IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 2 Ver. II (Mar - Apr. 2015), PP 10-15
www.iosrjournals.org

Evaluation of Engine Performance, Emissions, of a Twin Cylinder Diesel Engine Fuelled with Waste Plastic Pyrolysis Oil, Ethanol and Diesel Blends with Cetane Additive AC2010A

V.L. Mangesh[1], Prof C. Thamotharan[2]
[1,2,] *(Department of Automobile Engineering, Bharath Institute of Science and Technology, Bharath University Selaiyur, Chennai - 73, Tamil Nadu, India)*

Abstract: *Environmental concern and availability of petroleum fuels have caused interests in the search for alternate fuels for internal combustion engines. Waste plastics are indispensable materials in the modern world and application in the industrial field is continually increasing. In the present paper waste plastic pyrolysis oil, ethanol, diesel blend with Cetane additive AC 2010 TOTAL has been introduced as an alternative fuel. In this study, a review of research papers on various operating parameters have been prepared for better understanding of operating conditions and constraints for waste plastic pyrolysis oil and its blends. The objective of adding Cetane Additive is to improve the combustion of blended fuel and have better performance characteristics for the blend. The AC2010A additive improves the cetane number of diesel by 2 to 3 points. In effect, it upgrades the ignition quality of fuel to near global norms. In this study, the diesel engine was tested using Ethanol blended with waste plastic oil and diesel at certain mixing ratios of (Ethanol: WPPO: Diesel) 5:5:90, 10:10:80 and 15:15:70 respectively. The cetane additive added is 1ml per 1000ml of blended fuel. Experimental results of blended fuel and diesel fuel are also compared.*

Keywords: *Alternate Fuel, Cetane Additive, Ethanol, Waste Plastic Pyrolysis Oil*

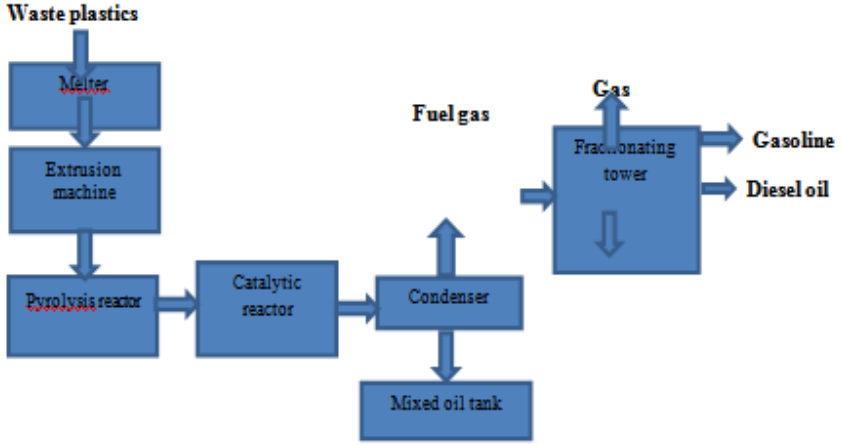
I. Introduction

Waste to energy is the recent trend in the selection of alternate fuels. Fuels like alcohol, biodiesel, liquid fuel from plastics etc are some of the alternative fuels for the internal combustion engines. In recent years, significant growth in the consumption of plastic globally has been due to the introduction of plastics into newer application areas such as in automotive field, rail, transport, aerospace, medical and healthcare, electrical and electronics, telecommunication, building and infrastructure, and furniture. This significant growth in the demand for plastic and its forecast for future have certainly proved that there has been a quiet plastic revolution taking place in every sector. The objectives of this report are to analyse the fuel consumption and the emission characteristics of a kirloskar twin cylinder diesel engine. This report describes the setups and the procedures for the experiment which is to analyse the emission characteristics and fuel consumption of diesel engine due to usage of both fuels. Data that are required for the analysis is observed from the experiments. Calculations and analysis have been done after all the required data needed for the thesis is obtained. A four stroke Twin cylinder diesel engine was adopted to study the brake thermal efficiency, specific fuel consumption, brake power, and emissions at full load. In this study, the diesel engine was tested using Ethanol blended with waste plastic oil and diesel at certain mixing ratios of (Ethanol: WPPO: Diesel) 5:5:90, 10:10:80 and 15:15:70 respectively. The cetane additive added is 1ml per 1000ml of blended fuel. Experimental results of blended fuel and diesel fuel are also compared. We found that the blends of Diesel & Waste Plastic Pyrolysis Oil & Ethanol with cetane additive gives nearer values to Diesel fuel in the Kirloskar Diesel engine, without any further modification in the engine itself.

II. Pyrolysis

Pyrolysis is the chemical decomposition of organic substances by heating, the word is originally coined from the Greek-derived elements pyro "fire" and lysys "decomposition". Pyrolysis technology is thermal degradation process in the absence of oxygen. Plastic waste is treated in a cylindrical reactor at temperature of 300ºC – 350ºC. The plastic waste is gently cracked by adding catalyst and the gases are condensed in a series of condensers to give a low sulphur content distillate. All this happens continuously to convert the waste plastics into fuel oil.

The process of oil from waste plastics takes place as shown in figure below



III. Properties Of Fuel

Properties of Diesel, Ethanol, Waste Plastic Pyrolysis Oil

S.No	Properties	Diesel	Ethanol	WPPO
1	Density	850	789	793
2	Kinematic Viscosity @ 40Deg. C (cst)	3.05	1.04	2.149
3	Cetane Number	55	8	51
4	Flash Point °C	50	16.6	40
5	Fire Point °C	56		45
6	Carbon Residue (%)	0.20 %		0.01 %
7	Sulphur (%)	<0.035		<0.002

Table 1

Properties Of Blended Fuel

Blended fuel in the mixing ratio of Ethanol 10% / WPPO 10% / Diesel 80% was tested at Italab Private Limited, Parrys, Chennai, India. Again Blended fuel in the mixing ratio of Ethanol 10% / WPPO 10% / Diesel 80% + Cetane Additive was tested at Italab Private Limited, Parrys, Chennai, India.

S.No	Properties	Blend of E/WPPO/D	E/WPPO/D & Cetane Additive
1	Kinematic Viscosity @ 40Deg. C (cst)	2.33	2.33
2	Cetane Number	50	59
3	Carbon Residue (%)	0.01 %	0.01 %
4	Sulphur (%)	0.04 %	0.04 %

Table 2

Nomenclature

CI	Compression Ignition
CO	Carbon Mono-oxide
CO_2	Carbon di-oxide
NOx	Mono nitrogen Oxides
BTH	Brake Thermal Efficiency
SFC	Specific fuel consumption
WPPO	Waste Plastic Pyrolysis Oil
E/WPPO/D	Diesel/Ethanol/Waste Plastic Pyrolysis blend oil
E/WPPO/D + Cetane Additive	Diesel/Ethanol/Waste Plastic Pyrolysis blend oil + Cetane Additive
E5/WP5/D90	5% Ethanol, 5 % Waste Plastic Pyrolysis Oil, 90% Diesel and Cetane Additive

Table 3

IV. Experimental Setup

The experimental setup consists of a diesel engine and a gas analyser. The engine used in the experiment is a constant speed Kirloskar engine, four stroke twin cylinder, direct injection vertical diesel engine. The engine is water cooled. The load applied on the engine is by means of electric loading device. The engine is mounted on concrete bed with suitable connections for water cooling and lubrication. The outlet temperature of water from engine is maintained at 50° C by adjusting the flow of the coolant. The schematic arrangement of experimental setup is shown in figure. (10)

Engine Specifications

Engine Make	**Kirloskar**
Engine Type	Four stroke Twin cylinder diesel engine
No. of cylinders	2
Stroke	110mm
Bore	87.5mm
Method of cooling	Water cooled
Horse power HP	10HP
Compression ratio	17.5:1
Rated speed RPM Max	1800
Load type	Electric load bank
Cubic capacity	0.661 Liters

Table 3

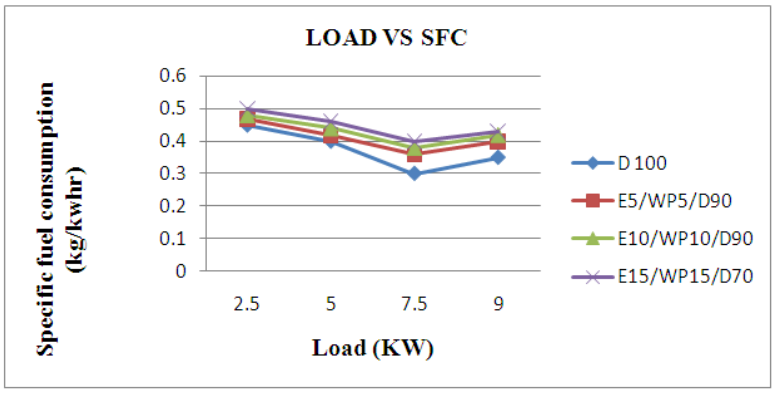
V. Results and Discussions

The Engine Performance and emission test of Waste Plastic Pyrolysis oil, Ethanol, Diesel with a Cetane Additive with different blends are discussed below

5.1 Variation Of Sfc (Kg/Kw Hr) Vs Load (Kw)

The variation of SFC for different loads (KW) applied on the engine for different ratios of waste plastic pyrolysis oil, Ethanol and diesel blends with Cetane Additive are shown below in the Graph 1.

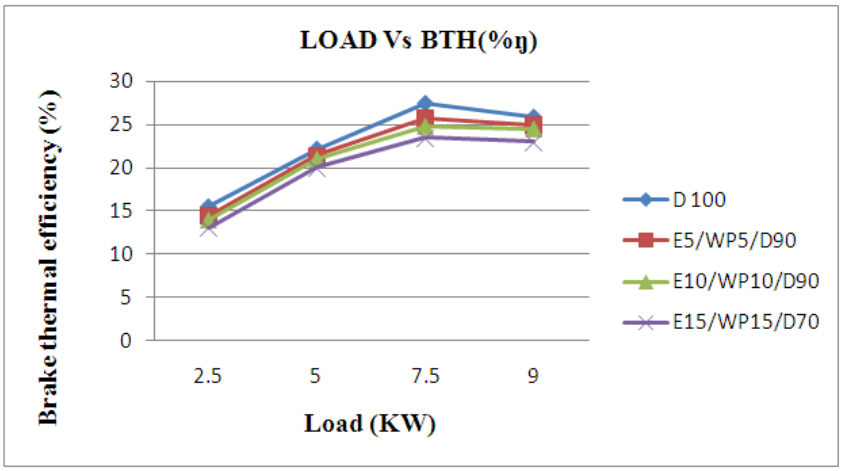
The SFC of blended oil is marginally higher than diesel oil. The E5/WPP5/D90 blend has SFC values much closer to diesel.



Graph 1

5.2 Variation Of Brake Thermal Efficiency (%) Vs Load (Kw)

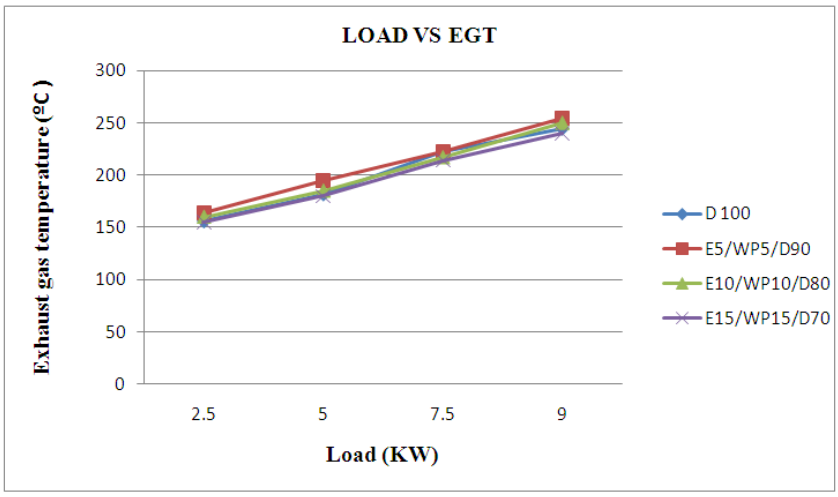
The variation of the brake thermal efficiency for various loads with respect to different ratios of diesel, waste plastic pyrolysis oil, Ethanol and Cetane additive blends are shown in graph 2. The brake thermal efficiency of blended oil is marginally lower than diesel oil. The E5/WPP5/D90 blend has brake thermal efficiency values much closer to diesel.



Graph 2

5.3 Variation Of Exhaust Gas Temperatures (°c) Vs Load (Kw)

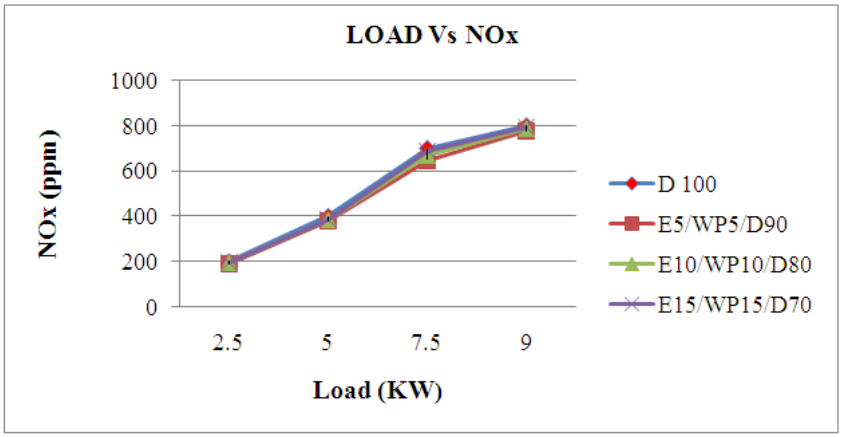
The EGT values of blended oils are almost similar to diesel fuel values as shown in graph 3.



Graph 3

5.4 Variation Of Load(Kw) With Nox (Ppm)

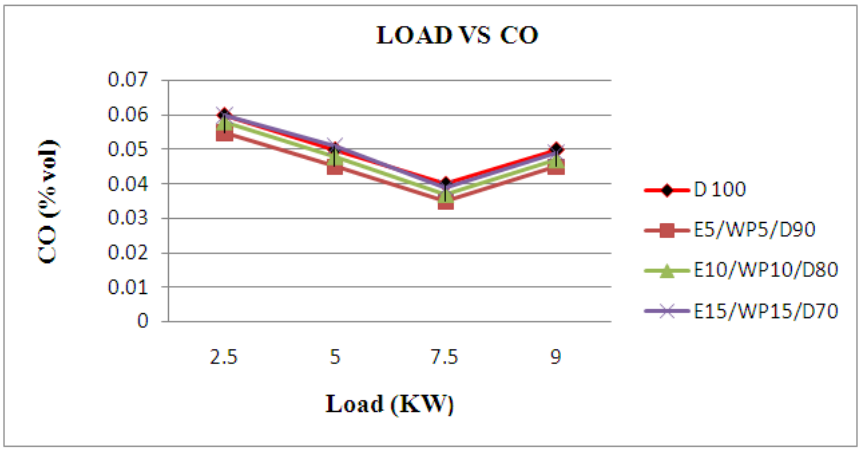
It is observed that the variation of nitrogen oxide emission with the various loads. The NOx emissions from diesel, waste plastic pyrolysis oil, Ethanol and Cetane Additive blends are slightly lower than the normal diesel fuel at higher loads.



Graph 4

5.5 Variation Of Load(Kw) With Co (% Vol)

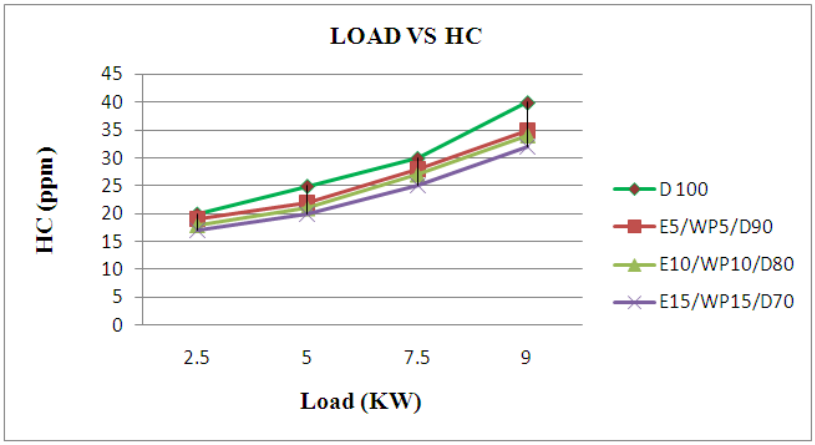
The various CO levels for different blends are shown in graph 5. From the readings it is concluded that emission of CO is similar to that of Diesel.



Graph 5

5.6 variation of load(kw) with hc (ppm)

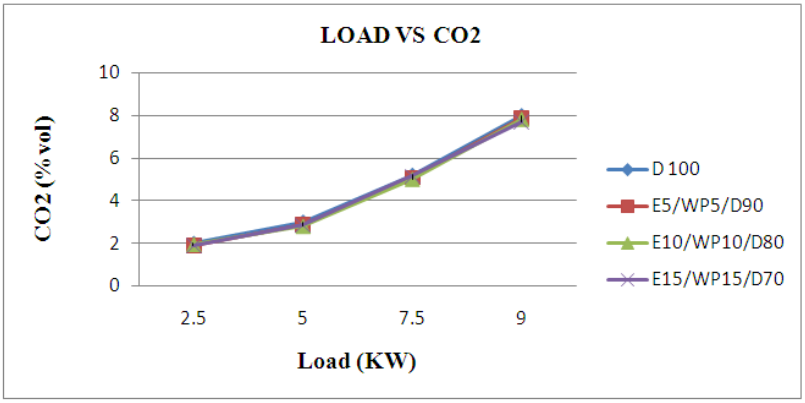
The various HC levels for different blends are shown in graph 6. From the readings it is concluded that emission of HC is similar to that of Diesel. Except at higher loads the HC emissions are slightly lower than diesel.



Graph 6

5.7 variation of load (kg) with co2 (%vol)

The various CO_2 levels for different blends are shown in graph 6. From the readings it is concluded that emission of CO_2 is similar to that of Diesel.



Graph 7

VI. Conclusion

Based on the Engine Performance and Emission test of the Waste Plastic Pyrolysis oil, Ethanol, Diesel and Cetane Improver blend represents a good alternative fuel which gives good performance and better emission characteristics. In this study the diesel 90%, Waste Plastic Pyrolysis Oil 5%, Ethanol 5% blends with Cetane Improver gives good performance when comparing to the other blends.

References

Journal Papers:

[1] Alan C Hasen, Qin Zhang, Peter WL Lyne, "Ethanol Diesel fuel blend" University of Illionis, (2004).
[2] S.Murugan, M C Ramaswamy and G Nagrajan, "Assessment of Pyrolysis oil as an energy source for Diesel engines". Anna University, Chennai, India.
[3] Sutton D, Rush M and Richard P, "Diesel Engine Performance and Emission using different fuel/ additives combustion", SAE Technical Paper 880635, (1988).
[4] Walendzienwski Jerzy, "Engine fuel derived from waste plastics by thermal treatment", Journal of Fuel, 81 473-481 (2002).
[5] Mr Kaustav Mukherjee, Prof C.Thamotharan "Performance and Emission Test of Several Blends of Waste Plastic Oil with Diesel and Ethanol on Four Stroke Twin Cylinder Diesel Engine" Volume 11, Issue 2 Ver. I (Mar- Apr. 2014).
[6] Sk.Mohammad Younus, 2V.Ranjith Kumar, 3DR.Y.V.Hanumantha Rao "Performance and Emissions Characterstics of Diesel Engine Fueled With Tyre Pyrolysis Oil&Diesel Blends with Additives" International Journal of Engineering Science Invention Volume 2 Issue 5 ǁ May. 2013 ǁ PP.32-37
[7] G.V.N. Kumar, G.G. Srinivas, AnilKumar. Ch, "Experimental Investigations on Diesel Engine Fueled with Tyre Pyrolysis Oil and Diesel
[8] Blends" International Journal of Emerging trends in Engineering and Development Issue 2, vol.7 (Novemeber 2012) ISSN 2249-6149.
[9] Lei Zhu, C. S. Cheung, W. G. Zhang, and Zhen Huang, "Influence of Methanol–Biodiesel Blends on the Particulate Emissions of a Direct Injection Diesel Engine" Aerosol Science and Technology, 44:362–369, 2010, ISSN: 0278-6826 print / 1521-7388.
[10] Y. Tarun, Prof. C. Thamotharan, K. Mukherjee "Evaluation of engine performance, emissions, of a twin cylinder diesel engine fuelled with waste plastic oil and diesel blends with a fraction of methanol" International Journal of Engineering & Technology, 3 (2) (2014) 123-128

Books:

[11] Heywood JB, "Internal Combustion engine fundamentals", McGraw Hill Publication, http://www.mcgraw-hill.com (1988).
[12] V ganeshan, "Internal Combustion Engines", (2004)