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PERFORMANCE AND EMISSION ANALYSIS OF TURMERIC LEAF OIL AS AN ALTERNATIVE FUEL USED IN C.I ENGINE WITH AN ADDITIVE

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Abstract: ***In this experimental investigation, performance and emission parameters of a single cylinder water cooled diesel engineat various load conditions has been studied. Theengine tests have been carried out by using Diesel, Biodiesel blends(B10,B20,B30) and adding additive Di MethylCarbonate(DMC)tothe best biodiesel blend B20 in various proportions i.e(B20+500mg, B20+1000mg,B20+1500mg).Brake thermal efficiency of diesel is 29.1% at 2.31kW BP and 28.5% at 2.88kW BP where as brake thermal efficiency of B20+1000mg additive shows closer value to diesel because of better combustion of fueli.e 28.6% at 2.31kW BP and 27.6% at 2.88kW BP. The brake specific fuel consumption decreases for B20+1000mg compared to that of B20blend and its value is closer to that of diesel. Result shows thatCO, HC, and NO_X decreases with adding additive to biodiesel blends.Performance and emission analysisare satisfactory with all the test fuels.Therefore this paper provides a good future scope to use thisbiodiesel fuel in C.I engine without any engine modifications***.

Keywords: DI Methyl Carbonate, Emissions, Performance of, Turmeric Leaf oil and Biodiesel.

1. INTRODUCTION

An enormous increase in the number of automobiles in the recent years has resulted in the huge demand for the crude oils. These fossil fuel reserves are going to extinct in few decades. Reduction of this crude oil would cause a major influence on transportation area. The combustion of fossil fuels is the major problem in increasing the global warming day by day. This results in increasing the global CO2 level and global warming. The harmful pollutants affect both environment and human being. These CO emissions cause breathing problem, headache. Irritation occurs in respiratory system due to HC emissions. No_x emissions leads to problem in eyes, nose and throat, & it causes headache and damage to lungs. This prompted the researchers to find out alternative and sustainable energy source for internal combustion engines. Among many alternative fuels, esterified vegetable oils to be the important alternative to diesel due to the following reasons. esterified vegetable sources does not contain Sulphur, metal and crude oil residues. Biodiesel is mostly obtained from renewable sources which increases the energy independence.

Experimental work has previously been done to use vegetable oils both in its pure form and its improved form. Studies have shown that usage of vegetable oils in pure form is possible but not suitable to do. The high viscosity of vegetables oils and their low volatility influences the atomization, spray pattern of fuel, leading to incomplete combustion and more carbon deposits. The method which was used to reduce to viscosity is transesterification, pyrolysis, and emulsification. Among these most often transesterification is used. Biodiesel is environment favourable alternative diesel fuel consisting of alkyl monoesters of fatty acids from vegetable oils and animal fats. Biodiesels obtained from natural sources are gaining overall consideration due to their possibility in several parts of the world and are more efficient, nature friendly as well as more economical also.

2. LITERATURE REVIEW

Mr. S. I. MeshramP [1] worked over the turmeric leaf biodiesel and found that BSFC is more than petrol at low engine speeds. While brake thermal efficiency of engine with turmeric leaves oil is slightly less as compared to gasoline. The CO and HC emissions using turmeric leaves oil was reduced by 13.7% and 16.94% respectively in to that of gasoline, while the NOx concentration was increased by 10%.

Adaileh and Khaled [2] studied the performance, combustion and emission characteristics of DI diesel engine filled with biodiesel. The testing results show that without any modification to diesel engine under all conditions dynamical performance kept normal and B20 and B5 blend fuels gives satisfactory emissions at variable load. The experimental results compare with diesel show that biodiesel provided significant reduction of CO and HC but increase in NO_x. Biodiesel has 5.95% increases in BSFC due to its lower heating value. However using B20 & B5 get better emissions.

Swarup Kumar nayak and Bhabani Prasanna Pattanaik [3] Studied the experimental investigation on performance, combustion and emission analysis of DI diesel engine filled with mahua biodiesel. The experimental work is conducted in two phases are:-

- In the first phase the experiment is conducted on pure diesel fuel to get baseline parameters.
- In second phase the experiment is done on mahua biodiesel blends i.e.M85, M90, M95 and M100 by adding Dimethyl carbonate(D) i.e. DC15, DC10, DC5 and DC0 can be finally both additive and biodiesel can written as M85+DC15, M90+DC10, M95+DC5 and M100+DC0.

The experimental results showed that superior performance analysis for M85+DC15 and EGT of M100 is higher than diesel. The emission analysis i.e. CO and HC emissions is lesser for M100 compare to diesel fuel where smoke and NOx emissions of M85+DC15 is closer to diesel fuel.

3. MATERIALS AND METHODS

3.1TURMERIC LEAF OIL

The alternative fuel using in this project work is turmeric leaf oil. The biological name of turmeric is Curcuma Longa. The turmeric leaf oil is obtained from the agricultural waste of the turmeric crop by hydro distillation process.It contains 1.32% of essential oil containing α-phellandrene 38.24%, C8-aldehyde 20.58%, 1,8-cineole 8.64, α-pinene 2.88% and β-pinene 2.36%. Out of these, α-pinene and β-pinene are the hydrocarbons and these burns in the process of combustion.The properties of diesel and biodiesel are shown in the below fig.

Table 3.1 Properties of Diesel, Biodiesel blends

S.No	Property	Units	Diesel (D100)	Turmeric leaf Biodiesel(B100)	B10	B20	B30
1	Density	kg/m^3	842	895	850.3	858.5	866.9
2	Viscosity @40^oC	m^2/s	2.54	5.2	3.32	3.38	3.49
3	Calorific Value	kJ/kg	44000	41430	42950.2	42935.4	42901.6
4	Flash Point	^oC	60	185	66	74	82
5	Fire Point	^oC	72	235	80	88	96
6	Cetane Number		48	55	49.4	50.6	51.2

Table 3.2 Properties of Biodiesel blends with DMC

Property	Units	B20+500ppm	B20+1000ppm	B20+1500ppm
Density	kg/m^3	864	872	880
Viscosity @40^oC	m^2/s	3.42	3.58	3.67
Calorific Value	kJ/kg	42975	43048	43120
Flash Point	^oC	76	80	84
Fire Point	^oC	92	95	99
Cetane Number		51.2	52	50.8

3.2Dimethyl carbonate additive;

Di Methyl Carbonate is a colourless, transparent liquid under normal temperature. This helps to get complete combustion and to reduce emissions of fuel. Its molecular formula is $C_3H_6O_3$.

4. EXPERIMENTAL PROCEDURE

The experimental study was carried out to investigate the performance and emission characteristics of a diesel engine with Turmeric leaf oil biodiesel using additive and comparing it with that of diesel. The prepared biodiesel was passed through various tests to determine its physical and chemical properties like kinematic viscosity, density, flash point, fire point, cetane number, calorific value. The experimental setup consists of Engine, fuel tank, dynamometer, and manometer. A single cylinder vertical type four stroke Kirloskar engine is used. The diesel engine was first initially started with diesel and then with the prepared test fuels. Speed of the engine was kept constant at 1500 rpm under varying load conditions to measure the performance parameters such as brake power, brake thermal efficiency, brake specific fuel consumption and also to measure the emission parameters like carbon monoxide,unburnt hydrocarbon and nitrogen oxide emissions for both diesel and the prepared test fuels.

Fig 4.1 Experimental set up

Table 4.1Engine Specifications

S.NO	Parameters	Specifications
1	Engine	Kirloskar
2	Engine Type	Four Stroke Single Cylinder Water Cooled Engine
3	Bore	80mm
4	Stroke	110mm
5	Speed	1500rpm
6	Rated Power	5HP
7	Power Output	3.7kW

5.RESULTS AND DISCUSSION

5.1PERFORMANCE ANALYSIS

5.1.1Brake Thermal Efficiency (BTE);

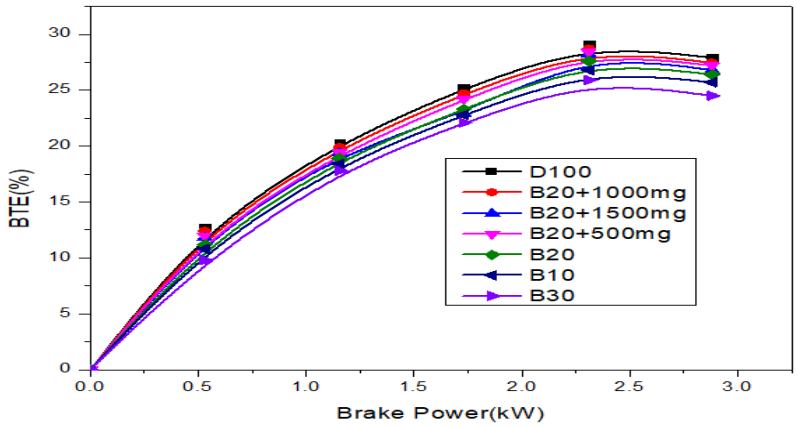


Fig5.1 Brake Thermal efficiency variation

BTE is defined as the ratio of brake power to product of fuel consumption and calorific value. Above Fig shows the variation in Brake thermal efficiency (BTE) in case of diesel, B20+500mg, B20+1000mg,B20+1500mg, B10, B20, B30. It is clearly seen that BTE increases up to 2.31 kW and then decreases at full load due to incomplete combustion. From the present test results it is observed that diesel has highest BTE of 29.1% at 2.31KW BP and 28.5% at 2.88 kW BP because of highest heat content, cetane value and lower viscosity. However with the addition of additive to best biodiesel blend B20 (B20+500mg, B20+1000mg, B20+1000mg) better combustion of test fuel takes place due to increase in heat content value. The outcome shows that BTE of B20+1000mg is closer to diesel i.e 28.6% at 2.31 kW BP and 27.6% at 2.88 kW BP.

5.1.2 Brake Specific Fuel Consumption (BSFC);

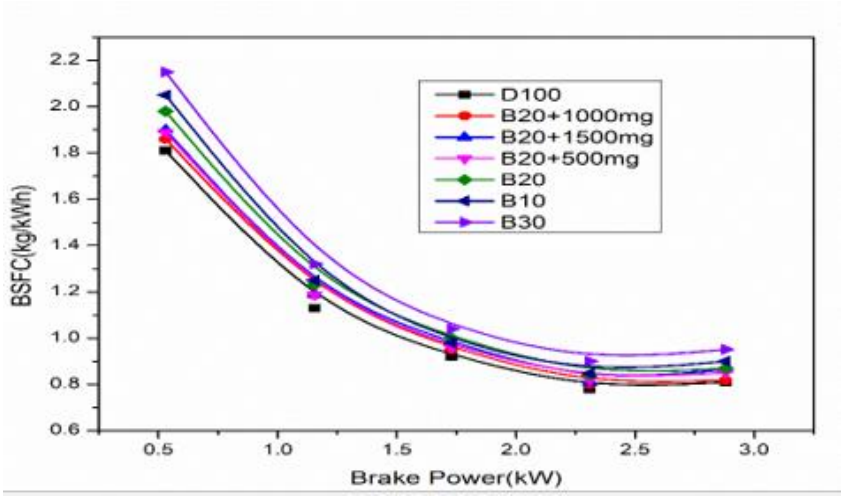


Fig 5.2 Brake Specific fuel consumption variation

BSFC is the amount of fuel consumed by an engine for each unit of power output.Above fig shows the variationin BSFC for diesel, B20+500mg, B20+1000mg, B20+1500mg, B20, B10, B30. It is observed that BSFC first decrease with all the test fuels up to 2.31kW BP and then increases at 2.88kW BP. The BSFC for diesel is 0.77kg/kWh at 2.31KW BP and 0.812kg/kWh at 2.88 KW.As the turmeric biodiesel concentration is increased in the diesel fuel the BSFC increases due to increase in viscosity and decrease in calorific value of fuel.However with the addition of additive (DMC) of 500mg,1000mg, 1500mg to the blend B20 which is best among B10 and B30.The outcome shows that additive B20+1000 mg shows the closer value to that of diesel due to improved combustion (0.8 kg/kWh at 2.31KW BP and 0.84 kg/kWh at 2.88 kW BP).

5.2 EMISSION ANALYSIS

5.2.1Carbon monoxide (CO);

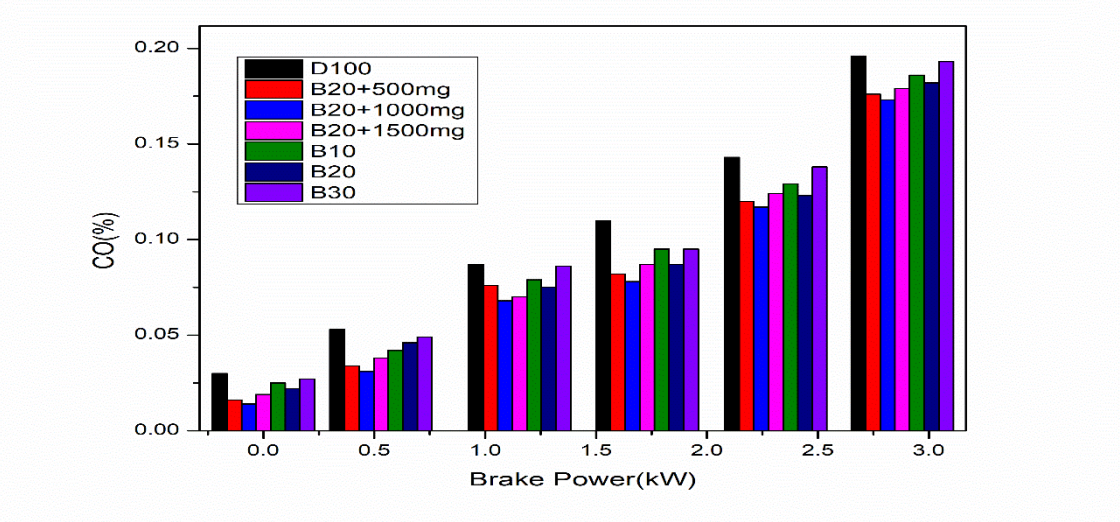
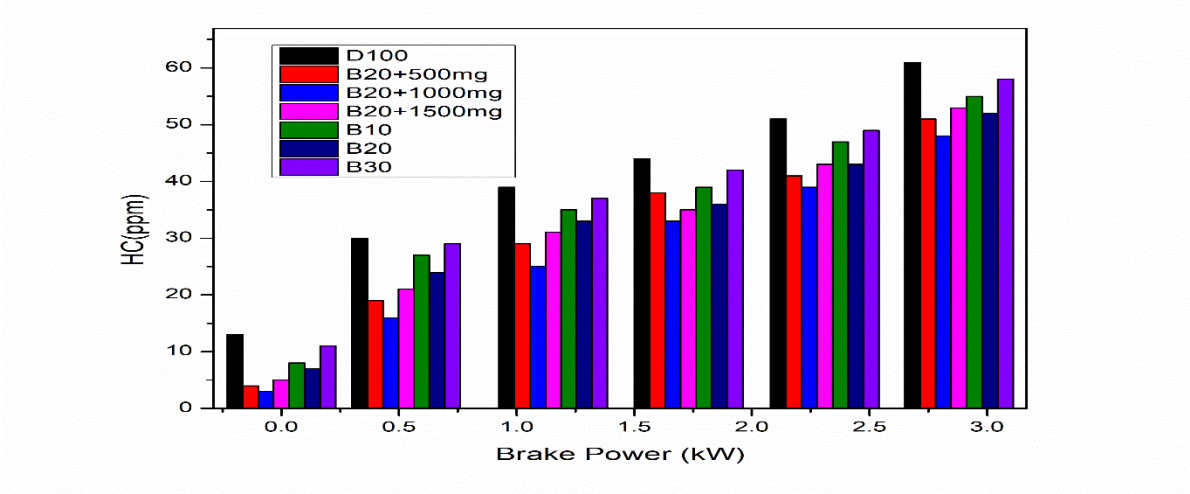


Fig 5.3 Variation inCO emission

Above fig shows the variation in CO emissions with BP for diesel, biodiesel blends and biodiesel blends with adding additiveDi Methyl Carbonate (DMC) to the best biodiesel blend. As the biodiesel concentration is increased in the diesel fuel theCO emissions decreases compared to diesel fuel due to increase in oxygen content of fuel. By considering CO emission for B20 blend which is less compared to B10 and B30. With addition of additive (DMC) to B20 in the proportions of 500mg,1000mg and 1500mg. CO emissions are lesser for 1000mg proportion than 500mg and 1500mg. However, with adding additive CO decreases for all the prepared test fuels because of good spray characterization, good air-fuel ratio and proper combustion. CO emission for diesel is 0.192 % where as for B20+1000mg is 0.173%.

5.3.2 Hydrocarbon (HC);



5.4Variation in HC emission

Above fig shows the variation in HC emissions with BP for diesel, biodiesel blends and biodiesel blends with adding additive Di Methyl Carbonate (DMC) to best biodiesel blend. It is seen that unburnt hydrocarbon emissions increase with increase in BP for all prepared test fuels. From fig it is understood that biodiesel produces less HC emissions compared to that of diesel because of better combustion and its blend with additive due to presence of oxygen. Here DMC additive is added to the B20 blend in the proportions of 500mg, 1000mg and 1500mg then HC emissions decrease in both but by comparing additive proportions B20+1000mg shows lower HC emissions than B20+500mg, B20+1500mg.The HC emissions of diesel are 62ppm. The outcome shows that HC emissions of B20+1000mg is lesser than diesel.

5.3.3 Oxides of Nitrogen (NO_X);

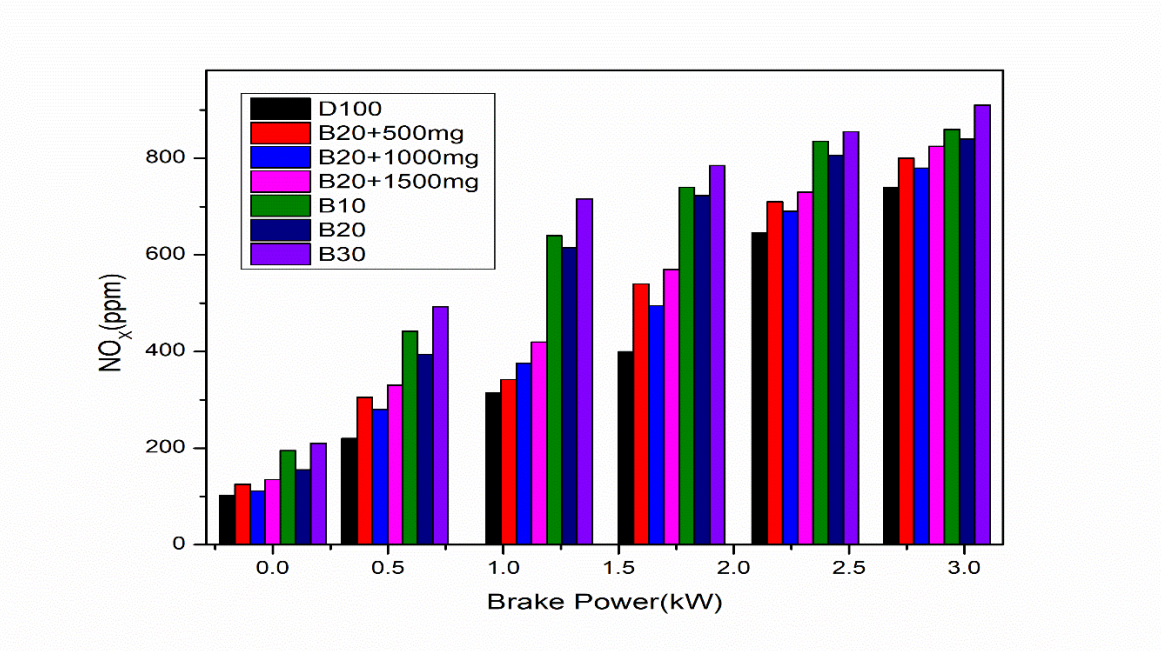


Fig 5.5 Variation in Oxides of Nitrogen

Above fig shows the variation in NO_X emissions with BP for diesel, biodiesel blends and biodiesel blends with adding additive Di Methyl Carbonate (DMC) to the best biodiesel blend. NO_X emissions are directly proportional to the power output of the engine because NO_X emissions increases with increase in combustion and exhaust temperature. The present test results shows that NOx increase linearly with increase in brake power which is because of higher cylinder pressure and temperature. Biodiesel produces more emissions because of having high oxygen content which results in complete combustion causing higher exhaust temperature. NO_X decreases with the adding additive because of reduction in enginecylinder temperature. The NO_X emissions of diesel are 740ppm at 2.88 kW BP.Whereasfor biodiesel blend B20+1000mg shows lesser NO_X emissions than remaining biodiesel blends(B20+500mg,B20+1500mg).

5. CONCLUSIONS

During the present investigation several tests were carried out on a four stroke single cylinder vertical water cooled diesel engine using diesel, Turmeric leaf oil biodiesel and Turmeric leaf oil biodiesel with additives at various proportions. From the experimentation following conclusions were drawn.

- Brake thermal efficiencyof B20+1000mg (DMC) value is closer to diesel valuecompared to the remaining B20 blends with varying proportions.
- Brake specific fuel consumption is more for biodiesel at all brake powers because of high density, high volatility and low heat content of biodiesel but with adding additive, BSFC decreases because of better Combustion.
- CO and HC emissions are highest for diesel and low for biodiesel because of higher oxygen content. It is also concluded that with adding additive in Turmeric leaf oil biodiesel both CO and HC tends to decrease.
- NOx decreases with adding additive because of reduction in engine in-cylinder temperature because of smooth combustion, causing reduction in exhaust gas temperature.

Nomenclature	
Symbol	**Abbrevations**
DMC	Di Methyl Carbonate
D100	Diesel 100%
B10-D90	Turmeric biodiesel blend 10% + Diesel 90%
B20-D80	Turmeric biodiesel blend 20% + Diesel 80%
B30-D70	Turmeric biodiesel blend 30% + Diesel 70%
B20-D80+500mg	Turmeric biodiesel blend 20% + Diesel 80% + 500mg DMC
B20-D80+1000mg	Turmeric biodiesel blend 20% + Diesel 80% + 1000mg DMC
B20-D80+1500mg	Turmeric biodiesel blend 20% + Diesel 80% + 1500mg DMC
BP	Brake Power
BTE	Brake Thermal Efficiency
BSFC	Brake Specific Fuel Consumption
CO	Carbon Monoxide
HC	Hydrocarbons
NO_X	Oxides of Nitrogen

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