

Performance and Emission Characteristics of Pongomia Oil using VCR Engine with Turbo Charger Setup



S.Prakash, M.Prabhahar, Rajkumar, Saran Kumar.S, Prasanth. S

Abstract: The diesel motors has prompted the outflow of risky gases like Sulfur oxides, nitrogen oxides and carbon monoxide, which can additionally prompted issues like acid rain, These discharges can likewise influence human well being and increment a dangerous atmospheric deviation which has prompted the requirement for interchange energizes. Biodiesel is one of the choices which are by and large broadly considered and its generation from oil seeds is constrained by yield land dislodging, The impact of variable pressure proportion at various burdens with turbocharger is utilized to break down the presentation and to improve the exhibition of an I.C motor and to expand the effectiveness of the single chamber four stroke diesel motors. The turbocharger is utilizations to the vitality of fumes gas to drive more air-fuel blend into chamber to expand the motor power. The properties of Pongamia pinnata oil mixes with diesel are tried in a variable pressure proportion motor (VCR motor) with turbo charger arrangement. The presentation attributes of the motor are utilized to decide the brake control, explicit fuel utilization, warm effectiveness, and so on.

Keywords: Pongamia pinnata oil, VCR Engine, Turbo Charger

I. INTRODUCTION

The diesel motors has prompted the emanation of perilous gases like Sulfur oxides, nitrogen oxides and carbon monoxide, which can additionally prompted issues like corrosive downpour, These discharges can likewise influence human wellbeing and increment an Earth-wide temperature boost which has prompted the requirement for substitute powers. Biodiesel is one of the options which are in effect broadly contemplated and its generation from oil seeds is constrained by harvest land relocation, The impact of variable pressure proportion at various burdens with turbocharger is utilized to break down the exhibition and to improve the presentation of an I.C motor and to build the productivity of the single chamber four stroke diesel motors. The turbocharger is utilizations to the vitality of fumes gas to drive more air-fuel blend into chamber to expand the motor power. The properties of Pongamia pinnata oil mixes with diesel are tried in a variable pressure proportion motor (VCR

motor) with turbo charger arrangement. The presentation qualities of the motor are utilized to decide the brake control, explicit fuel utilization, warm proficiency, and so forth. Because of weight on palatable oils like groundnut, rapeseed, mustard and soybean and so forth non-eatable oil of jatropha curcas and karanja (PongamiaPinnata) are assessed as diesel fuel extender. Pongamia pinnata is a types of family Leguminasae, local in tropical and calm Asia including some portion of India, China, Japan, Malaysia, Australia. Generally it is called as karanja (in MS), pongam (in Gujarat), dalkaramch (in Tamilnadu). Karanja is dry season safe, semi-deciduous, nitrogen fixing leguminous tree. It develops around 15-20 meters in tallness with a huge covering which spreads similarly wide. The leaves are delicate, sparkly burgundy in late-spring and develop to a lustrous, dark green as the season advances. [2] Flowering beginnings as a rule following 4-5 years. Editing of cases and single almond estimated seeds can happen by 4-6 years and yields 9-90 kg's of seed. The yield potential per hectare is 900 to 9000 Kg/Hectare. According to statics accessible pongamia oil has a capability of 135000 million tones for every annum and just 6% is being used. The tree is appropriate to serious warmth and daylight and its thick system of parallel roots and its thick long tap roots make it dry season tolerant.

A. ORIGIN OF PROBLEM

At present scenario every country is facing two major challenges namely energy crisis and environmental degradation. Carrying need of the day to mean fuel, more fuel and cheaper fuel. [1] Particulate matter (PM), oxides of nitrogen (NOX)carbon monoxide(CO),total hydrocarbon(THC) are the causes of acid rain, depletion of ozone layer and various respiratory problem.

B. OBJECTIVE OF THE PAPER

To experimentally, find the optimum running parameters of diesel engine were the emission level will be minimum and performance can be enhanced. Increase the dependency on biodiesel fuel. To save the fossil fuel for further generation and provide the hazard free environment.

II. LITERATURE REVIEW

Bryan R. Moser et al. Coriander (C. sativum L.)(2012) were evaluated seed oil methyl esters as an alternative biodiesel fuel and were prepared in 94 wt% yield by a standard transesterification procedure with methanol and sodium methoxide catalyst. Acid-catalyzed pretreatment was necessary beforehand to reduce the AV of the oil from 2.66 to 0.47 mg KOH g-1. Coriander oil contained a high level of petroselinic acid (68.5 wt%) hitherto unreported as the principle



Manuscript published on 30 September 2019.

* Correspondence Author (s)

S.Prakash -Research Scholar, Department of Mechanical Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Mission Research Foundation, Deemed to be University Prakash.mech94@gmail.com

Dr. M.Prabhahar - Professor, Department of Mechanical Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Mission Research Foundation, Deemed to be University mprabhahar@gmail.com

Rajkumar, Saran Kumar. S,Prasanth. S, UG Scholar, Aarupadai Veedu Institute of Technology, Vinayaka Mission'S Research Foundation

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

FA component in biodiesel fuels. [7] Paula Berman et al.(2013) Investigated Alternative oilseeds are being used as biodiesel feed stocks. In this study, the specifications in ASTM D6751 and D7467 which are related to the fatty acid composition of pure castor methyl esters (B100) and its blend with petro diesel in a 10% volume ratio (B10) were investigated. [8] M.K.-K. Figueiredo et al.(2014) a Low Temperature Conversion (LTC) process carried out on a sample of castor seeds, *Ricinus communis*, generated fractions of pyrolysis oil, pyrolytic char, gas and aqueous extracts in the following relative amounts, respectively: 50%, 28%, 10% and 12% [w/w]. The pyrolysis oil was added at loadings of 2%, 5%, 10%, 20% and 30% [w/w] to commercial diesel. The LTC of the castor seeds was carried out under a constant nitrogen flow at 380°C, the collection of four fractions: pyrolysis oil [50%], aqueous [12%], pyrolytic char [28%] and gas [10%] fractions. Significant absorptions of pyrolysis oil in the FTIR spectra are as follows: 3349 cm⁻¹ (axial deformation of -OH group); 2924 cm⁻¹ and 2854 cm⁻¹ (axial deformation of C-C aliphatic); 1711 cm⁻¹ (carbonyl group) and 1463 cm⁻¹ (angular deformation of -CH₃ and -CH₂- groups). The results of the analyses obtained where all were made using mixtures of diesel reference. The high percentage of the pyrolysis oil fraction (50%) obtained by the LTC process from castor seeds makes this biomass a very promising energy source in admixtures with commercial diesel. The results obtained in this work show that binary mixtures (P-diesel) of up to 10% pyrolysis oil in commercial diesel are very effective. Horng-Wen Wu et al.(2015) determined the optimal operating factors for achieving good combustion performance, low NO_x and smoke, at various engine loads and at 1500 rpm he used taguchi method to determine the optimal combinations of concentrations for a diesel engine with diesel/biodiesel blend using H₂ and cooled exhaust gas recirculation (EGR) at the inlet port. Furthermore, the combustion performance and emissions are compared between the optimum combination factors and original baseline diesel engine. As a result he observed that for a combination of B20 (A2), 30% hydrogen (B3) and 40% EGR ratio (C3) the performance characteristics like brake thermal efficiency and specific fuel consumption is more which got at a load of 60%, the reduction rate is 25.4% for BSFC, 74.1% for NO_x and 29.6% for smoke. The predictions using Taguchi's parameter design technique are in adequate agreement with the confirmation results, with a confidence interval of 95%, and this technique saves 67% of the time taken to perform the experiment in this research.

III. EXPERIMENTAL SETUP

Presently a day, explores were being a ton of doing work in I.C motor to improve the motor productivity. Diesel motor were utilized in gaseous petrol for financial and condition control points of interest. This venture will survey the variable pressure proportion for various burden utilizing single chamber four stroke diesel motors to decide the parameter and delivered the greatest vitality proficiency. Diesel motors described are low fuel utilization and low outflow for CO and NO_x will be high. A significant issue in NO_x outflow is higher for the contamination control. Because of contact misfortune and fumes loss of the presentation at influence the proficiency. It appears that a fuel utilization rate is lower contrast with pressure proportion is high in the part load. The motor arrangement comprises of a

solitary chamber, four strokes, variable pressure proportion associated with vortex current dynamometer. A kirloskar motor is altering to variable pressure proportion diesel motor. The primary segments of the framework are fuel infusion siphon, dynamometer, turbocharger, fumes gas analyser. An important instrument is a burning pressure, wind current, temperature, wrench edge, cylinder, fuel stream and burden estimations. The rota meter is utilizations to cooling water and calorimeter water stream are estimated. The motor execution were arrangement study incorporates of torque, brake control, demonstrated power, grinding power, brake explicit fuel utilization, showed explicit fuel utilization, brake warm proficiency, demonstrated warm effectiveness and warm productivity.

IV. THEORETICAL CALCULATIONS

[3] Compression Ratio: It is the ratio of the total volume of the combustion chamber if the piston moved at bottom dead centre to the total volume of the combustion chamber if the piston moved at top dead centre. $R_c = \frac{\text{Total Volume at BDC}}{\text{Total Volume at TDC}}$

Friction Power: The link between the output of brake power and the output of indicated power of an engine. $FP = IP - BP$.

[4] Indicated Power: It may be the power developed by combustion of fuel in the combustion chamber. It is the sum of friction power and brake power. $IP = \frac{ImepLAN}{60}$. Indicated

Mean Effective Pressure: It may be the average pressure acting on a piston during a power stroke of its cycle. $Imep = \frac{60IP}{LAN}$. Brake Specific Fuel Consumption: It

may be thought of as fuel consumption per unit of thrust of the brake power. $BSFC = \frac{M}{BP}$ Indicated Specific Fuel

Consumption: It may be thought of as fuel consumption per unit of thrust of the indicated power. $ISFC = \frac{M}{IP}$. [5] Brake

Thermal Efficiency: It is defined as brake power of a heat engine as a function of the thermal input from the fuel. $BTE = \frac{BP \cdot 3600}{M \cdot CV}$.

[6] Indicated Thermal Efficiency: It is defined as the ratio between the indicated power output of an engine and the rate of supply of energy in the fuel. $ITE = \frac{IP \cdot 3600}{M \cdot CV}$. Mechanical Efficiency: It is measured as a

ratio of the measured performance of an ideal machine. $ME = \frac{BP}{IP}$





Fig 1: Engine Setup with using Turbocharger

A variable compression ratio idea has additionally been assessed by methods for the reenactment of a turbocharged diesel motor. The impact of compression ratio on the motor execution at fixed burdens will be exhibited. The chief advantages are a decrease in fuel utilization at part load and a decrease in start delay. The expansion in the admission lift weight improves the brake warm effectiveness of the motor. For the pay of drop in volumetric proficiency of the protected motor 4% admission lift weight is required for turbocharging.

V. RESULTS AND DISCUSSION

The experiments were conducted with diesel fuel and Pongamia Biodiesel B20, B40 and B100 under the Turbo Charger setup. The results obtained from the experimental investigations, the combustion, performance and emission parameters were measured and discussed in this section.

A. BRAKE THERMAL EFFICIENCY

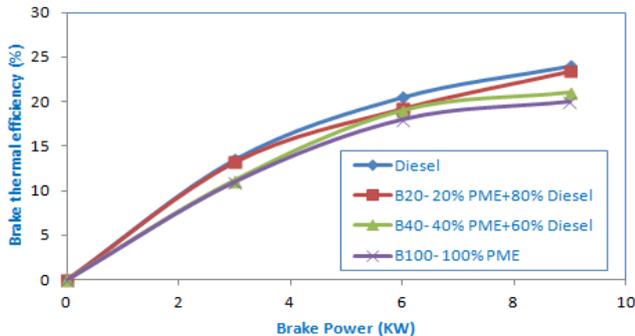


Fig 2: Variation of Brake thermal efficiency with BP

The maximum brake thermal efficiency for neat diesel is 21%. For B20 it is 23.4%, for B40 it is 21%, for B100 it is 20%. It can be seen that the Brake thermal efficiency characteristics for diesel is highest and lesser in the case of all biodiesel blends. This may be due to the reduced calorific value and increased viscosity of biodiesel when compared to diesel. Among the biodiesel blends, the maximum brake thermal efficiency is obtained for B20 blend (20% BME with 80% of diesel) at three fourth of load. This may be due to the reduced viscosity and increased calorific value, which leads to better combustion when compared to other biodiesel blends.

B. BASIC SPECIFIC FUEL CONSUMPTION

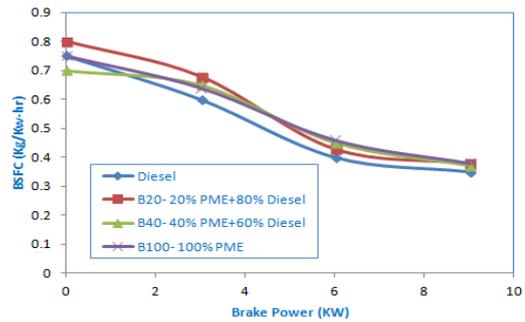


Fig 3: Variation of BSFC with BP

Specific energy consumption for neat diesel at three fourth of the load is 0.35 Kg/KW-hr. For diesel blends it starts to increase by 0.36%, 0.37%, 0.37%, for B20, B40 and B100 respectively. It is seen that the specific energy consumption characteristics for diesel is least and highest in the case of all biodiesel blends. This may be due to the less energy content of biodiesel when compared to diesel. Among all the biodiesel blends, B20 blend has lowest specific energy consumption at three fourth loads. This may be due to the higher energy content of the blend, which leads to better combustion when compared to other biodiesel blends.

C. NOx EMISSIONS

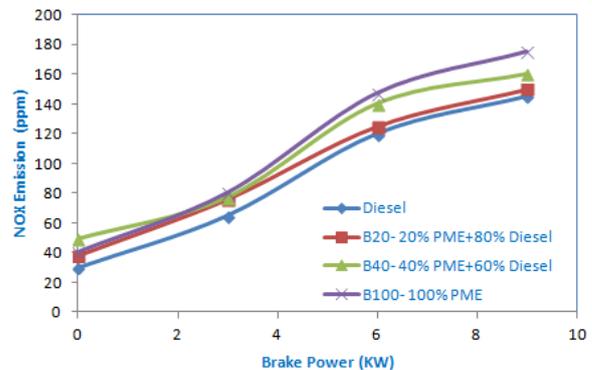


Fig 4: Variation of NOx emissions with BP

The NOx emission for neat diesel at maximum load is 145 ppm and it starts to increase for the biodiesel blends. The emission increases by 150, 160 and 175 B20, B40 and B100 for respectively. Among all the biodiesel blends, B20 has the minimum NOX emission. This may be due to the reduced viscosity and better combustion, which leads to higher combustion temperatures when compared to other biodiesel blends.

D. CO EMISSIONS

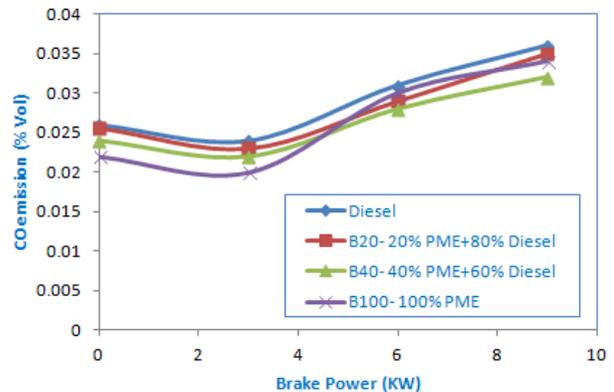


Fig 5: Variation of CO emissions with BP



Fig 5 Shows The carbon monoxide emissions for neat diesel at maximum load are 0.036%. The emissions decrease by 0.35%, 0.32%, 0.034%, for B20, B40, and B100 respectively at maximum load. Among the biodiesel blends B20 has the minimum CO emission. The result may be due to the lower carbon to hydrogen ratio of biodiesel when compared with diesel.

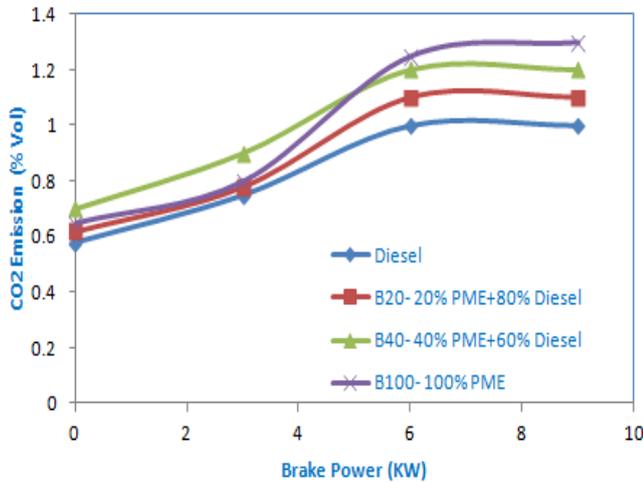


Fig 6: Variation of CO₂ emissions with BP

E. CO₂ EMISSIONS

Fig 6 shows The co2 emission for neat diesel at maximum load is 1%. And for diesel blends it is 1.1%, 1.2% and 1.3 % for B20, B40, and B100 respectively. When compared to other diesel blends B20 has nearest minimum co2 emission value, this is due to reduced viscosity of the blend.

F. HYDRO CARBON EMISSIONS

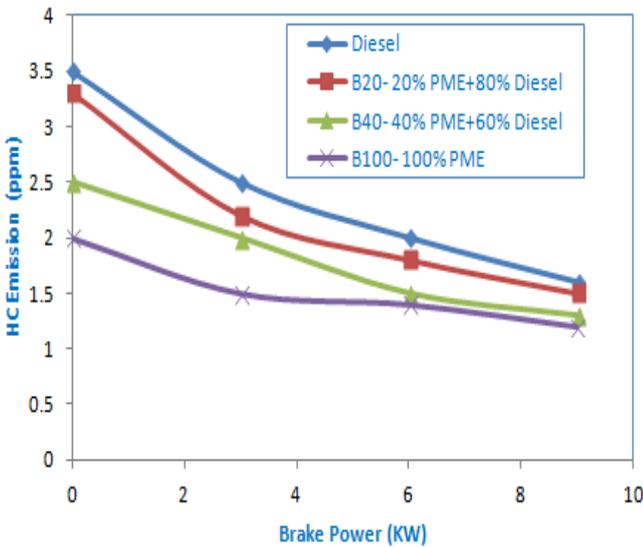


Fig 7: Variation of HC emissions with BP

The hydro carbon emission for neat diesel at maximum load is 1.6 ppm and it starts to decrease for bio diesel blends. The emission decreases to 1.5 ppm, 1.3 ppm, 1.2 ppm B20, B40, and B100 for respectively. This may be due to the fact that all the biodiesel contain oxygen in their chemical composition. This favours comparatively better combustion for biodiesel than diesel.

G.O₂ EMISSIONS

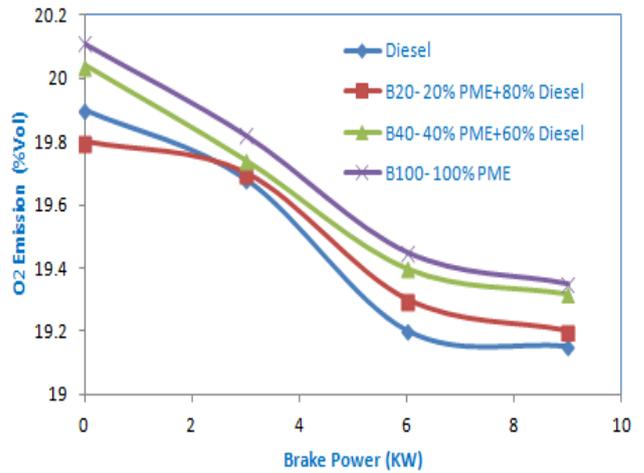


Fig 8: Variation of O₂ emissions with BP

The o₂ emission for neat diesel at maximum load is 19.15% vol and it starts to Increase for bio diesel blends. The emission increase to 19.2% vol, 19.32% vol, 19.35% vol for B20, B40, and B100 for respectively. The variation is mainly due to the difference in the degree of oxygenation of the different feedstock's and its chemical composition. Highly saturated oils, when used as feedstock's for biodiesel production are more oxygenated, burns cleaner and stable.

H. SMOKE DENSITY

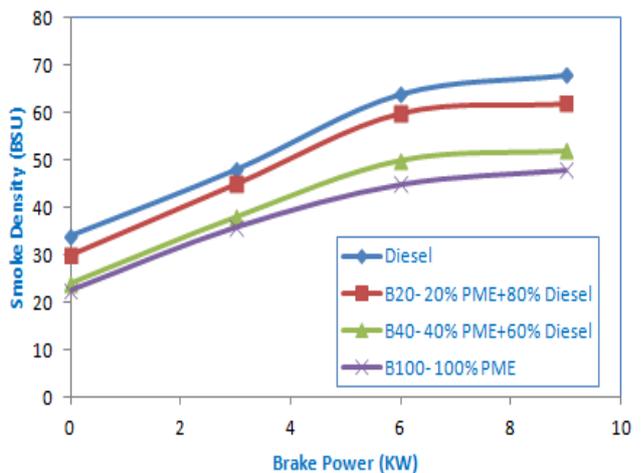


Fig 9: Variation of Smoke Density with BP

The variations of smoke density at different engine load are presented for neat diesel at maximum load is 68 BSU. The smoke emission increases with an increase in the load for all fuels. The smoke density for diesel is 3.6 BSU at full load, whereas for B20 and B100 it is 62 BSU and 48 BSU at full load. The reduction in smoke for biodiesel blends may be due to more oxygen atom present in the biodiesel, resulting in better combustion of biodiesel.

VI. CONCLUSION

Comparison of various performance and emission characteristics among diesel and various blends of Biodiesel with diesel



Table 1: Various Characteristics of Biodiesel with Diesel

VARIOUS CHARACTERISTICS	DIESEL	B20	B40	B100
Brake Thermal Efficiency (%)	24	23.4	21	20
Specific Energy Consumption (Kg/Kw/Hr)	0.35	0.38	0.37	0.38
Nitrogen Oxide Emissions (Ppm)	145	150	160	175
Carbon Monoxide Emissions (%Vol)	0.036	0.035	0.032	0.034
Carbon Dioxide Emissions (%Vol)	1	1.1	1.2	1.3
Hydro Carbon Emissions (Ppm)	1.6	1.5	1.3	1.2
Oxygen (%Vol)	19.15	19.2	19.32	19.35
Smoke Density (Bsu)	68	62	52	48

Among different mixes of Pongamia pinnata biodiesel tried in VCR motor with turbo charger arrangement. The B20 has the least fumes attributes and better execution qualities. Hence 20% PME oil and 80% of diesel blend at standard temperature of 27°C and standard compression ratio 18:1 gives slightly better performance and reduced emission when compared to other diesel blends.

REFERENCE

1. S. Sendilvelan, K. Bhaskar, Rasayan Journal of Chemistry, 9 (4), 692(2016)
2. S. Sendilvelan, K. Bhaskar, Rasayan Journal of Chemistry, 10 (1), 111(2017)
3. S. Sendilvelan, K. Rajan, Rasayan Journal of Chemistry, 10 (1), 190(2017) 12
4. S. Sendilvelan, K. Bhaskar, Rasayan Journal of Chemistry, 10 (3), 844(2017)
5. Horng-WenWu, Zhan-YiWu, "Using Taguchi method on combustion performance of a diesel engine with diesel/biodiesel blend and port-inducting H2" Applied Energy, Volume 104, April 2013, Pages 362-370.
6. P.Deivajothi, V.Manieniyam and S. Sivaprakasam, "Experimental Investigation on the Effect of Thermal Cracked Carbon Filtered Fatty Acid Biodiesel on Engine Performance and Exhaust Emission" International Journal of Engineering Trends and Technology (IJETT) – Volume 38 Number 7- August 2016.
7. M. Prabhakar, and K. Rajan, Performance and combustion characteristics of a diesel engine with titanium oxide coated piston using Pongamia methyl ester, Journal of Mechanical Science and Technology 27 (5) (2013) 1519~1526
8. M. Prabhakar, S. Sendilvelan, S. Prakash and M. Saravanakumar, Investigation Of Pine Oil Methyl Ester Blends With Diesel On A Compression Ignition Engine To Control Oxides Of Nitrogen And Soot Particles, Rasayan j.Chem. Vol. 10 | No. 4 |1075-1079 | October - December | 2017 ISSN: 0974-1496
9. Paula Berman, Shahar Nizri, Zeev Wiesman, (2009)," Castor oil biodiesel and its blends as alternative fuel", 86 (2009) 2476–2486
10. V Naresh and S Prabhakar, "Performance and Emission Characteristics of Algae Oil on VCR Diesel Engine" Journal of Chemical and Pharmaceutical Research, 2018, 10(4): 44-55, ISSN : 0975-7384.
11. M.K.-K. Figueiredo , G.A. Romeiro , L.A. d Avila , R.N. Damasceno , A.P. Franco (2011),"The isolation of pyrolysis oil from castor seeds via a Low Temperature Conversion (LTC) process and its use in a pyrolysis oil–diesel blend Fuel", 90 (2011) 2089–2097
12. Abdolsamad Zarringhalam Moghaddam, Erfan Salimipour, Ojtaba Saei Moghaddam and Nooshin Gholipour Zanjani (2011), "Improvement fuel properties and emission reduction by use of Diglyme-Diesel fuel blend on a heavy-duty diesel engine", International Conference on Environmental Engineering and Applications, Vol. 17, pp. 210-214.
13. Abhang B. and Hameedullah M. (2011), "Determination of optimum parameters for multi-performance characteristics in turning by using grey relational analysis", International Journal Adv Manuf Technology, pp.1-12.

AUTHORS PROFILE



S.Prakash -Research Scholar
Department of Mechanical Engineering,
Vinayaka Mission Research Foundation,
Deemed to be University
Prakash.mech94@gmail.com



Dr. M.Prabhakar - Professor
Department of Mechanical Engineering,
Aarupadai Veedu Institute of Technology
Vinayaka Mission Research Foundation,
Deemed to be University
mprabhakar@gmail.com