is limited to 20%. Taking these parameters into account, more experiments were conducted on the CI engine at various blends the performance and emission characteristics.

Table:1 properties of tamarind seed oil with blends[17]

Properties	Test method ASTMD6751	Diesel	TSDC	TSDC20	TSDC40	TSDC60	TSDC80	Limits ASTM D6751
Density (kg/m^3) @15 °C	ASTM D1298	830	884	845	851	857	868	860-900
Kinematic Viscosity (Cst)	ASTM D445	3.05	5.9	3.89	4.21	4.36	4.95	1.9-6
Calorific Value (MJ/kg)	ASTM D270	42.5	38.7	42.3	43.5	43.9	44.2	35
Flash point (°C)	ASTM D93	56	159	76	79	81	89	93
Cetane index	ASTM D613	43	52.4	49	52	54	59	47

Setup for the experiment

After conducting studies on a single cylinder, four-stroke, water-cooled diesel engine of 8 kW capacities manufactured by Kirloskar and operating at rated speed of 1500 rpm, the performance and emission characteristics were observed. Table 2 contains technical details on the experimental setup. For load fluctuations, an eddy current dynamometer was linked with a diesel engine. To gather performance parameters, a computerised data acquisition system is used. Fuel consumption can be measured using a burette and a digital timer. Time is recorded for each load's 20-cc gasoline consumption. An inclined manometer can be used to monitor air flow rate. The smoke level is measured using an external device, the AVL 437C smoke metre. The AVL 444-N five gas analyzer is used to measure several emission characteristics such as CO, HC, and NOX. The AVL 435C smoke metre is used tocalculate the filter smoke number (FSN).

Table: 2 CI engine Specification[18].

Parameter	Specification
Make	Kirloskar TV1
Description	Single cylinder, 4-stroke, compression ignition engine
Type of cooling	Water cooled
Displacement	661 cm^3
Type of injection	Direct injection
Speed	1500 rpm
Rated power	5.2 kW rated
Bore	87.5 mm
Compression ratio	17.5:1
Stroke	110 mm
Inlet valve open °	before TDC at 7.5
Injection timing	24° bTDC

Exhaust valve open	before BDC 37.5°
Inlet valve closes	after BDC 38.5°
Exhaust valve closes	after TDC 8.5°

Performance

Load with Brake thermal efficiency:-It is variations for all blends of tamarind seed oil methyl ester and diesel have been represented in Fig.4. the values of brake thermal efficiency when using biodiesel blends as fuel are lower than when using diesel, as indicated in the figure. The maincause of this decline in brake thermal efficiency is due to the tamarind seed biodiesel blends' lower heating values. Higher fuel viscosity leads to poor atomization and insufficient mixing of the heated air and fuel[19]. With an increase in load, the brake thermal efficiency also increases smoothly for diesel and all biodiesel blends. When compared to the other blends, B20TME's highest brake thermal efficiency at maximum load was 31%, which is closer to diesel's (34%)

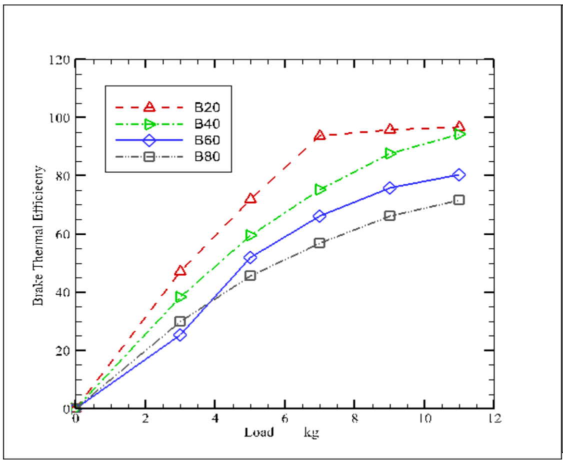


Fig: 4. variation of BTE with load

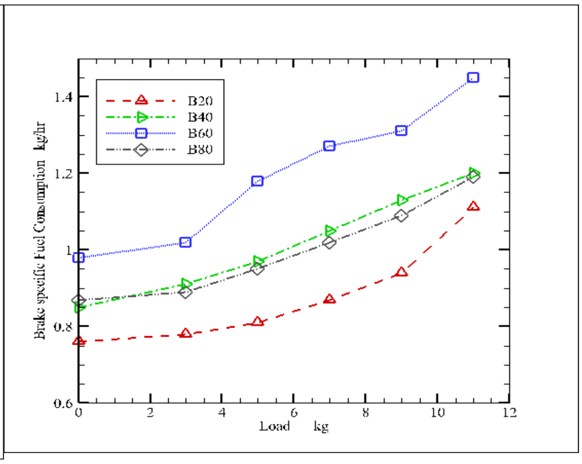


Fig: 5. variation of BSFC with load

Load with Brake Specific Fuel Consumption: - This is an important parameter to use when evaluating how different engine fuels perform. The characteristics of the tested fuels used in the engine affect performance according to Fig.5. The BSFC of each tested biodiesel fuel improves as the biodiesel concentration rises. Among all the blended fuels, the BSFC value for B20TME is nearer to that of diesel. Because more biodiesel blended fuel was injected into the engine cylinder for the same volume than diesel due to the biodiesel's higher density and lower calorific value, it was noted that the brake-specific fuel consumption numbers for all fuels decreased as the load increased.

Load with Brake Power: - In the experiment increasing the load will increase braking performance. The fluctuation of load with BP for tamarind seed oil at various combinations is shown in Fig. 6. Comparing DMC additives with diesel. At full load, the BP of B20 + 2 ppm DMC (30.26%) is comparable to that of neat diesel (29.54%). When compared to the individual biodiesel blend, the mixes of particles in the biodiesel blend encourage completecombustion.

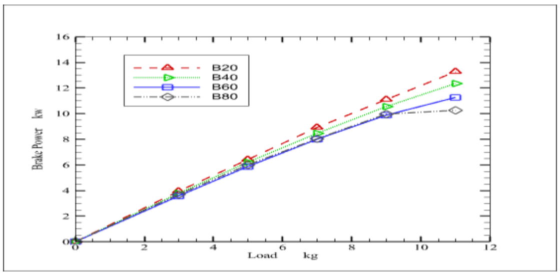
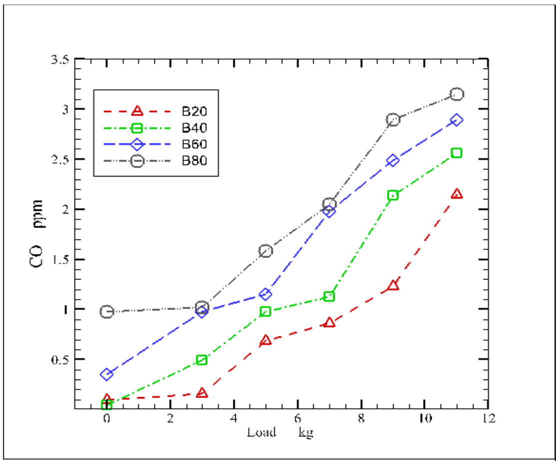


Fig: 6. variation of BP with load

The Emission Characteristic of Tamarind seed oil

Carbon monoxide with load:-The emissions produced by IC engine combustion cause environmental and/or health issues. In this session, the various emissions produced are described. The primary sources of the emissions listed below include inefficient fuel combustion, nitrogen dissociation, and contaminants in the fuel and air. As seen in Fig.7. the TME biodiesel and biodiesel blended fuels had lower CO emissions than the base diesel fuel[20]. It is found that the CO emissions decrease as the amount of methyl ester in tamarind seed increases.



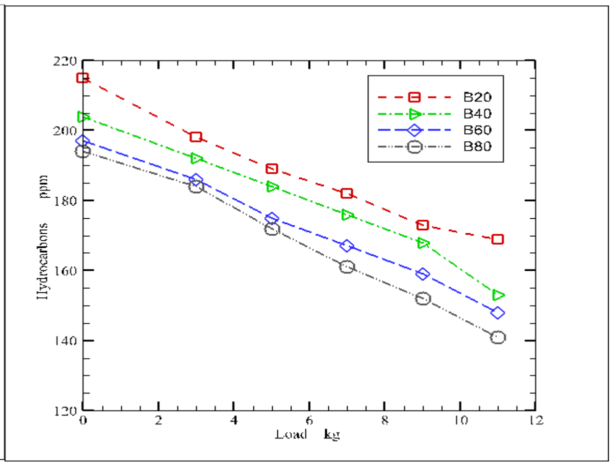
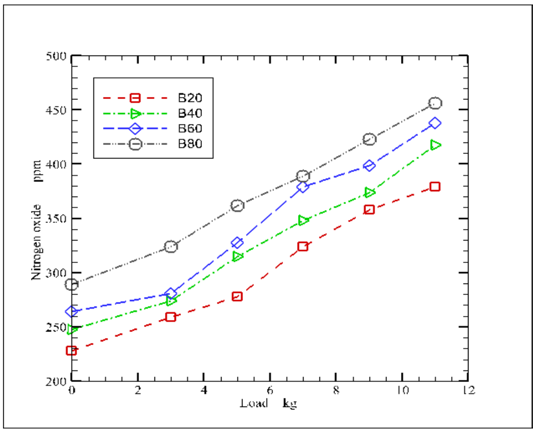


Fig: 7 variation of CO level with load

Fig: 8. variations of HC levels with Load

Load with Hydrocarbon Emission:- As show in Fig.8 found that the fluctuation of hydrocarbons with brake power for various used fuels. The graph showed that, for each fuel, the amount of hydrocarbons roughly increases as the braking power increases. At all load conditions, tamarind seed biodiesel and its various blend showed inferior hydrocarbons compared to diesel fuel.

Load with Oxides of Nitrogen (NO_X): The total emissions from all engines are 10- 30% of the overall emissions of nitrogen oxides are made up of NO_2. Zeldovich mechanism is the name of the process that produces NO_X. Nitrogen is introduced into the combustion chamber during the process. The main source of NO_X emissions, also known as thermal NO_X, is air intake [21]. The triple-bonded atmospheric nitrogen, which is normally an inert gas, breaks under high temperatures and through a sequence of chemical reactions with oxygen to produce NO_2.the high temperature brought on by fuel combustion. In comparison to all other biodiesels, the second-generation biodiesels displayed increased NO_X emissions as shown Fig.9.



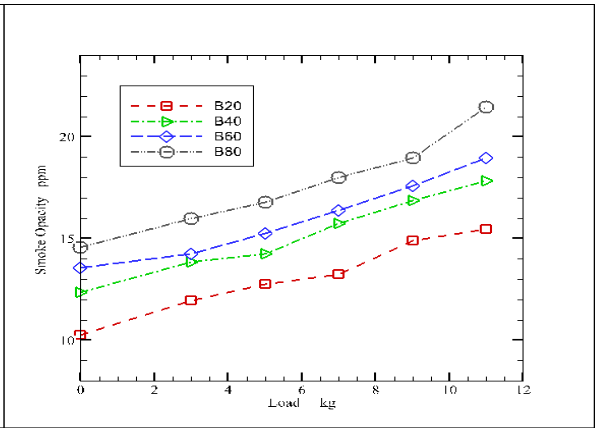


Fig: 9 the variation of NO_X with loads

Fig: 10 variation of smoke opacity with load

Smoke opacity with Load: - The relationship between smoke level and load for the fuel mixtures Diesel, B20, B40, B60, and B800 is shown in Fig. 10. For B20, smoke levels range from 3.2% at low load to 26.5% at full load; for diesel, they range from 3.2% at low load to 22.5% at full load; for B40, they range from 0.2% at low load to 17.4% at full load; and for B80 petrol, they range from 0.2% at low load to 6.5% at full load. B80 burns completely and emits less smoke, indicating that there is more oxygen present. B40, B60, B80, diesel, and B20 blends are the next to burn completely.

II. Conclusion

The use of alternative fuel as tamarinds seed bio-diesel in CI Engine varies the load, and different proportion but the methanol percentage is constant (2%) with compare to diesel are base fuel. In this four biodiesel Tamarind seed oil are finding better performance and less emission characteristics at blends of TB20 comparing the TB40, TB60, TB80, and TB100 at initial to full loads condition. The CB20 with initial to full load and compare to diesel fuel as standard fuels

1. It is proved that the engine's performance at maximum load (11 kg), maximum speed (1500 Rpm), and pure biodiesel B100 is more.
2. In comparison to diesel fuel, there is more improvement and less emission at B20, and the amount of NOX, CO, and smoke tends to decrease while the amount of hydrocarbons increases.
3. The BTE is predicted to decline by 1.42% and the SFC to rise by 9.12% in B20. When compared to diesel fuel, the emissions of smoke, CO, and NOX are tending to rise while those of hydrocarbon fall.
4. In B20, it is designed that the specific fuel consumption will rise while the brake thermal efficiency will fall. The NOX, Smoke, CO2, and CO emissions are rising in comparison to diesel, which is still a mixed fuel.
5. When compared to biodiesel, the B20 fuel has lower BTE and higher BSFC, while biodiesel has higher NOX, smoke opacity, CO, and CO2 and lower hydrocarbon air at beginning and full load.

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