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Perfomance Investigation of Camphor Addition Ricebran Biodiesel with VCR Comprression Engine

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ABSTRACT
The current scenario and the major crisis faced by automotive sector throughout the world is the depletion of fossil fuels and toxic, fatal emissions pushed out through the tailpipe of internal combustion engine. Especially the emissions from compression ignition engine has to be taken care of and with the help of technological development many are seeking to invent techniques and procedure to replace and keep aside diesel fuel with alternate fuels and especially bio-derived combustion fuels. In the recent year scientist have came up with ideas to replace diesel fuels and there are suggestions that bio oil- diesel blend bio fuels along with alcohol and other combustion enhancement or property improvement mixtures can do and bring acceptable changes with fulfilling the requirements. Former scientific investigations have presented that biodiesel and various blends can reduce emissions and improve performance of a diesel engine. In this current investigation rice bran oil-diesel blend and camphor were prepared to check its effect of performance and emission character in a compression ignition engine. Biodiesel was prepared in single stage alkaline trans-esterification process and after then biodiesel-diesel-camphor blend were prepared as B10, B20. These blends were tested in a single cylinder, diesel engine with rated power of 5KW, performance and emission data are compared with that of baseline commonly used diesel. Experimental investigation gave output that biodiesel-diesel-camphor blend can be used in compression ignition in without any changes in engine's working parameters and further emission is reduced using a photocatalyst titanium dioxide in exhaust gas track.

Abstract: Biodiesel is an alternative fuel derived from vegetable oils or animal fats. Research has shown thatbiodiesel fueled engines produce lesser carbon monoxide, unburned hydrocarbon, and particulateemissions compared to mineral based diesel fuel but emit higher oxides of nitrogen (NOx) emissions. NOx could be strongly correlated with density or cetane number of a fuel. The objective of the presentwork is to predict the NOx concentration of a neat biodiesel fueled compression ignition engine from thedensity of biodiesel fuels using regression model and reduction of NOx by exposing the exhaust gas to a photo catalyst titanium dioxide .
Experiments were conducted at different engine loads and the results were given as inputs to develop the regression model. A single cylinder, four stroke, constant speed, air cooled, direct injection diesel engine was used for the experiments. Five different biodiesel fuels were used and NOx were measured at different engine loads. The NOx concentration was taken as response (dependent) variable and the density values were taken as explanatory (independent) variables. The regression model has yielded R2 values between 0.918 and 0.995.

Keywords: Biodiesel, Density, Numerical modeling, Oxides of nitrogen, Regression.

I. INTRODUCTION

Global energy consumption has increased and, as a consequence, the carbon dioxide, sulfur dioxide and nitrogen oxides emissions from the combustion of fossil fuels have damaged the atmosphere to a significant extent. Carbon dioxide emissions have risen over the last two decades, reaching an atmospheric content of 360 ppm, estimating the world CO2 emissions at about 26 billion metric ton per year, 80 percent of which comes from the combustion of fossil combustibles such as coal, petroleum and natural gas [1]. Therefore, the engine manufacturers have intended alternatively fueled engines and fuel systems, which offer ample power while residing within regulatory emission-limits. At the same time a huge deal of research and development on internal combustion engines has taken place not only in the design area but also in finding a suitable fuel.

Many researchers have concluded that biodiesel holds vow as an alternative fuel for diesel engines, since its properties are very closer to those of diesel fuels. Therefore, biodiesel can be used in diesel engines with not many or no modifications. Biodiesel has a higher cetane number than diesel fuel, no aromatics, and contains around 10 – 11 % oxygen by weight [2]. These characteristics of biodiesel reduce the emissions of CO, HC and PM in the exhaust gas [2]. Furthermore, contribution of bio-fuels to green house effect is insignificant, since carbon dioxide emittedduring combustion is recycled in the photosynthesis process in the plants [3, 4]. However NOx emissions of biodiesel increase because of better combustion [3, 6]. Oxides of nitrogen may be treated as a strong function of density or cetane number of biodiesel. The objective of the present work is to predict the oxides of nitrogen (NOx) concentration of a neat biodiesel fueled compression ignition engine from the density of biodiesel fuels using regression model. To understand the impact of density of biodiesel on NOx emissions, experiments were conducted in adirect injection diesel engine with different biodiesel fuels namely, Rice bran oil methyl ester. The importance of the present work is to predict the engine's NOx concentration instead of undertaking complex and time-consuming experimental studies and reduction of it using newly invented photocatalystic reduction in presence of titanium dioxide .

Introduction: Diesel engines are one of the dominant prerequisites nowadays in so many sectors owing to the fact that it has better fuel economy, higher efficiency, more reliability, lower fuel cost, and onglasting capacity. Tailpipe emissions from these engines are very badly affecting the mankind and habitat from so many decades. Moreover, due to the hike in automobiles on roads the fossil fuels are depleting at an alarming rate which may result in its permanent deterioration in few decades. To vercome this, diesel engine specialists, researchers, and combustion analysts are trying to find a substitute fuel which can upgrade the performance characteristics of the engine and cut down exhaust emissions (Mahalingam et al., 2018; Mahla et al., 2018a; Singh et al., 2018; Chauhan et al., 2011). Biofuels is the primary choice of the researchers amidst all alternative fuels due to its properties which help in producing fewer greenhouse gases and soot emissions. Furthermore, these are sustainable in nature and economical than conventional fuels (Singh et al., 2018). Researchers have done experimentationand simulation study on diesel engines by using biodiesel prepared from various vegetable and animal fat oils .

II. EXPERIMENTS

2.1 Composition of biodiesel fuels

The basic composition of any vegetable oil is triglyceride, which is of three fatty acids and one glycerol molecule. Biodiesel is defined as the mono-alkyl esters of fatty acids derived from vegetable oils or animal fats. In simple terms, biodiesel is the product obtained when a vegetable oil or animal fat is chemically reacted with an alcohol to produce fatty acid alkyl esters in the presence of a catalyst (sodium or potassium hydroxide). In the process, glycerol is obtained as a co-product. The fatty acid composition of different biodiesel fuels is given in Table 1.

Fatty acids	Chain length	type	Fatty acid composition wt%
lauric	12:0	S	0.82
myristic	14:0	S	0.42
palmitic	16:0	S	17.9
stearic	18:0	S	21.3
oleic	18:1	US	42.6
linoleic	18:2	US	15.3
linolenic	18:3	US	0.28

2.2 Biodiesel production

A two step "acid – base" process with acid – pretreatment followed by main base – transesterification process was done. Methonal was used as a reagent and H_2SO_4 and KOH as catalysts for acid and base reactions. Accordingly biodiesels were produced from crude rice bran.

2.3 Fuel properties

The fuel properties were determined following the methods specified in ASTM standards as given in Table 2 RBME.

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Flash Point	°C	D 93 – 02a	Pensky martens open cup
Density	g/cc	D 1298	hydrometer
Viscosity	Mm^2/s	D 445-03	Redwood viscometer
Calorific value	MJ/kg	D 240-02	Bomb calorimeter

Engine Details :

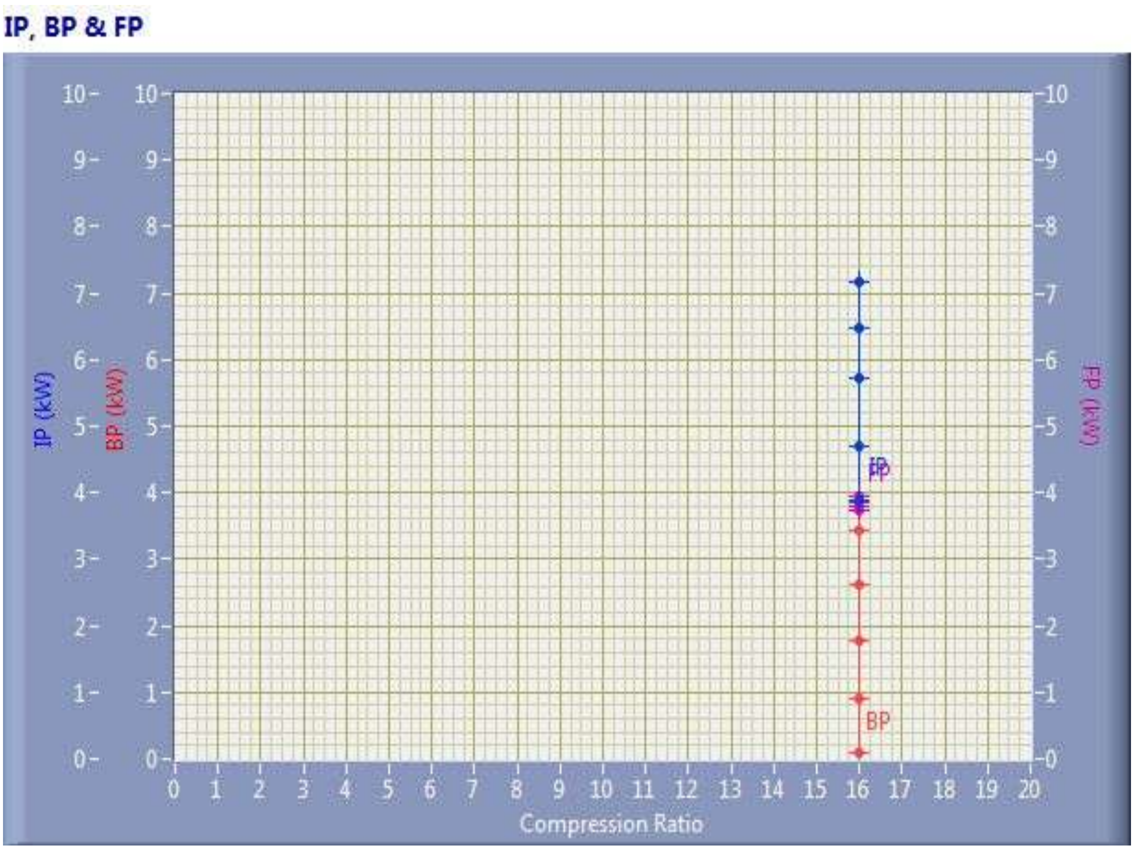
ICEngine set up under test is Research Diesel having power 3.50 kW @ 1500 rpm which is 1 Cylinder, Four stroke , Constant Speed, Water Cooled, Diesel Engine, with Cylinder Bore 87.50(mm), Stroke Length 110.00(mm), Connecting Rod length 234.00(mm), Compression Ratio 16.00, Swept volume 661.45 (cc)

Combustion Parameters :

Specific Gas Const (kJ/kgK) : 1.00, Air Density (kg/m^3) : 1.17, Adiabatic Index : 1.41, Polytrophic Index : 1.28, Number Of Cycles : 10, Cylinder Pressure Referance : 4, Smoothing 2, TDC Reference : 0

Performance Parameters :

Orifice Diameter (mm) : 20.00, Orifice Coeff. Of Discharge : 0.60, Dynamometer Arm Legnth (mm) : 185, Fuel Pipe dia (mm) : 12.40, Ambient Temp. (Deg C) : 27, Pulses Per revolution : 360, Fuel Type : Diesel, Fuel Density (Kg/m^3) : 830, Calorific Value Of Fuel (kj/kg) : 39900



Speed (rpm)	Load (kg)	IP (kW)	BP (kW)	FP (kW)
1548.00	0.26	3.88	0.08	3.81
1542.00	3.11	4.70	0.91	3.79
1525.00	6.12	5.73	1.77	3.96
1511.00	9.17	6.49	2.63	3.86
1498.00	12.09	7.18	3.44	3.73

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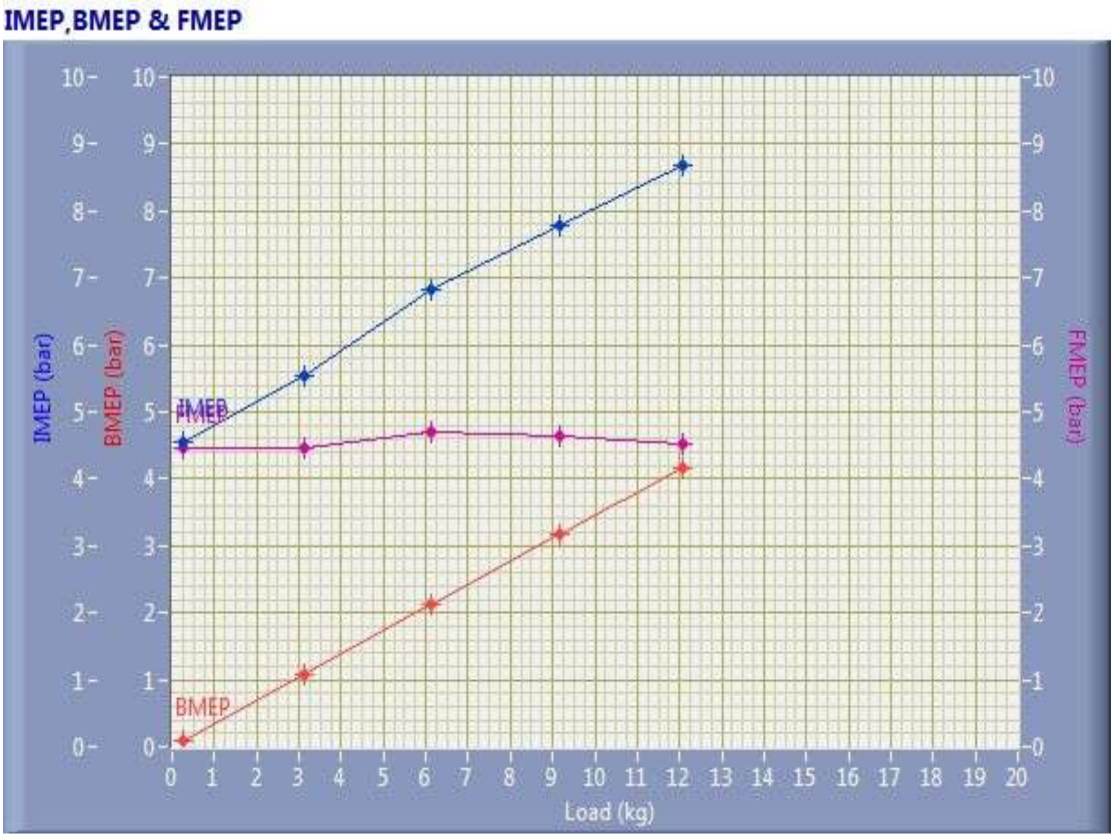

Speed (rpm)	Load (kg)	IMEP (bar)	BMEP (bar)	FMEP (bar)
1548.00	0.26	4.55	0.09	4.46
1542.00	3.11	5.53	1.07	4.46
1525.00	6.12	6.82	2.11	4.71
1511.00	9.17	7.79	3.16	4.63
1498.00	12.09	8.69	4.17	4.52

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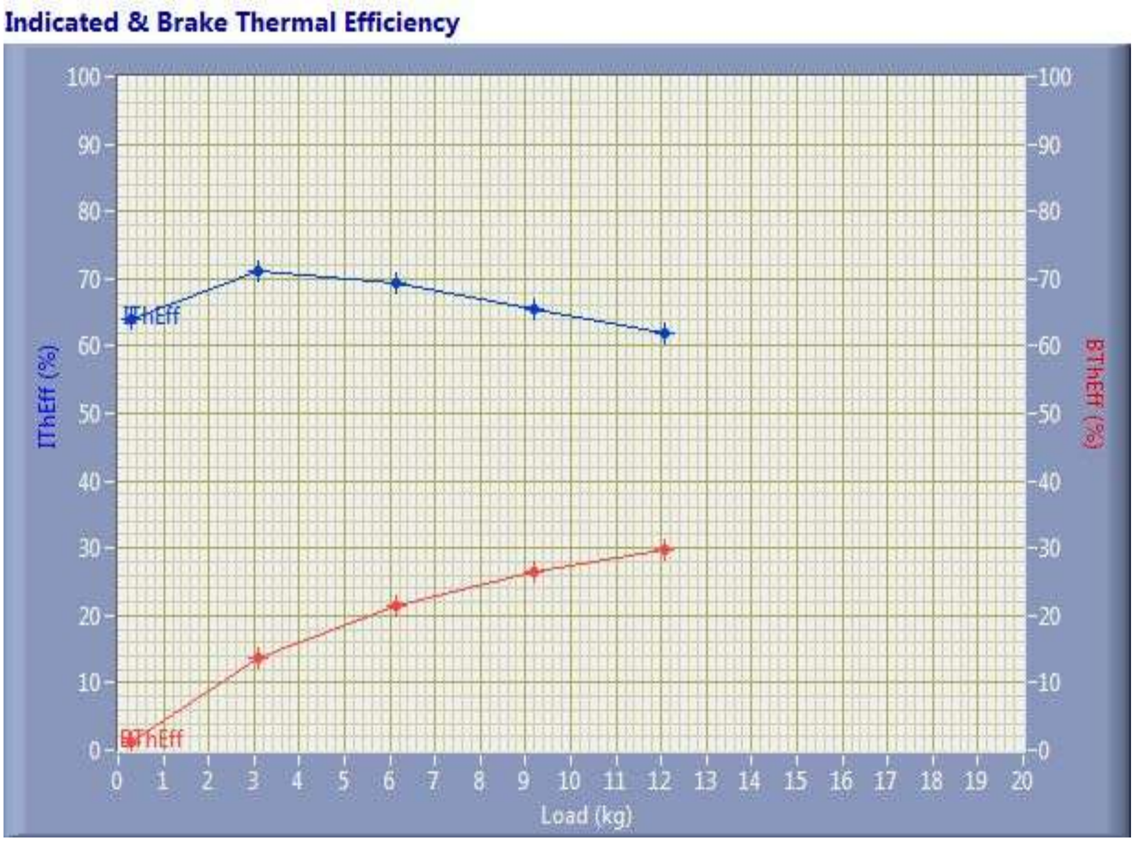
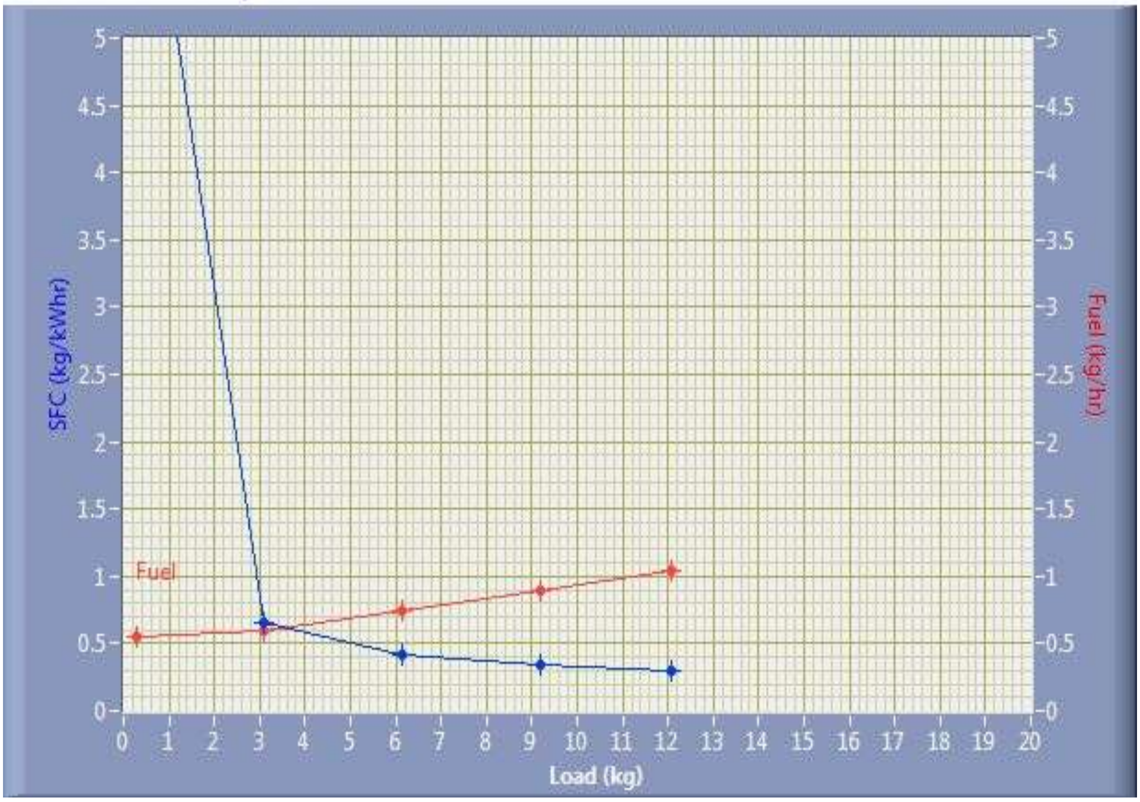


Air Flow (kg/h)	Fuel Flow (kg/h)	SFC (kg/kWh)	Vol Eff. (%)	A/F Ratio	HBP (%)	HJW (%)	HGas (%)	HRad (%)
28.96	0.55	7.05	80.31	52.86	1.28	22.40	17.53	58.79
28.82	0.60	0.66	80.24	48.23	13.74	20.61	18.98	46.67
28.37	0.75	0.42	79.87	37.98	21.44	19.25	19.24	40.07
27.78	0.90	0.34	78.93	30.99	26.52	19.93	18.86	34.69
27.12	1.05	0.30	77.72	25.93	29.70	20.81	19.75	29.73

Torque (Nm)	BP (kW)	FP (kW)	IP (kW)	BMEP (bar)	IMEP (bar)	BTHE (%)	ITHE (%)	Mech Eff. (%)
0.48	0.08	3.81	3.88	0.09	4.55	1.28	63.98	2.00
5.64	0.91	3.79	4.70	1.07	5.53	13.74	71.00	19.35
11.11	1.77	3.96	5.73	2.11	6.82	21.44	69.24	30.96
16.65	2.63	3.86	6.49	3.16	7.79	26.52	65.33	40.59
21.94	3.44	3.73	7.18	4.17	8.69	29.70	61.91	47.98

SFC & Fuel Consumption



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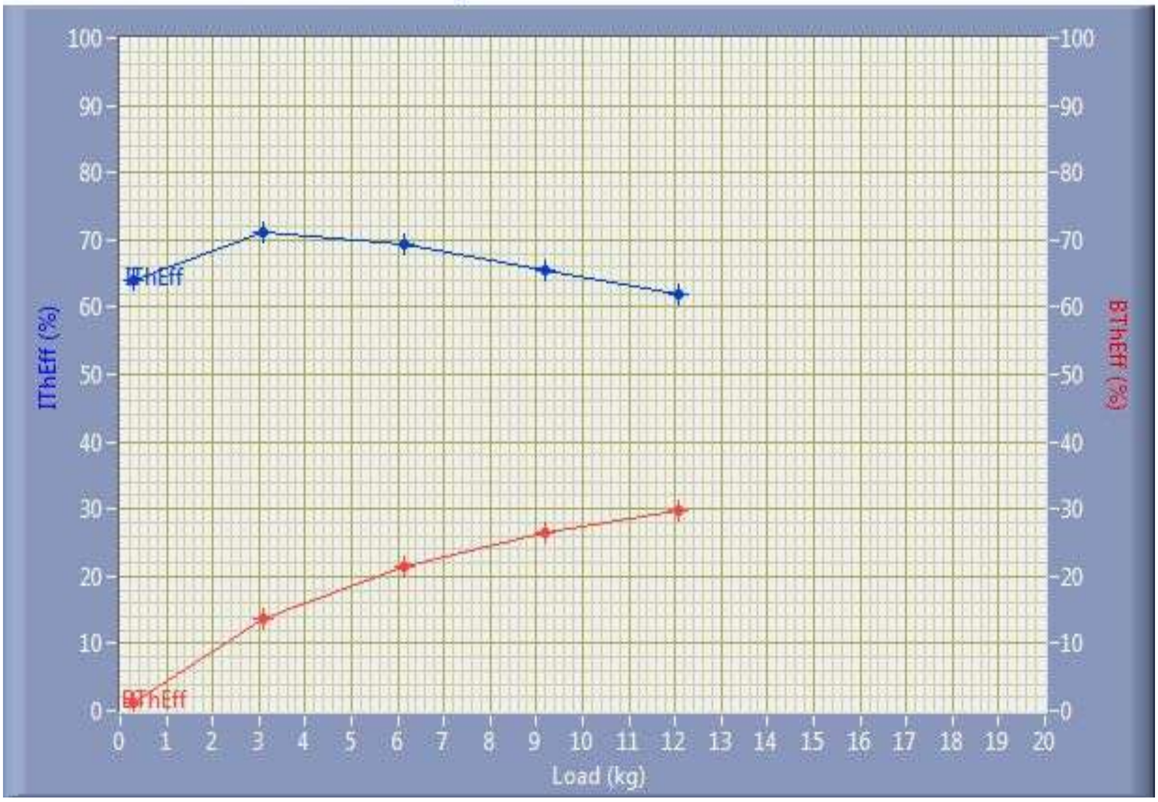
Indicated & Brake Thermal Efficiency



Torque (Nm)	BP (kW)	FP (kW)	IP (kW)	BMEP (bar)	IMEP (bar)	BTHE (%)	ITHE (%)	Mech Eff. (%)
11.21	1.80	3.47	5.26	2.13	6.24	20.44	59.90	34.13
16.44	2.61	3.72	6.33	3.12	7.58	26.41	64.08	41.21
21.80	3.43	3.74	7.17	4.14	8.67	28.36	59.35	47.78

Air Flow (kg/h)	Fuel Flow (kg/h)	SFC (kg/kWh)	Vol Eff. (%)	A/F Ratio	HBP (%)	HJW (%)	HGas (%)	HRad (%)
28.13	0.80	0.44	78.91	35.30	20.44	17.47	21.69	40.39
27.54	0.90	0.34	77.99	30.73	26.41	16.99	21.40	35.20
26.85	1.10	0.32	76.78	24.50	28.36	16.87	20.40	34.37

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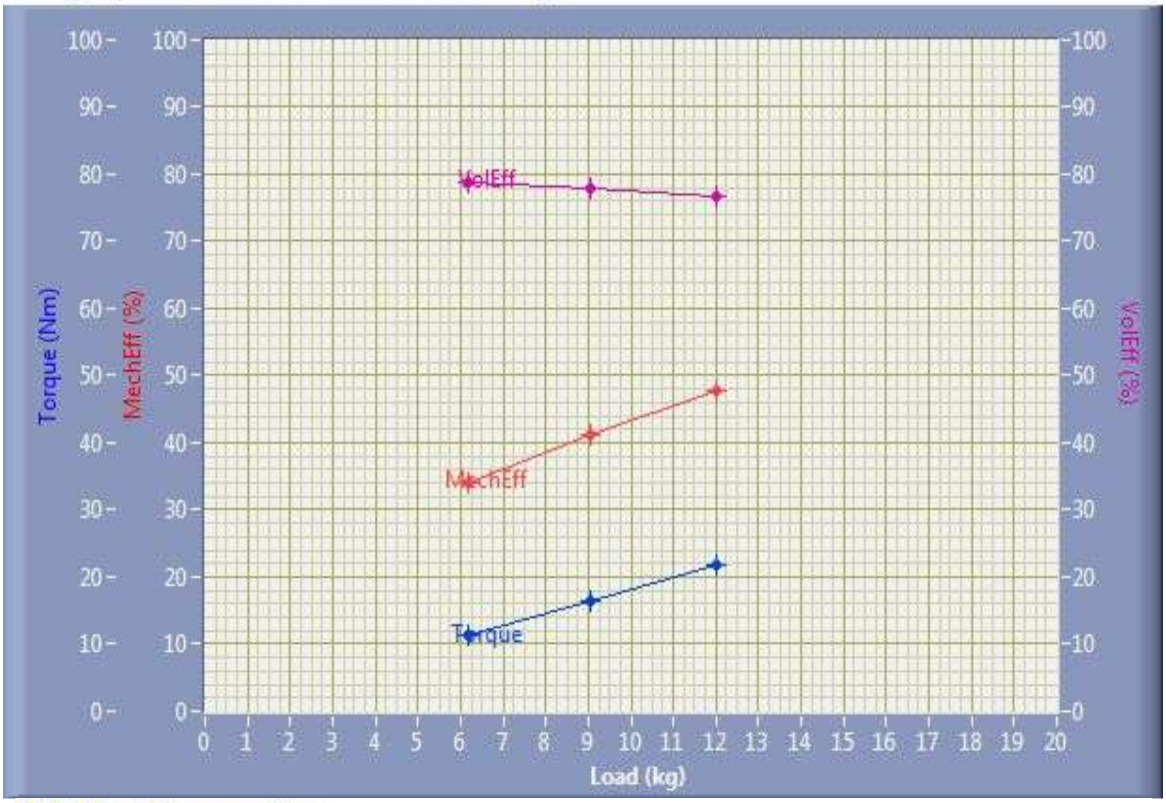
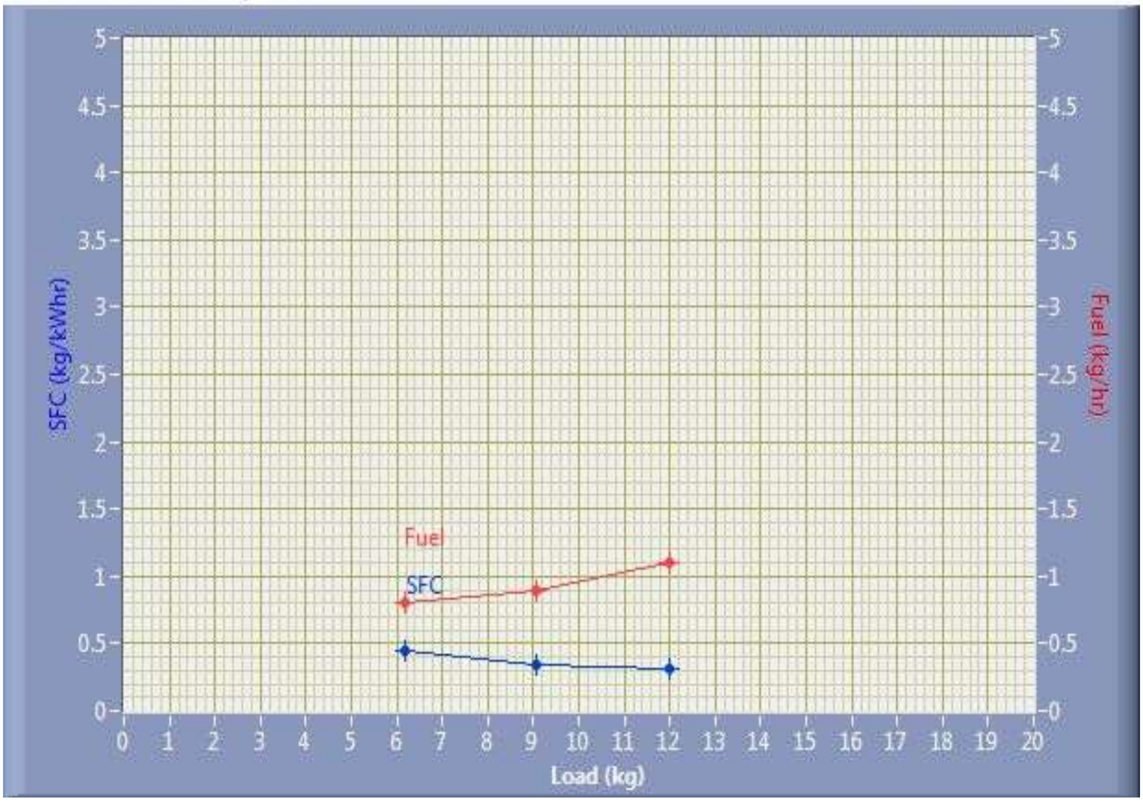
TORQUE, Mechanical & Volmetric Efficiency



SFC & Fuel Consumption



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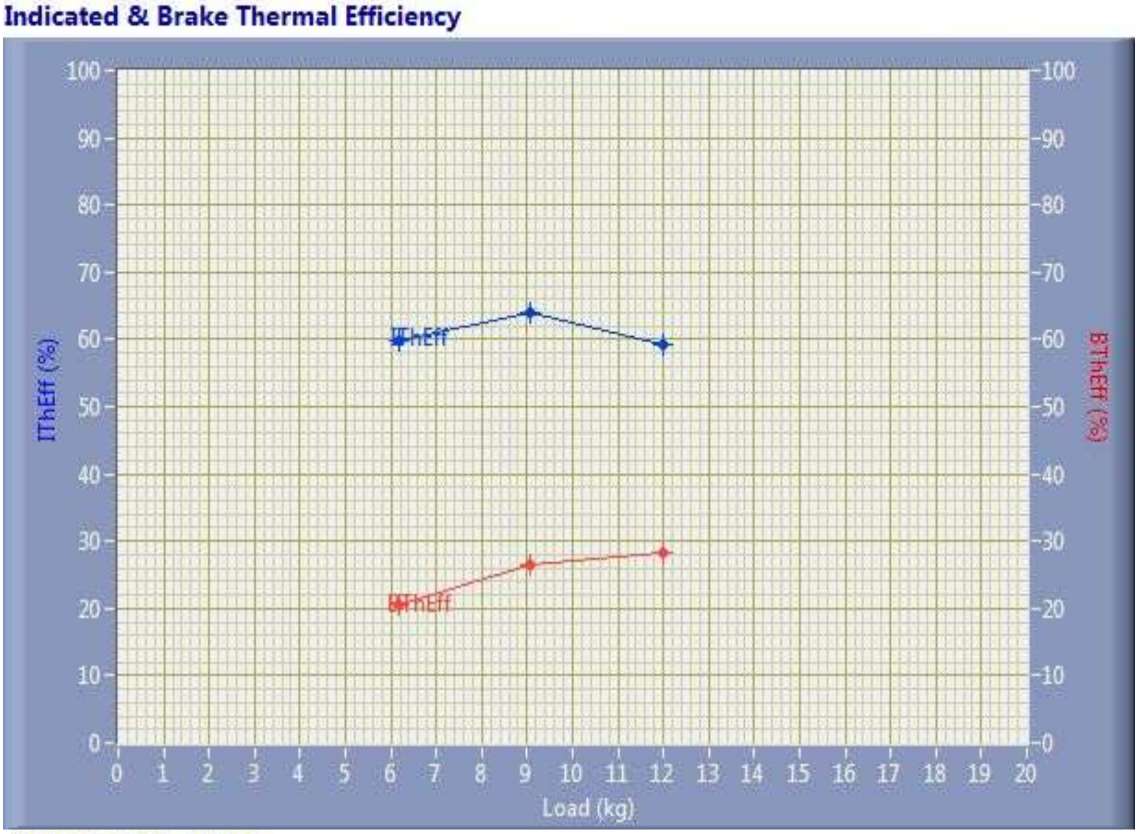

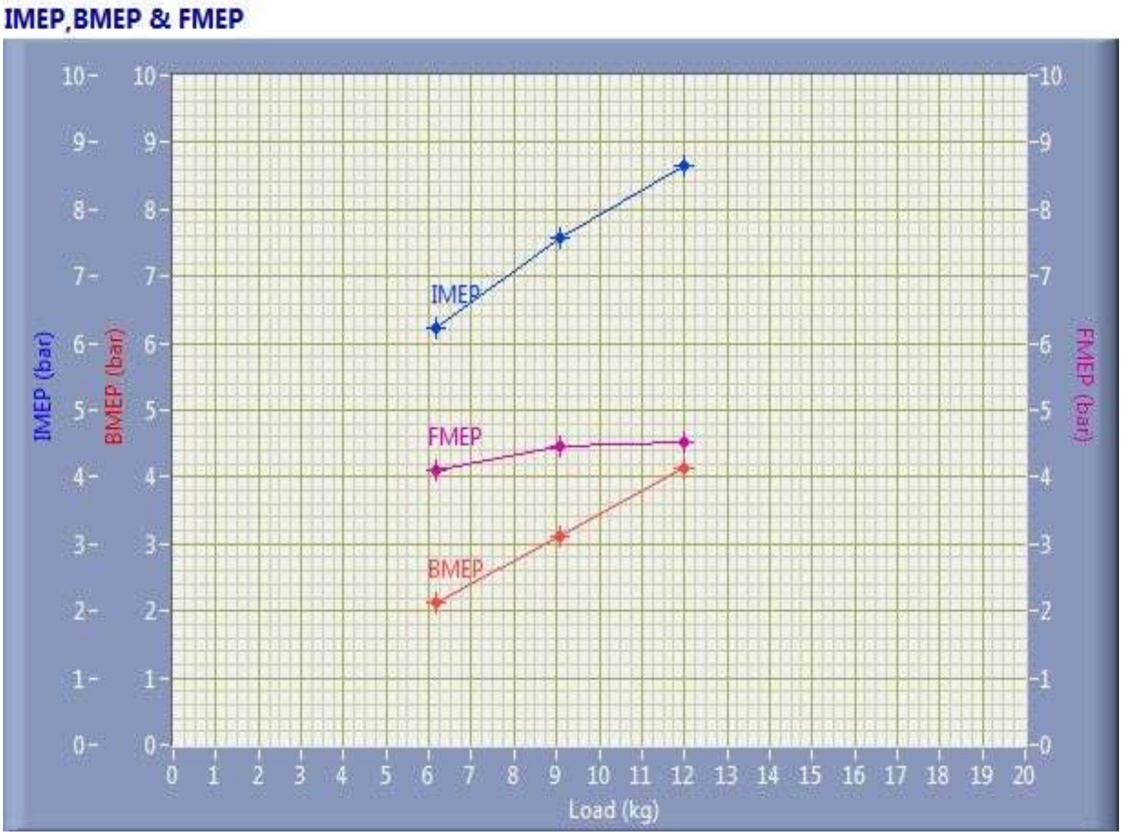

III. CONCLUSIONS

An experimental investigation was performed on a single cylinder diesel engine using rice bran biodiesel and camphor blend B20, in presence of photocatalyst titanium dioxide. Performance and emissions characteristics were noted at various engine loads and SFC, BTE, CO, HC and NOx, were compared with diesel fuel. Following was concluded:

1. Brake specific fuel consumption increased with increase in the quantity of biodiesel and camphor in the blends and is higher than diesel fuel.
2. Brake thermal efficiency enhanced for camphor added B20 bio-diesel fuel
3. Carbon monoxide emissions and smoke were found to be decreased with the inclusion of rice bran biodiesel in the blends and were further decreased with photocatalyst
4. Blends with rice bran oil also found to reduce hydrocarbon emissions, further reduced with the help of photocatalyst
5. Nitrogen oxide emissions reported more by adding biodiesel but experimenting photocatalyst in exhaust gas track and triggering its working with a light source showed lowering of nitrogen oxide values through tail pipe

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