International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

Performance and Emission Characterstics of Single Cylinder Diesel Engine using Transformer Oil and Pine Oil Blend with Butanol Additive

R. Venkatesh Babu, Killedar Prashant

Abstract*: Reuse and recycling are better options to derive energy or value added products from waste substances and to minimize the disposal problems. Transformer oil is generally used as a coolant in welding transformers, power transformers and electromotive units. After a prolonged use in these devices, the transformer oil becomes waste and is disposed of. The disposal of used transformer oil causes an environmental pollution. However, the used transformer oil has properties that are similar to that of diesel fuel with a marginally higher viscosity and lower calorific value. The aim of the primary investigation is to reuse the used transformer oil as a possible source of energy to run a small powered, single cylinder, four stroke, and direct injection diesel engine with different compression ratios to study the performance and emission characteristics of used transformer oil. The results are analyzed and compared with diesel fuel operation.

***Keywords* :. Transformer Oil, Pine Oil, SMOG, CIDI engine, Internal Combustion, carbon dioxide**

I. INTRODUCTION

In the current upcoming manufacturing field as well as population enhancement during the past five decades, more fossil fuels were consumed. India is one of the best ever growing country with constant growth of economic view to multiply the requirement of different transportation in various fields.

In the current time, petroleum products are getting depletes much faster due to more power usage hence, there is an emergency requirement to find out the suitable renewable alternate fuels to overcome the above issue. The alternative fuels are likely to be renewable and addresses so many concerns such as global warming, pollution etc. In general the type of bio fuel extracted from the plant based sources and biomasses are whispered to indulge the stipulate of petroleum fuels in the nearby forthcoming.

Manuscript published on November 30, 2019.
*Correspondence Author
Dr. R. Venkatesh Babu* , Dean - Academics, Bharath Institute of Higher Education and Research, Chennai. Email:deanacademic@bharathuniv.ac.in
Killedar Prashant Ashok, Research Scholar, Department of Mechanical Engineering, Bharath Institute of Higher Education and Research, Chennai. Email: pkilledar@yahoo.com

In general, Internal Combustion (IC) engines are functioning through normal petroleum fuels which resulted in increasing Green House Gases (GHG) about past 30 years extensively to the atmosphere. Bio fuels being renewable and bio-degradable which minimizing the exhaust level such as hydrocarbon, carbon monoxide etc significantly. The carbon dioxide (CO2) emission is greatly affects the global warming which should be reduced through alternate fuels with blends. In general IC engines are producing more disagreeable exhaust during its operation. Both Compression Ignition (CI)and Spark Ignition (SI) engines are producing uniform emission during their operations.

In this paper discusses in section 2 literature review; in section 3 presents materials and experimental set up; in section 4 presents results and discussions; in section 5 presents conclusion of this research work.

II. LITERATURE SURVEY

In this section, many literature article related to the area of research were discussed.The earlier research studies are limited in this area of specialization due to new technique established. This research study is a new and novel idea in the field of alternate fuel and its applications.

The testing in CI engine using used transformer oil and its diesel blends like UTO10, UTO20 and UTO30 by volume basis was carried out. They found to be 56.79%, 61.61%, 63.96% and diesel was 54.23%. They said that decreasing by necessary blends of UTO as compared with to DF by means of lesser heating value. BSFC at blend UTO 30 will be obtained as optimum blend [1,2 and3]. According to experimental recorded parameters of the engine were normal during the engine testing. The engine lubricating system parameters of the engine collapse since the lubricating oil started to thicken. Engine testing both in and out of the laboratory were required to authenticate these usual explanations [4,8&9]. The experiments to estimate presentation, exhaust gas emissions, and carbon deposits in DI diesel operated with ETHANOL, rapeseed oil, methyl ester of rapeseed oil, and these fuels blended with ethanol or diesel fuel with dissimilar fuel temperatures and revealed for short term operation that both of vegetable oil generation an agreeable engine presentation and exhaust gas emission levels, but they triggered payment of carbon build ups and penetrating of piston rings after protracted operation were carried out [5,6,7&10].

Based at the above study, an strive changed into made on this research to analyse the presentation and emission traits of single cylinder diesel engine fuelled with used transformer oil and pine oil mixtures with additive.

III. MATERIALS AND EXPERIMENTAL RESULTS

In this section presents the materials and experimental set of this research work.

A. Transformer Oil

The transformer oil is utilized in electrical transformer which is an equipment utilized to transmit and distribute the electrical energy without loss mounted with different sizes such as small, medium and large station and also its utilized in arc welding equipments as well as electromotive units in trains.

Table 1: Properties of Diesel and Utilized Transformer Oil

Characteristics	***Diesel***	***UTO***	***B30***
Calorific value (kJ/kg)	*43000*	*42250*	*42727*
Density(kg/m^3)	*830*	*880.9*	*845.3*
Kinematic viscosity (cSt)	*4.3*	*9.54*	*5.872*
Flash point(ºc)	*58*	*126*	*78.4*
Fire point(ºc)	*68*	*132*	*87.2*

From the above Table 1 found that calorific value, density and kinematic viscosity of pure diesel like43000kJ/kg, 830kg/m3 and 4.3cSt respectively. Similarly 42727 kJ/kg, 845.3kg/m3and 5.872cSt for blend B30.We compared both value and found that calorific value of B30 is 0.63% less than pure diesel, density of B30 is 1.81% more than pure diesel and also kinematic thickness of B30 is 26.77% more than pure diesel.

A 3.5 kW, 1500 rpm, Kirloskar diesel engine is utilized in this investigation and the schematic diagram and the pictorial view of experimental setup is depicts in Figure 1. The detailed specifications are specified in Table2.

Table 2: Test Engine Specifications

Engine Type	***FourStroke, SingleCylinder Direct Ignition DieselEngine***
Ratedpower	*4.4kW*
Ratedspeed	*1500rpm*
Boresize	*87.5mm*
StrokeLength	*110mm*
CompressionRatio	*16:1*
Injectionpressure	*200bar*
Injectiontiming	*23bTDC*

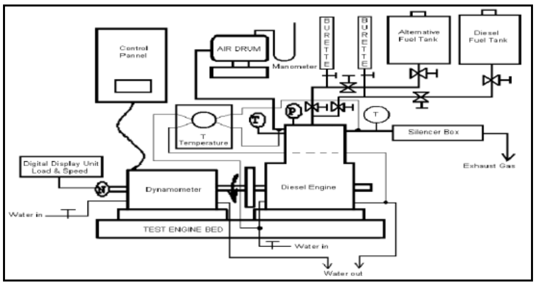

Fig. 1.ExperimentalSetup Line Diagram

The two detach gas tanks through a gasoline knobs machine are utilised, one for tank of diesel (D100) and other one for tank of biodiesel (B100). Fuel expenditure is calculated the use of optical sensor. A degree of difference strain transducer is utilized to degree airflow rate. A piezoelectric force transducer is set up in steam engine canister head to degree burning strain. Indications from stress transducer are nourished to price amplifier. A high accuracy nonconformist angle encoder is utilized to provide indicators intended for top lifeless centre and eccentric angle.

The indicators from fee amplifier and also crank attitude encoder have furnished to information gaining method. An AVL exhaust gasoline analyzer, AVL smoke meter are utilized to calculate emission parameters (CO, HC, CO2, O2& NOX) and smoke depth in that order. Thermocouples are utilized to degree tire out temperature, coolant temperature bay air temperature.

Table 3:Properties of Diesel, Pineoiland n-Butanol

Properties	***Diesel***	***Pine oil***	***n-Butanol***
Density(kg/m³)	*830*	*850*	*810*
SpecificGravity	*0.83*	*0.85*	*0.81*
Kinematicviscosity @ 40ºc(cSt)	*1.57-3.9*	*1.77*	*3.6*
Calorific value(kJ/kg)	*42600*	*44843*	*33100*
Flash point(ºC)	*49-58*	*50*	*35*
Fire point 52	*52*	*60*	*39*

While starting the engine, the gasoline tank is crammed in necessary gas proportions up to its capacity. The engine is permitted to run for 30 min, for regular circumstance conditions, earlier than load is accomplished. as a final point, the engine is run by honne oil diesel mixture at diverse injection pressures the corresponding observations are noted. The test is done on the Engine for the subsequent gasoline intermingle:

100% Diesel
30% Pine oil
P30+5% Butanol+65% Diesel
P30+10% Butanol+60% Diesel
P30+15% Butanol+55% Diesel

Experiments had been initially done on the engine the usage of diesel as gasoline with a purpose to give foundation procession records.

IV. RESULTS AND DISCUSSIONS

In this section presents results and discussions of this research work. Initially, used transformer oil of its diesel blends in the used transformer oil concentration for 30%, increase in thermal efficiency with significant improvement in reduction of smoke was observed for used transformer oil and its diesel blends compared to that of diesel. The engine fuelled with the used transformer oil was tested at varying compression ratio 16:1, 17:1, 18:1, 19:1 and 20:1.

The results indicated that increasing compression ratio increases the thermal efficiency, NOx emission and reduced smoke emission. The optimum compression ratio was found to be 18:1. With this compression ratio, the NOx emission was found to be decreased than that of the used transformer oil and diesel. The smoke emission was found to decrease with variation of compression ratio respectively compared to that of the UTO and diesel at maximum brake power.

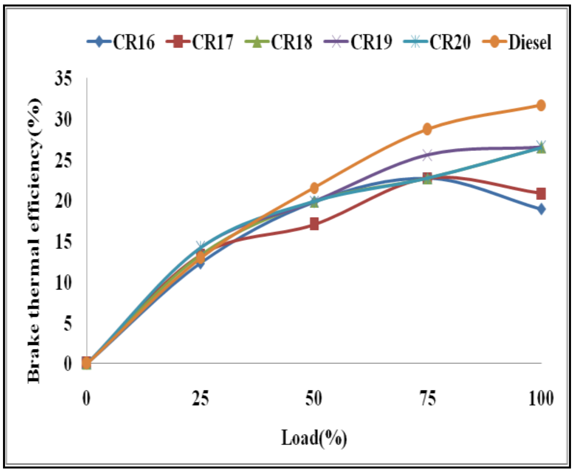

Fig. 2.BTE Disparity under Different Loading Conditions

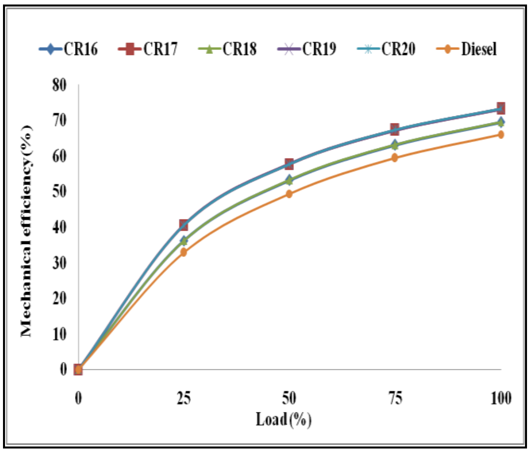

Fig. 3.Disparity of Mechanical Efficiency under Various Loads

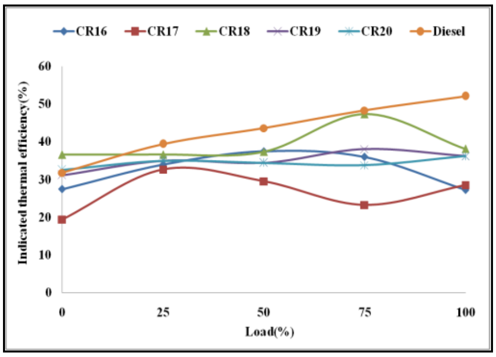

Fig. 4.Disparity of ITE under Different Loads

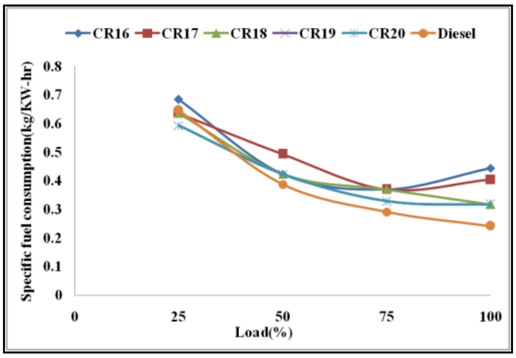

Fig. 5.SFC Deviation under Different Loading Conditions

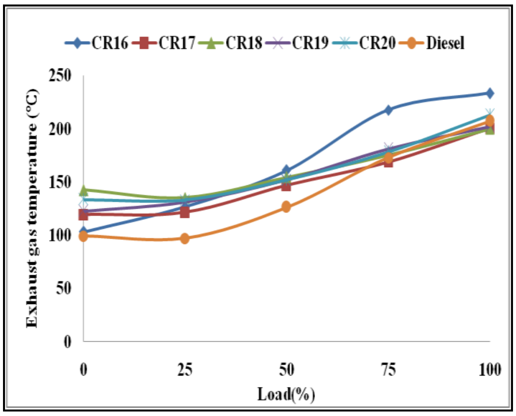

Fig. 6.Distinction of Outlet Heat of Gas under Various Loads

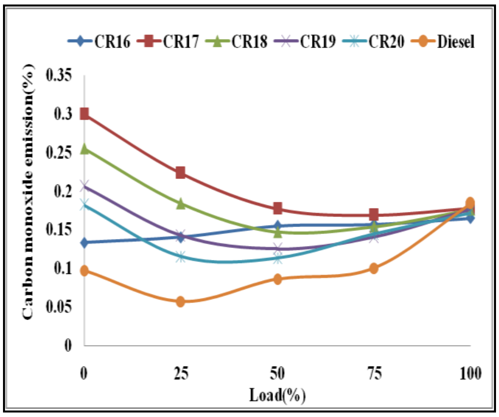

Fig. 7.Disparity of CO under Different Loads

Retrieval Number: D8887118419/2019©BEIESP
DOI:10.35940/ijrte.D8887.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

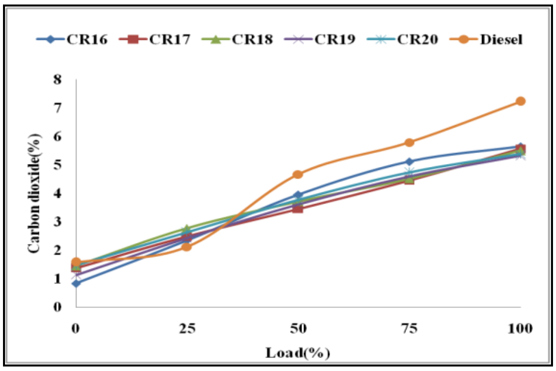

Fig. 8.Distinction of Carbon Dioxide under Various Loads

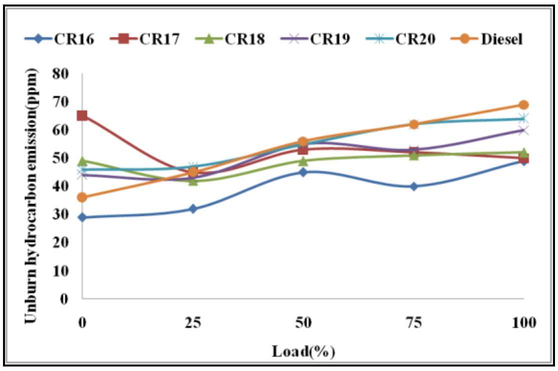

Fig. 9.Distinction of unbured HC Smoke under Different Loading Conditions

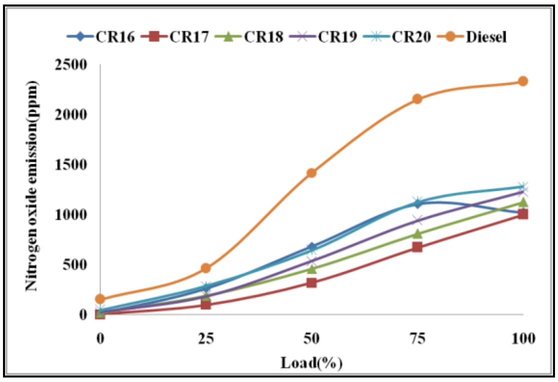

Fig. 10. Distinction of Nox Discharge under Different Loads

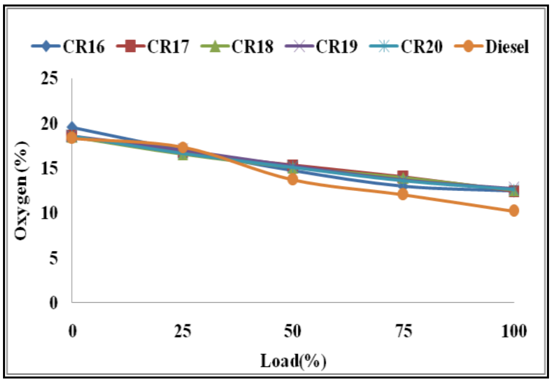

Fig. 11. Dissimilarity of Oxygen under Various Loads

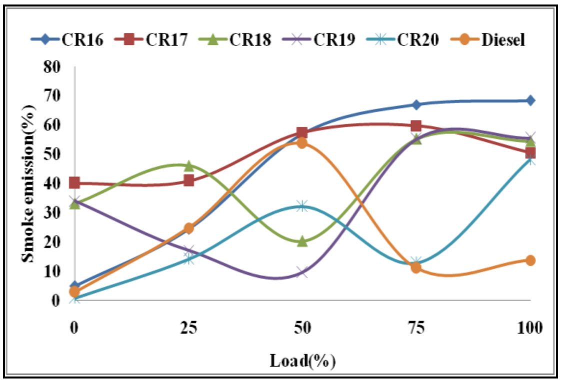

Fig. 12. Dissimilarity of Exhaust Opacity under Different Loads

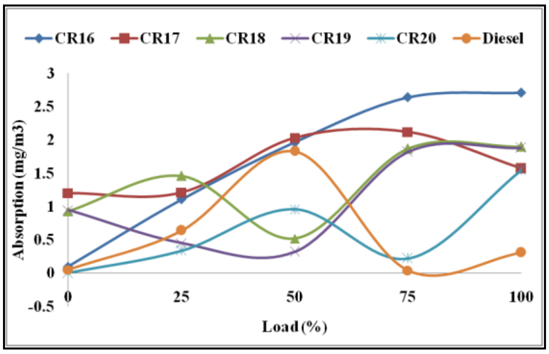

Fig. 13. Dissimilarity of Smoke Absorption under Various Loading Conditions

Alternate fuels which are extracted from Vegetable oils will positively reduce the usage of fossil fuels. There are various types of vegetable oils that can be used as alternate fuels. The different vegetable oils are: Jatropha oil, Cotton seed oil, Pine oil, Rubber seed oil, Rape seed oil, Rice bran oil, Orange peel oil. Out of these different vegetable oils, Pine oil is most important. Because the Calorific value of the Pine oil is almost equal to the calorific value of the Diesel. As Pine trees are available in abundance in India, one can easily extract oil from its seeds which can be successfully used as an alternate fuel to meet the requirements of fuel at the most economical rate.

The oil extracted from pine tree can be blended with Diesel and used in Diesel Engine. Several researchers have taken efforts to adopt suitable methods of using Pine oil which exhibits improved performance and reduced emissions. The objective secondary investigation is to blend the Pine oil, diesel fuel with butanol at various proportions by volume. The Pine oil will be directly blended with diesel fuel and P30 with 5%, 10% and 15% butanol additive without any trans-esterification process, because of its low viscous property.

The prepared blends with tested in a diesel engine at various loads. Finally the observed performance and emission characteristics such as brake thermal efficiency, Specific fuel consumption, CO, Hydro carbon, CO2, Nox emission of these blends were compared with pure diesel fuel. Among the results the P30 with 5%, 10% and 15% butanol blends were increases brake thermal efficiency and decrease of specific fuel consumption gives better performance and reduce the CO, Hydro carbon, CO2, Nox emission compared to P30 and Diesel.

Retrieval Number: D8887118419/2019©BEIESP
DOI:10.35940/ijrte.D8887.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

In the beginning the engine turned into commenced utilizing diesel fuel and permitted to run for couple of transcription till in the direction of attain consistent country; the base line information have been used. consignment became numerous from zero to complete freight situation and Emissions, smoke and gasoline consumption analyzing had been recorded.

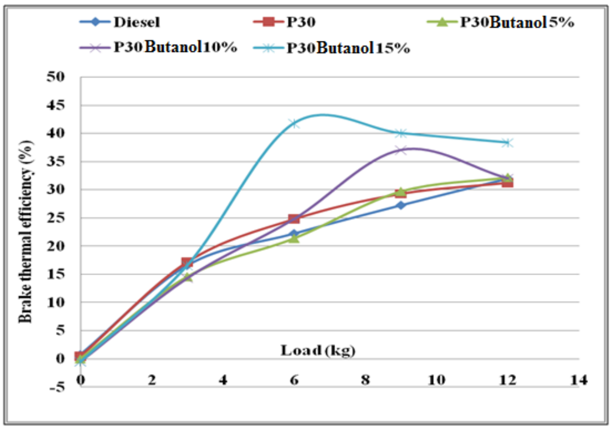

Fig. 14. Dissimilarity of BTE under Different Loads

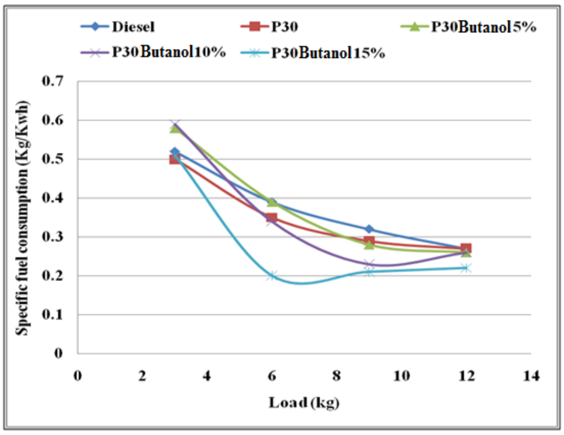

Fig. 15. Dissimilarity of SFC under Different loading Conditions

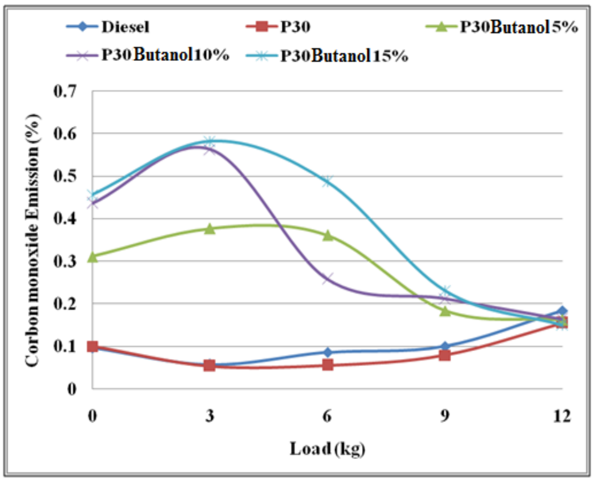

Fig. 16. Dissimilarity of CO Discharge under Different Loads

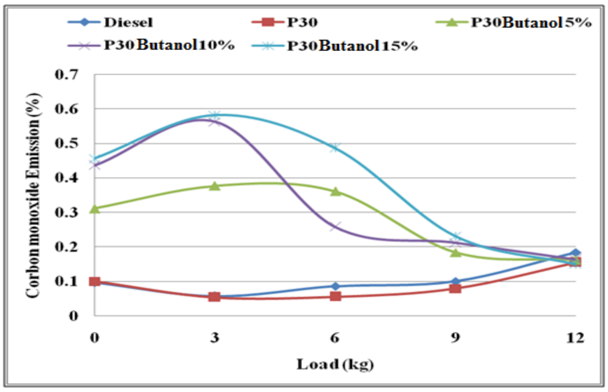

Fig. 17. Dissimilarity of CO Discharge under Different Loads

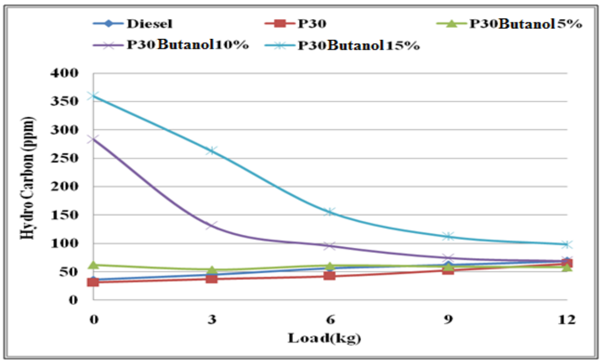

Fig. 18. Dissimilarity of HC Discharge under Different Loads

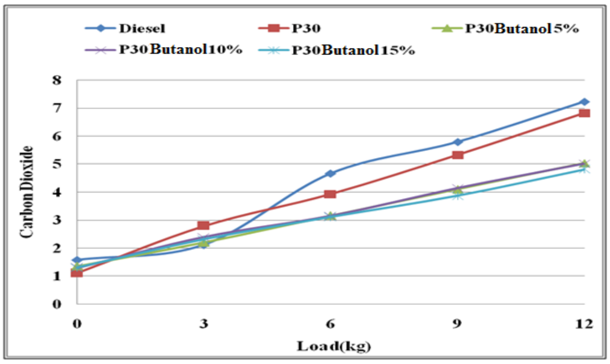

Fig. 19. Dissimilarity of CO2 Discharge under Different Loads

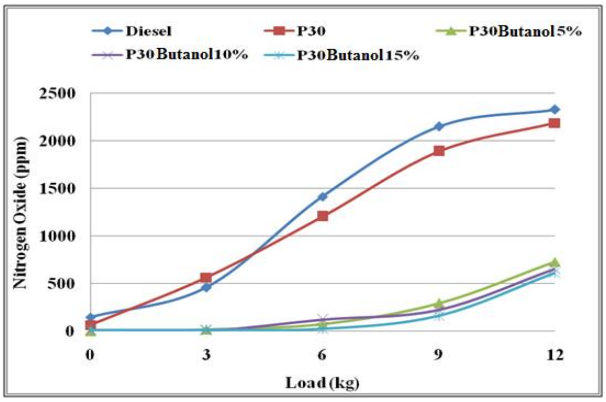

Fig. 20. Dissimilarity of NOXDischarge under Different Loads

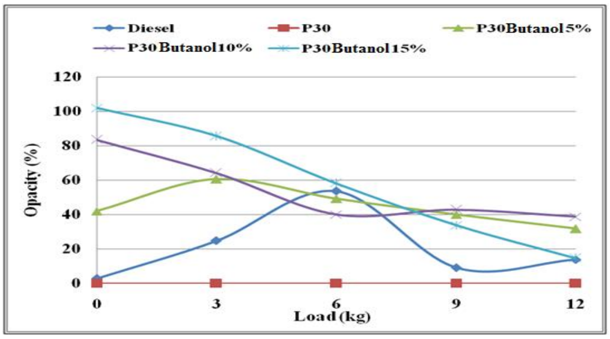

Fig. 21. Dissimilarity of Discharge Capacity under Various Loads

The research analysis was done to examine the suitability of used transformer oil and pine oil blends with butanol additive as a replacement to diesel for diesel engine for our future. From the results of replacement of used transformer oil it was found that, B30 and Variable Compression Ratio (VCR) and pure diesel being exercised effectively by way of good enough depiction along with best emission control as associated to the pure substance fuel at certain extent.The BTF of B30 is 5.19% lesser as equated with pure diesel at full load complaint for used transformer oil. So we can use it in place diesel in future. Specific fuel consumption of used transformer oil at full load at condition of B30 is 23.66 % lesser than diesel and optimum compression ratio is CR18.The heat of gas release of used transformer oil is 3.44% more than clean substance fuel with maximum loading conditions and optimum compression ratio is CR18.Carbon monoxide emission of used transformer oil at full load condition is less then diesel. The CO releases of used transformer oil with full loads are less then diesel so carbon monoxide emission is reduced at CR18.The CO_2 emission of used transformer oil at full load is 1.73% less then diesel. The carbon dioxide emission for used transformer oil at all loads and all compression ratios but (CR 18) is optimum compression ratio. The unburned hydrocarbon emission of used transformer oil at full load is 24.64% less then neat diesel. It shows that hydrocarbon emission decrease at compression ratio 18:1 (CR 18).The nitrogen oxide emission of used transformer oil of the entire compression ratio is 51.76% less then diesel at full loads but (CR 18) is optimum compression ratio.The smoke opacity of used transformer oil is 28.34% less then neat diesel at load. It shows that smoke emission decrease with the use of. It means used transformer oil can be use in only small vehicles.

V. CONCLUSION

In this research work concludes that B30 of used transformer oil and compression ratio18:1 of CR 18 being effectively exercised with suitable and enhanced performance than clean diesel. It means 30% of used transformer oil and 70% of diesel can replace at the place of diesel for compression ignition engine. To obtain smaller amount emission and enhanced presentation with consequently help to different environmental parameters. In future in the place of diesel we can use used transformer oil to provide a better solutions to reduce the current aggressive ecological effluence troubles. Similarly, from the results of pine oil blends with butanol additive the following decisions were made. From the observed outcomes of depiction and emission characteristic of pine oil the following concluding remarks were arrived.Pine oil with additive gives optimum results in showing the depiction pollution characteristics very closer to the diesel especially by reducing the Co and HC

REFERENCES

1. Pullagura, G., Kumar, K.R., Verma, P.C., Jaiswal, A., Prakash, R. & Murugan, S. (2012). Experimental investigation of hydrogen enrichment on performance and emission behavior of CI engine. International Journal of Engineering Science and Technology, 4(3), 1223-1232.
2. Ntui, V.O., Thirukkumaran, G., Iioka, S. & Mii, M. (2009). Efficient plant regeneration via organogenesis in 'Egusi' melon (Colocynthis citrullus L.). SciHortic (Amsterdam), 119, 397-402.
3. Modi, M.A., Patel, T.M. & Rathod, G.P. (2014). Parametric optimization of single cylinder diesel engine for palm seed oil & diesel blend for brake thermal efficiency using Taguchi method. IOSR Journal of Engineering, 04(05), 49-54.
4. Hanbey Hazar & Huseyin Aydin. (2010). Performance and emission evaluation of a CI engine fueled with preheated raw rapeseed oil (RRO)-diesel blends. Applied Energy, 87, 786-790.
5. Lakshmanan, T. & Nagarajan, G. (2010). Experimental investigation on dual fuel operation of acetylene in a DI diesel engine. Fuel Processing Technology, 91, 496-503.
6. Lin, L., Cunshan, Z., Vittayapadung, S., Xiangqian, S. & Mingdong, D. (2011). Opportunities and challenges for biodiesel fuel. Applied Energy, 88, 1020-1031.
7. Nagarhalli, M.V. & Nandedkar, V.M. (2011). Effect of injection pressure on emission and performance characteristics of Karanja biodiesel and its blends in C.I. Engine. International Journal of Engineering Research, 1(2), 786-792.
8. Santhosh Kumar Gugulothu et al. Effect of Injection Timing & Split Injection on different piston bowl configuration in a DI Diesel engine. Procedia Engineering 127(2015) 924- 931.
9. Naseb Khan et al. Performance and emission characteristics of a diesel engine with varying injection pressure and fueled with hydrogen and cottonseed oil methyl ester blends,ICMPC 2017, Materials Today: Proceedings 5 (2018) 3369–3377.
10. Avinash Kumar Agarwal et al. Combustion, performance and emissions characteristics of a newly developed CRDI single cylinder diesel engine, Vol. 40, Part 6, September 2015, pp. 1937–1954._c Indian Academy of Sciences.

AUTHORS PROFILE

Dr. R. Venkatesh Babu is a Doctorate in Engineering with more than 19 years of experience in teaching, research and administration. Having done his graduation in Mechanical Engineering, Post-Graduation in Computer Aided Design, he did his Doctorate in the field of IC Engines. He has served as an Assistant Director in the All India Council for Technical Education (AICTE) and National Board of Accreditation (NBA), under the Ministry of Human Resource Development (MHRD), Govt. of India. He has served as a Principal of top engineering institutions in Chennai and is presently the Dean – Academics of Bharath Institute of Higher Education and Research, Deemed to be university in Chennai. With more than 27research articles in various international journals and conferences, he is presently guiding 6 Ph.D. research scholars. An expert in the field of Accreditation and Approval processes, he is a member in the Academic Council of various universities across India and been invited as a guest speaker for delivering lectures in several universities and institutions in countries like UK, France, Canada, South Korea, Taiwan, Japan and China. As a service to the student community, he has also been providing professional career guidance to students for more than a decade.

Killedar Prashant Ashok is an Assistant Professor in the Government Polytechnic College, Pune. He is a Post graduate in Mechanical Engineering and is pursuing his Doctoral Degree in IC Engines in Bharath Institute of Higher Education and Research, Chennai.