A Review Paper on Performance And Emission Analysis Of Single Cylinder Four Stroke CI Engine Using Waste Plastic Oil With Additives

[1]Harshal A Mehta, [2]Gaurav N Sutaria, [3]Altafhussain G Momin
[1]Post Graduate Research scholar, [2,3]Assistant Professor,
[1,2,3]Department of Mechanical Engineering,
[1,2,3]L D college of engineering, Ahmedabad, India

Abstract: Energy is the basic need of every one and today energy consumption is increasing significantly with time. Basic sources of energy are fossil fuels such as coal, natural gas and petroleum products such as gasoline and diesel. But these sources of energy are limited in quantity and they are non-renewable. They will not be available in nearby future for use hence these emphasis on searching for new energy resources. If we talk about the automobile sector petroleum products gasoline and diesel are widely used as energy source. To meet the demand of energy alternate sources of energy are being found and some of these are hydrogen, biodiesel, ethanol, biogas etc. A lot of research work is done and being done so that we can find suitable alternatives for Internal Combustion Engines (IC Engines) and hence petroleum fuel last longer. To meet increasing energy requirement, these have been growing interest in alternative fuel like biodiesel to provide a suitable diesel oil substitute for internal combustion engine. Biodiesels are offers a very promising alternative to diesel oil since they are renewable and have been similar properties. In this experimental work Waste Plastic Oil chosen to measure the performance and exhaust emission of the engine .For the performance measurement biodiesel blends from (B10 to B50 with increment of 5) will take. From this analysis best performed blend will decide which gives best performance and exhaust emission of the engine.

***Index Terms* – Alternate Source of Energy, Internal Combustion Engine, Waste Plastic Oil**

I. INTRODUCTION

Plastics have become an indispensable part in today's world, due to their lightweight, durability, and energy efficiency, coupled with a faster rate of production and design flexibility; these plastics are employed in entire gamut of industrial and domestic areas; hence, plastics have become essential materials and their applications in the industrial field are continually increasing. At the same time, waste plastics have created a very serious environmental challenge because of their huge quantities and their disposal problems. Waste plastic pyrolysis in liquid fuel (gasoline, diesel oil, etc.) or chemical raw materials not only can effectively solve the problem of white pollution, but also can alleviate the energy shortage to a certain extent. Recycling of waste plastics is expected to become the most effective way. Waste plastics' recycling, regenerating, and utilizing have become a hot spot of research at home and abroad and gradually formed a new industry.

The plastics include polystyrene, poly (vinyl chloride), polypropylene, PE terephthalate, acrylonitrile-butadienestyrene, and PE. In some cases, plastics were copyrolyzed with other materials such as waste motor oil . With regard to fast pyrolysis of PE, pyrolysis of LDPE, HDPE, and various mixtures was reported. In all PE studies, the properties of the resulting bio-oil were not reported, nor were the upgrading to fuel-grade hydrocarbons and subsequent fuel property determination.

The objective of this study was the production, characterization, and evaluation of alternative diesel fuel from pyrolysis of HDPE waste plastics. Comparison of our pyrolyzed oil with conventional petroleum-derived diesel fuel was a further objective, along with a comparison to petrodiesel standards such as ASTM D 975 and EN 590. Blends of waste plastic pyrolysis oil (WPPO) with diesel were prepared and the resultant fuel properties were measured. It is anticipated that these results will further the understanding of the applicability and limitations of HDPE as a feedstock for the production of alternative diesel fuel.

The plastic used in this study was used waste plastic containers (HDPE) for domestic purposes. Waste plastics were cleaned with detergent and water to remove contained foreign materials such as mud and oil.

- The main additives are as under:-
- Jatropha methyl ester
- Diethyl ether
- 2-methoxy ethyl acetate (MEA)
- Oxygenated three high-carbon alcohols

- N-butanol
- Sorbitan monolaurate (span 20)
- Polyoxyethylene (tween 80)

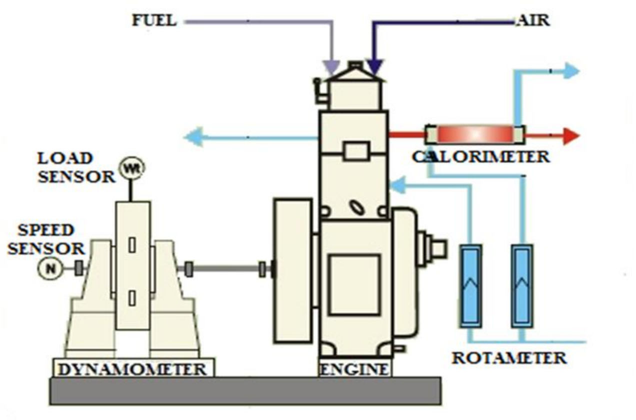

Figure : Schematic representation of test engine setup

II. EFFECT OF JATROPHA METHYL ESTER ON WASTE PLASTIC OIL FUELED DI DIESEL ENGINE

P. Senthilkumar , G. Sankaranarayanan (2015) conducted Experimental examination that Waste plastic oil exhibits a higher cylinder peak pressure compared to diesel because of evaporation of waste plastic oil inside the cylinder by absorbing heat from the combustion chamber. The heat release rate with waste plastic oil is higher compared to diesel fuel due to better combustion. With an increase in percentages of JME, NOx increase due to the presence of oxygen molecule in biodiesel that lower heat release rate and combustion temperature. From the experimental investigation the following conclusions were drawn:

Brake thermal efficiency, increased by about 2.24% with PJ20 operation at full load compared to waste plastic oil.NOx emission is 20 ppm higher for PJ20 operation than waste plastic oil at full load. HC emission for PJ20 operation is about 11 ppm lower than waste plastic oil at full load. CO emission for PJ20 operation is about 0.13% lesser than waste plastic oil at full load.Smoke emission decreased by about 11.4% in the case of PJ20 compared to waste plastic oil at full load.[1]

III. EFFECTS OF USING DEE ADDITIVE IN A DI DIESEL ENGINE FUELED WITH WASTE PLASTIC OIL

Viswanath K. Kaimal , P. Vijayabalan(2016) conducted an inclusive experimental investigation to analyze the effects on the performance, combustion and emission characteristics of a diesel engine fueled with plastic oil and its blends with DEE. The study revealed that the neat plastic oil and its blends can be used directly in a diesel engine without any modifications. The PO-DEE blends showed lower BSEC than plastic oil because of the higher cetane number, low viscosity and density. The thermal efficiency was also improved with DEE addition. The peak pressure and heat release were reduced for DEE blends when compared to plastic oil. There was an increase in delay period, which resulted in delayed start of combustion.

Emissions from the engine were improved considerably while using DEE blends. Among all the blends and plastic oil, PD15 showed better emission characteristics. The smoke and NOX were reduced by 25% and 29% respectively at maximum load for PD15. The CO emissions for the blends were lower, but the HC emissions were slightly higher when compared to neat plastic oil operations. The addition of DEE to plastic oil has improved the engine characteristics in every aspect. It gives better performance and cleaner emissions when compared to plastic oil. Thus addition of DEE with plastic oil can be considered as a viable solution to the problems involved while using plastic oil as a fuel in diesel engines, without any modifications.[2]

IV. MEA AND DEE AS ADDITIVES ON DIESEL ENGINE USING WASTE PLASTIC OIL DIESEL BLENDS

Pappula Bridjesh , Pitchaipillai Periyasamy , Arani Vijayarao Krishna Chaitanya , Narayanan Kannaiyan Geetha (2018) lead an experimental study lead to assess the diesel engine performance using WPO and oxygenated additives like MEA and DEE and compared with diesel without any modifications in the engine. The following results were obtained.

The physical and chemical properties of WPO, 50D50W, 50D40W10MEA and 50D40W10DEE are adequate and favorable to be used as fuels on diesel engine. The heat release analysis reveals some interesting features, which throw some light on the combustion mechanism with the test fuels. At all loads, the HRR for WPO is higher than other test fuels. Ignition delay was caused with premixed MEA and DEE and phasing of the peak of in-cylinder pressure and heat release was observed in the premixed stage of combustion. When compared with diesel, higher heat release occurred in diffusion phase combustion. This is probably due to different auto ignition characteristics of MEA and DEE addition to WPO Diesel blends.BTE increased with load for all test fuels and with increased spray atomization along with faster fuel vaporization, BTE for 50D40W10MEA is a little higher than diesel. The presence of oxygenated functional groups in plastic oil and lower EGT with consequent reduction of heat losses along with molecular structural dependency for the ease of exploitation of energy from the fuel might have led for the increase in BTE with 50D40W10MEA. BTE increased by 5.5% with 50D40W10MEA than 50D40W10DEE.Due to the high injection rates which might have exposed more hydroxyl compounds with oxygen in plastic oil for combustion at high loads, HC and CO emissions for 50D40W10MEA are found to be lower than other test fuels. Whereas, HC emission for WPO is higher than other test fuels. HC and CO for 50D40W10MEA decreased by 5.9% and 19.3% respectively than 50D40W10DEE.NOx emission is very high with WPO than other test fuels. NOx characteristics in neat diesel combustion are changed and improvements are found simultaneously with premixed MEA and DEE addition. For 50D40W10DEE, the NOx emission is found to be lower by 5.5%. MEA in 50D40W10MEA has very little effect on NOx emission. NOx for 50D40W10MEA increased by 7.2% than 50D40W10DEE.

BSFC values are effectively and directly proportional to fuel mass flow rate. It is observed that BSFC for 50D40W10MEA is very close to diesel. The presence of alkanes in lower proportions attributes to the lower heating value of WPO and blends of WPO. Because of the cetane index of WPO and blends of WPO, more fuel being burnt in premixed combustion phase. BSFC for 50D40W10DEE is increased by 2.5% than diesel. Whereas, BSFC for 50D40W10MEA decreased by 1.6% than 50D40W10DEE. Volatility of MEA being high, smoke emission is significantly reduced (15% than diesel) with the use of MEA in 50D40W10MEA with respect to that of other test fuels. Also DEE has remarkable effect on the reduction (7.7% than diesel) of smoke in 50D40W10DEE. Smoke emission for 50D40W10MEA decreased by 9.4% than 50D40W10DEE.[3]

V. EXTRACTION AND CHARACTERIZATION OF WASTE PLASTIC OIL (WPO) WITH THE EFFECT OF N-BUTANOL ADDITION

Another Experimental investigation was carried out by D. Damodharan , A.P. Sathiyagnanam , D. Rana , B. Rajesh Kumar , S. Saravanan (2017) that Waste plastic oil (WPO) was extracted from mixed waste plastic by catalytic pyrolysis and its chemical composition was characterized by using GC/MS. Later, this study sets out to investigate the effects of n-butanol addition to WPO/diesel blends in a single cylinder, direct injection diesel engine. Three ternary blends (D50- WPO40-B10, D50- WPO30-B20 and D50-WPO20-B30) were prepared and the effect of n-butanol addition on performance and emission characteristics of a DI diesel engine was then compared with diesel and WPO for any improvements. The following conclusions were drawn from the investigation;-

WPO could be extracted from mixed waste plastic by pyrolysis using ZSM-2 as a catalyst. The properties of WPO determined using ASTM methods, were found to be closer to diesel and can be used in its neat form in a diesel engine without modifications. GC/MS characterization revealed that WPO consists of 15 chemical compounds with heavy hydrocarbon chains varying from C13 to C22. The aromatic content was found to be 39%.BTE of the engine increased with increasing n-butanol fraction in the blends when compared to WPO. D50- WPO40-B10 and D50-WPO30-B20 blends delivered better performance than WPO. BTE of D50-WPO20-B30 was found to be even better than baseline diesel operation.BSFC of the ternary blends was higher than ULSD due to its lower energy content. However the blends presented lower BSFC when compared to WPO. Ternary blends burned leaner when compared to WPO in the engine.

Smoke opacity decreased with increasing n-butanol fraction in the blends. Smoke opacity reduced favorably for D50-WPO40-B10, D50-WPO30-B20 and D50-WPO20-B30 when compared to both WPO and diesel.Addition of 10% n-butanol by vol. to WPO/ULSD blend (D50- WPO40-B10) reduced NOx emissions favorably when compared to both WPO and diesel. However NOx emissions were higher than the corresponding WPO case for higher volume nbutanol blends (D50-WPO30-B20 and D50-WPO20-B30).

HC emissions are generally high for WPO when compared to diesel. HC emission increased with increasing n-butanol content in the blends. CO emissions remained unchanged for all WPO/ULSD blends after the addition of n-butanol. Low volume addition of n-butanol (10% by vol.) to WPO/diesel blends presented less NOx, smoke emissions with improvement in engine performance when compared to diesel. In summary, n-butanol was found to be favorable in terms of emission and performance of WPO and its addition could be an advantageous strategy to improve the utilization of both a recycled component (WPO) and a renewable bio-component (n-butanol).[4]

VI. EFFECTIVE UTILIZATION OF WASTE PLASTIC OIL IN A DIRECT INJECTION DIESEL ENGINE USING HIGH CARBON ALCOHOLS AS OXYGENATED ADDITIVES FOR CLEANER EMISSIONS

D. Damodharan, A.P. Sathiyagnanamb, D. Ranac, S. Saravanand, B. Rajesh Kumar, B. Sethuramasamyrajae(2018) experimental an effective method to utilize waste plastic oil (WPO) in diesel engines using high-carbon alcohol additives to mitigate the carcinogenic smoke emissions was presented. Consequently, a comparative analysis on the effects of 30% by vol. of n-pentanol/WPO (WPO70P30), n-hexanol/WPO (WPO70H30) and n-octanol/WPO (WPO70O30) blends on emissions and performance of a single cylinder DI diesel engine was carried out. A response surface methodology optimization based on a 3×3 full factorial experimental design matrix was employed to determine the best combination of alcohol/WPO blend, EGR and injection timing for minimum NOx, smoke density and BSFC of the engine. RSM coupled with desirability approach was used to model, predict and optimize the response data for NOx, smoke density and BSFC measured from the experiments. From desirability approach,theblendWPO70P30injected at 21°CA bTDC with 10% EGR is considered to deliver optimum emission and performance characteristics with a maximum desirability of 0.968. Pentanol was found to be the best alcohol among n-hexanol and n-octanol for optimum emissions and performance. The top solutions predicted by desirability approach were validated by confirmatory experiments. Results indicated that the models developed using RSM for all responses were adequate to describe the experimental results with an error in prediction below 6%. With respect to neat WPO operation, it was concluded that n-pentanol addition to WPO injected at 21° CA bTDC with 10% EGR reduced smoke emissions by 74.2% with a slight penalty of 9.7% increase in NOx emissions along with a slight improvement in BSFC by 3.2%.

With reference to diesel operation, it was found that n-pentanol addition to WPO injected at 21° CA bTDC with 10% EGR reduced smoke emissions by 76.8% and increased NOx emissions by 32% with an improvement in BSFC by 17.8%. WPO7P30 presented highest peaks of pressure and HRRs accompanied with longest ignition delay and shortest combustion duration followed by nhexanol, n-octanol and diesel.[5]

VII. CONCLUSION

- Reduction in Specific Fuel Consumption.
- It analyse & check the performance of the engine with different proportion of Waste plastic oil and its additives.
- With an effect of Jatropha methyl ester , Brake thermal efficiency increased by about 2.24% with PJ20 operation at full load compared to waste plastic oil.
- The addition of DEE to plastic oil has improved the engine characteristics in every aspect. It gives better performance and cleaner emissions when compared to plastic oil.
- With an additive of MEA(Methoxyethylacetate), Volatility of MEA being high, smoke emission is significantly reduced (15% than diesel).
- The high carbon alcohols as oxygenated additives with reference to diesel operation, n-pentanol addition to WPO reduce smoke emissions and increased Nox emissions.
- For advantageous strategy in diesel operation, the emission problems in waste blends is solved by improvement in engine performance with addition of n-butanol additive.

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