Analysis of Palm Oil Biodiesel Emissions from a C.I Engine Using a Nano Additive (ZnO)

A. Harigaran[1]*, P. Balu[2]

[1] *Research Scholar, Department of Automobile Engineering, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India*

[2] *Department of Automobile Engineering, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India*

***Corresponding author: harigaran.am@gmail.com**

Abstract

In this research paper, experiment was conducted to analysis the emissions from Palm Oil biodiesel blended with zinc oxide additive. A single cylinder four stroke, water cooled diesel engine is used for the testing purpose. AVL437C Smoke meter and five gas analyser are used for testing emissions. The emission comparison was done between diesel and Palm Oil biodiesel blended with zinc oxide nano additive. The results show that PF (Palam fuel) B20 20ppm has good emission reduction values compared to diesel. Emissions such as carbon monoxide, carbon dioxide, Hydro carbons, Nitric oxides and smoke are studied and compared with respect to diesel fuel standards.

Key words: *Diesel engine, Non-edible oil, Palm Oil, Biodiesel, ZnO, Emissions*

1. Introduction

High living standards of people enormously increased the energy crisis manly fossil fuels. The Energy Information Administration (EIA) stated that nearly 110.6 million bbl/day requirement may rise by the year 2035. To overcome this, systematic efforts are to be made in recent years [1].

Vegetable oil was into use as alternative fuels from renewable sources in early 1900s. In 1937 palm oil was reported as diesel substitute. In India edible oil are mostly importing, so it difficult to use them as alternative fuels. Non edible oil such as Neem, Karanja, Jatropha, are widely available in India [2]. This paper describes the Palm Oil use as feed stock to develop the alternative diesel fuel and emissions in IC engine. The Palm Oil which is non edible, easy available and low cost production oil can be used in existing diesel engine without any alternations. This can alter the high speed requirements of diesel fuel. The results will give growth of economy of the country [3]. So steps to taken for the growth and production of seeds.

The vegetative propagation and techniques for the quality planting material are studied. The various plant cultivation techniques are available for the proper cultivation of seeds. India have good climatic atmosphere for supporting the growth of plants. IBM standards are 100ppm before sowing for good germination. Recent advance in nanotechnology and nano science produce Nano scale energetic materials which have so many advantages. Many researchers analyzed the applications with reference to automobiles [4]. Results reviewed that nano fluids can achieve green environment. They reported the challenges and critical issues in the preparation and use of nanofluids. They also stated that addition of nanoparticulares to diesel and biodiesel has effect on combustion [5].

2. TRANSESTERFICATION

The formation of methyl ester by transesterfication of Palm Oil requires raw oil, Methanol 15% and sodium hydroxide on mass basis. It is an equilibrium process requires alcohol to drive the reaction for completion. The Palm Oil reacts with alcohol in presence of catalyst to form methyl esters. *C*atalyst alters the fuel properties which enhance clean process. In a separating funnel the mixture was stirred throughout the reaction and then allowed to settle under gravity. After 24h two layers were formed, upper layer ester and lower layer glycerol. Ester produced is mixed with warm water to remove catalyst. The process takes 24h to settle under gravity. Then after methyl ester was mixed in various concentrations with mineral diesel to form biodiesel blends [6].

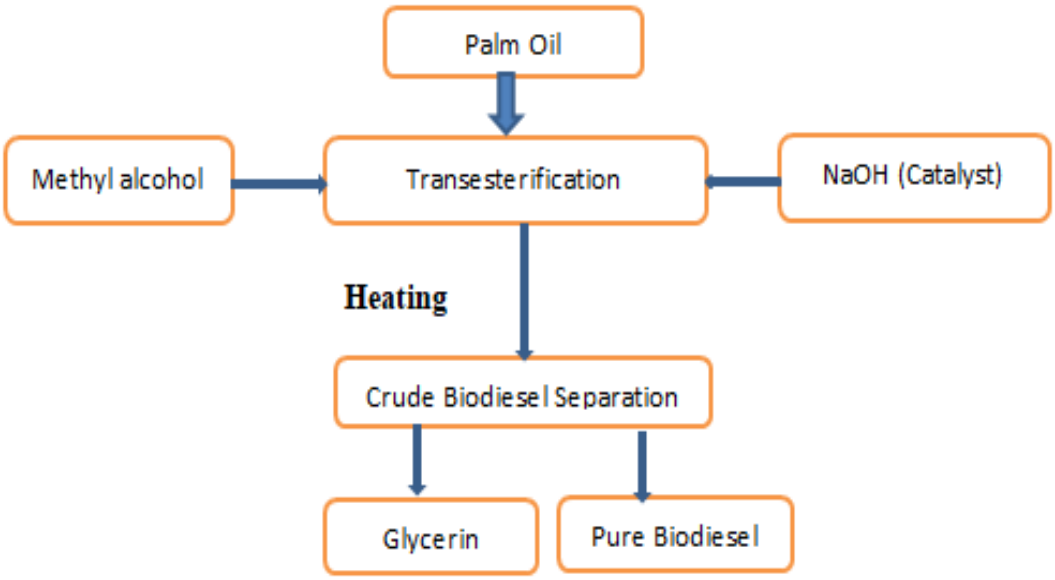

Figure 1 Processing of Palm Oil via Transesterification

3. EXPERIMENTAL SETUP

The setup consists of single cylinder, four strokes, diesel connected to eddy current sort measuring instrument for loading of its given necessary instrument for combustion pressure and crank angle measurement. These signals are interfaced to laptop through engine indicator for Pθ-PV diagrams. Provision is additionally created for interfacing airflow, fuel flow, temperatures and cargo measurement. The setup has standalone panel box consisting of air box, fuel tank, manometer, fuel activity unit, transmitters for air and fuel flow measurements, method indicator and engine indicator. Rotameters are provided for cooling water and measuring device water flow measurement.

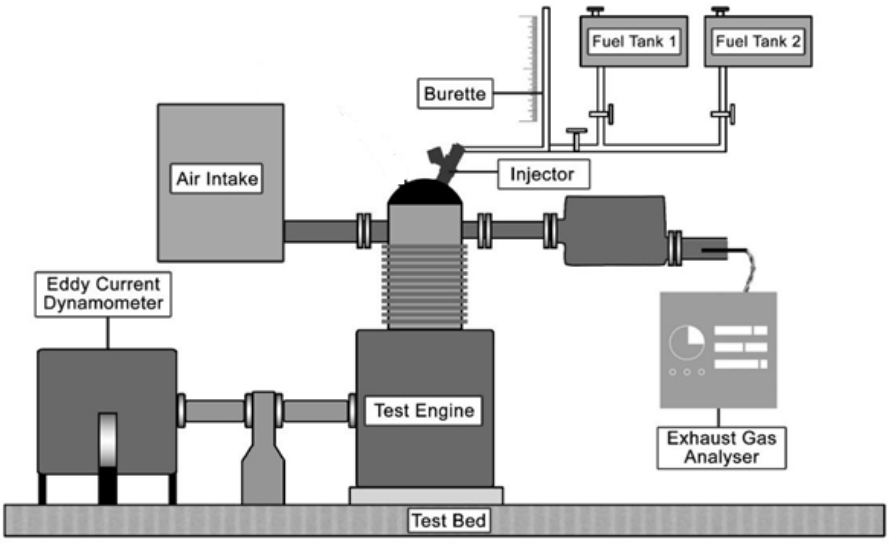

Figure 2: Experimental Setup

The setup permits study of engine performance for brake power, indicated power, resistance power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F quantitative relation and warmth balance. Science lab read based mostly engine performance "Engine soft" is provided for on-line performance evaluation [7]. A computerized diesel injection pressure measurement is optionally provided. The present investigation was done to study the performance parameters between the diesel and Palam oil blend (B20) with ZnO additive of 20ppm, 40ppm, and 60ppm.The engine was first tested with mineral diesel and then Palam blends. The Eddy current dynamometer is used for applying loads. In this test parameters are calculated with respect to brake power.

4. Results and Discussion

The experimental investigation was carried out to analyse the emissions at various load. The results were plotted with respect to brake power (KW).In ester based fuel contains 10-12% of excess oxygen. During combustion it leads to high oxidation, and high formation of carbon dioxide then carbon monoxide. So emissions in figure 3 reduced drastically. In Figure 3 carbon monoxide Vs brake power was shown. Carbon monoxide was measured in percentage of volume and brake power in kilowatt. Carbon dioxide emissions for blend measured to be lower in comparison with diese [8]l.

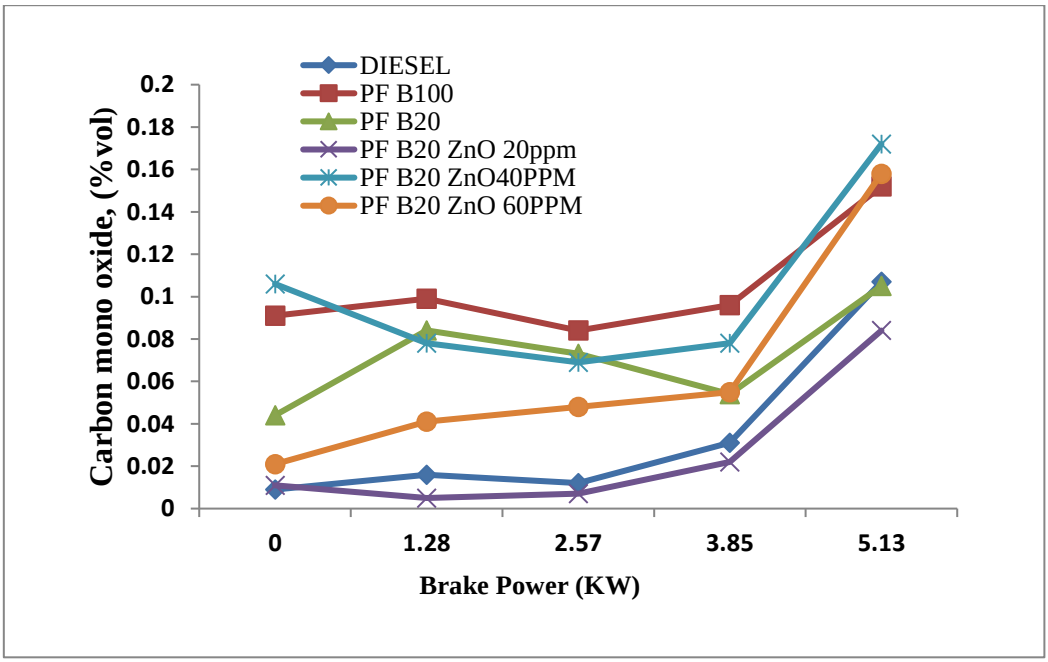

Fig 3 Brake power Vs carbon monoxide

In figure 4 carbon dioxide Vs brake power was shown. Carbon dioxide was measured in percent of volume and brake power in kilowatt.

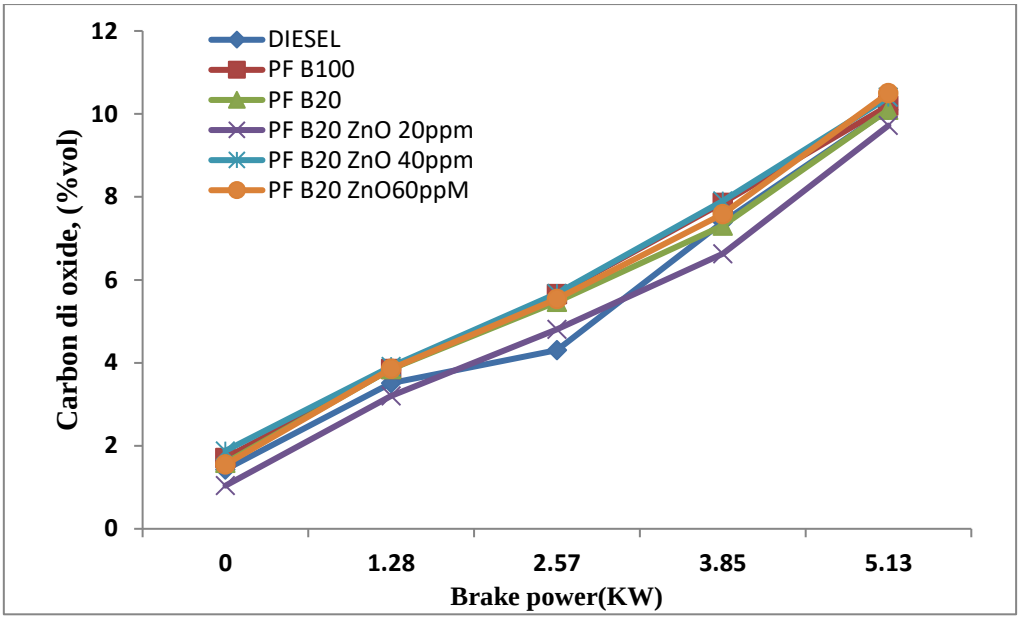

Fig 4 Brake power Vs carbon dioxide

In figure 5 Hydro carbons Vs brake power was shown. It is clearly observed that hydrocarbon emissions also less in Palam oil bend compared to diesel. Initially it is same but with increase in load it decreased gradually [9].

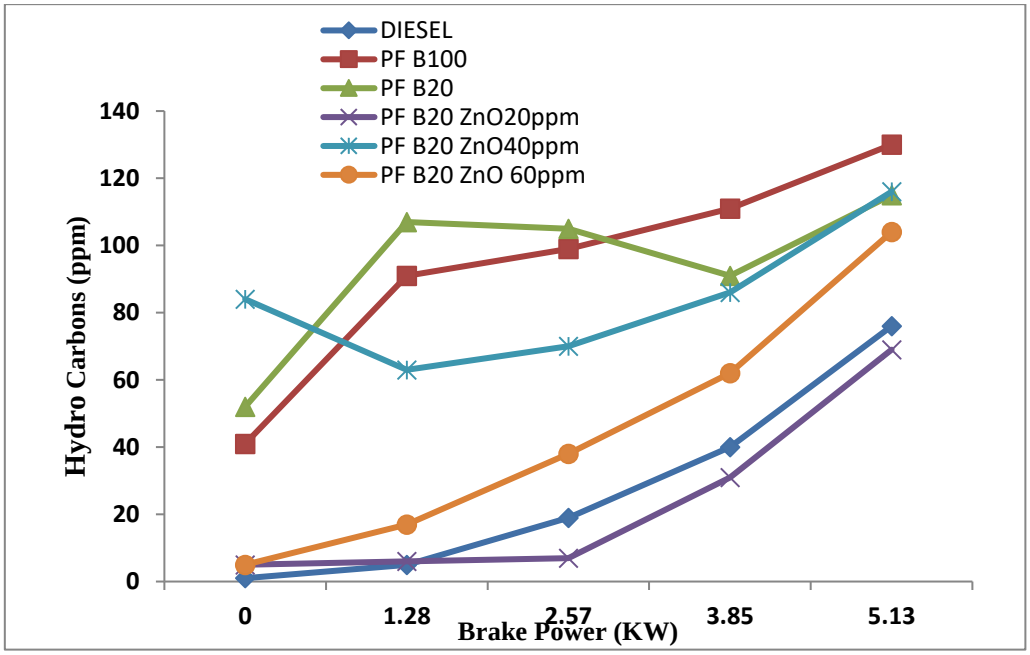

Fig 5 Brake power Vs Hydrocarbons

In figure 6 variation of nitrogen oxides and brake power was shown. The factors affecting the NOx emissions are injection duration, combustion quality, injection timing. It shows that NOx result shows almost same but slightly high at middle [10].

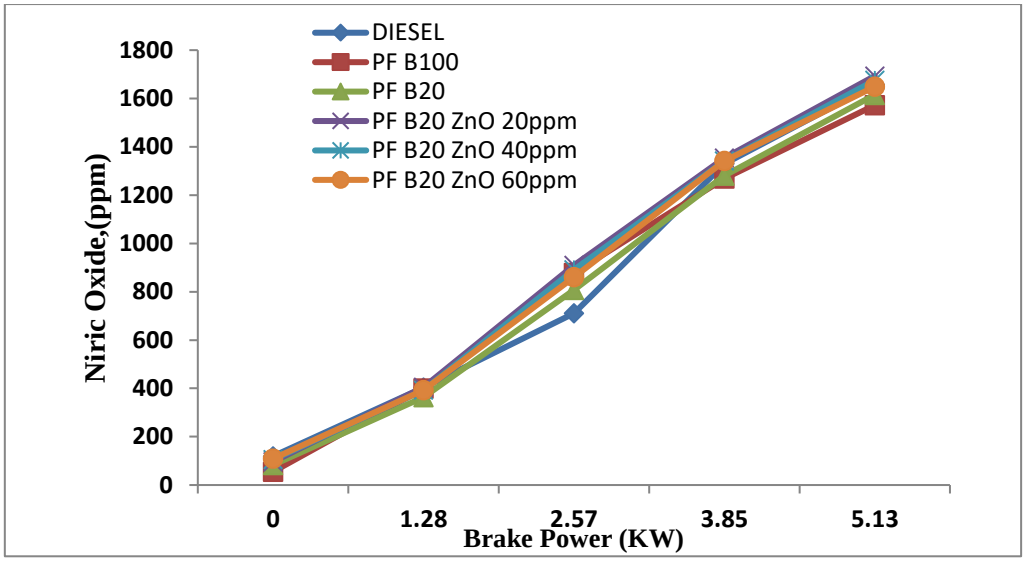

Fig 6 Brake power Vs Nitric Oxides

In figure 7 smoke Vs brake power was shown. Smoke density was calculated by opacity test for Palam oil blends and diesel. Palam oil blend gives high smoke density compared to mineral diesel. For decreasing smoke density combustion chamber design and injection pressure are to be changed.

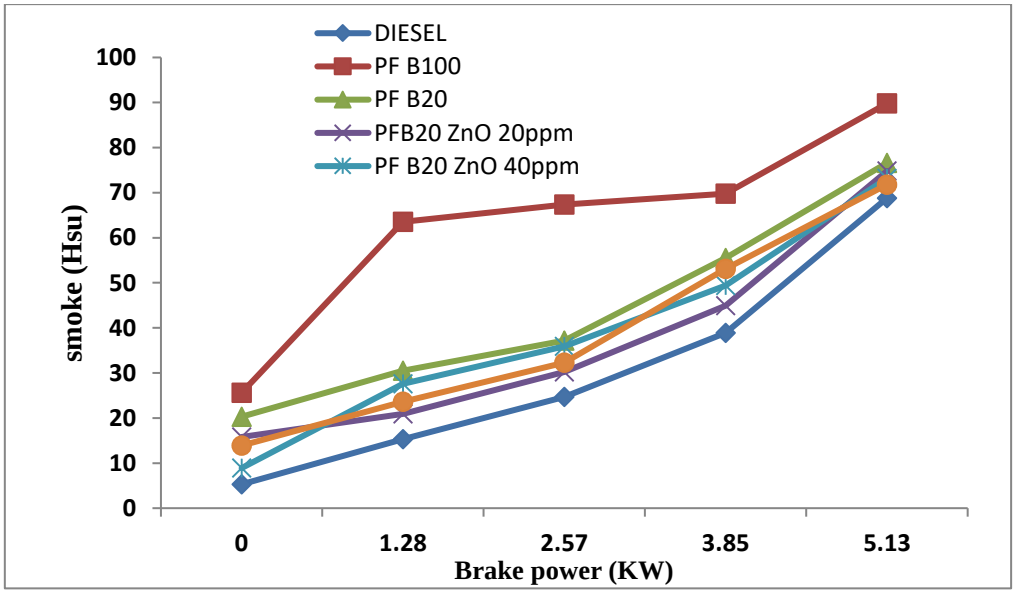

Fig 7 Brake power Vs Smoke

Conclusion

The experimental results obtained from testing Palam oil blend with nano additive zinc oxide doped with 20ppm, 40ppm, 60ppm and mineral diesel draws the conclusion that PF B20 20ppm have good reduction in emissions. Carbon monoxide and carbon dioxide are less. Hydro carbons are initially same but gradually decreased with increasing in load. NOx are almost same at low and high loads. In case of smoke it is slightly high in all blends. PF B100 has high emissions compared to all.

References

[1] T Venkatewara Rao, G Prabakara Rao (2013), "Performance and emission analysis of Pongamia, Jatropha and Neem methyl ester as biodiesel in a C.I engine". IJMERR, Vol.2.

[2] R. Sabarish, D. Mohan Kumar (2018), "Experimental study of nano additives with biodiesel and its blends for diesel engine". International journal of pure and applied mathematics, Vol 118 no.18.

[3] A.P. Senthil kumar, R.Y.Sudhir,(2019) " Investigation on emission characteristics of variable compression ratio engine using nanoparticles blended diesel fuel" International journal of engineering and advanced technology, vol 8 issue 5.

[4] K.Veeraraghavulu, Sudhakar Uppalapati, (2016) "Performance test on IC engine using Pongamia oil" IJIET Vol 6 issue 4.
[5] S.Manibharathi, B.Annaduri, (2014) "Experimental investigation of CI engine performance by nano additive in biofuel." Vol 3, issue 12.

[6] Shaik Syed meer, Mahes Mallampati , A. RamaRao , Sobhanadri Anantha , P. Balu Compression ignition of Hydrogen (H2) in a direct injection diesel engine Modified to operate as a Low Heat Rejection. YMER || ISSN : 0044-0477 VOLUME 21 : ISSUE 2 (Feb) - 2022

[7] Vandaarkuzhali S , J. Selvakumar , Balu P , Muthukumaran K.Combustion Analysis of Various Speed on Hydrogen (H2) in a Direct Injection Diesel Engine Modified to operate as a Low Heat Rejection (LHR). YMER || ISSN : 0044-0477 VOLUME 21 : ISSUE 2 (Feb) – 2022.

[8] K. Chandrasekar , S. Sudhakar , R. Rajappan , S. Senthil , P. Balu. Present developments and the reach of alternative fuel: A review. Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2021.04.505

[9] Ramanujam Soundararaj , Joseph Raj Francis Xavier , Rajendiran Ramadoss , Pandian Balu4 , Veerasundaram Jayaseelan. Surface Ignition using ethanol on Mo and Al2O3-TiO2 coated in CI engine for environmental benefits. Advances in Environmental Technology 1 (2021) 19-27 DOI: 10.22104/AET.2021.4591.1261

[10] Moranahalli Ponnusamy Sudeshkumar Joseph Raj Francis Xavier Pandian Balu Veerasundaram Jayaseelan4 Kumarasamy Sudhakar. Waste plastic oil to fuel: An experimental study in thermal barrier coated CI engine with exhaust gas recirculation. Environ Qual Manage. 2022;1–7. DOI: 10.1002/tqem.21853