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Performance Aspect Of Kerosene Blended Waste Plastic Oil When Fueled In Diesel Engine

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Abstract
The aim of the present work to study the effect of the addition of kerosene oil on the performance of oil derived from the waste plastic. For this fuel samples were synthesized using the blend of waste plastic oil and diesel which is one of the reference fuels. Then other samples were prepared by adding 10% and 20% of kerosene oil in the waste plastic oil-diesel. Raw diesel is also selected as another reference fuel. The test has been conducted on a single cylinder diesel engine and the performance characteristics like brake thermal efficiency, brake specific fuel consumption, brake specific energy consumption, air-fuel ratio and exhaust gas temperature of the fuel samples were investigated, the results were analyzed. Finally the results of the kerosene oil blended fuels were compared with the selected reference fuels. It is found that addition of kerosene oil in the waste plastic oil improves the performance characteristics.

Keywords: *Alternative fuel, Diesel, Performance, Waste plastic oil, kerosene oil.*

1. Introduction

Over the last century, energy consumption has rapidly increased due to the significant growth of the world's population. Diesel fuel is regarded as a highly critical fuel in many countries due to its wide applications in heavy duty transport vehicles, rail transportation systems, agricultural machineries and construction equipments. The result of this rapid growth has caused high-energy demands among fossil fuel resources and has thus caused fossil fuel depletion. Because fossil fuels have limitable resources, there has been an increased demand for alternative sources of energy. On the other hand, environmental pollution is becoming a big concern all over the globe due to the extensive use of fossil oil, which has given researchers stronger motivation to look for an alternative sustainable energy source, which is more environmentally friendly. [1-2]. 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.. 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 to liquid fuel (gasoline, diesel oil, etc.) or chemical raw materials can effectively solve the problem of the energy shortage to a certain extent. The properties of the oil derived from waste plastics were analyzed and found that it has properties similar to that of diesel so the waste plastic fuel is use in diesel engine [3-5].

The objective of the present work is to study the effect of the addition of kerosene oil in waste plastic oil on the performance of the fuel in diesel engine. For these different fuel blends of waste plastic oil, diesel and kerosene oil has been prepared and their physical and chemical properties have been examined. Then the fuels were tested on a single cylinder diesel engine for their performance evaluation.

2. MATERIAL AND METHODS

2.1 Synthesis of fuel samples

The waste plastic oil is procured from Sustainable Technologies & Environmental Projects Private Limited (STEPS), Vasai, Mumbai. Waste plastic oil has been prepared by de- polymerization of waste plastic, carried out in a specially designed reactor in the absence of oxygen and in the presence of a proprietary catalyst. The maximum reaction temperature was 350^0C.

In order to investigate the fuel quality results and its performance and emission study on an engine different composition of waste plastic oil, diesel and kerosene oil were mixed with the help of mechanical magnetic stirrer. The mixing process was carried out at an ambient temperature of 35^0C and the samples were allowed to stir for one hour. Each sample is prepared on volumetric basis of volume of 3.5 liters.

Table1: Details of samples and their identification

Sr No.	Sample ID	Quantity on volume basis (%)		
		Diesel	**Waste plastic oil**	**Kerosene oil**
1.	D100	100	-----	-----
2.	WPO100	------	100	-----
3.	WPO30D70	70	30	------
4.	WPO30KO10D60	60	30	10
5.	WPO30KO20D50	50	30	20

2.2 Determination of Physico-Chemical Properties

Specific gravity of the oil was measured by the standard method IP 59/82. The apparatus used is Westphal balance. The viscosity of the oil was measured by the redwood viscometer as Standard ASTM D2270 method. The flash point and fire point of the oil was determined by the Pensky Martenes apparatus as standard ASTM D93-80 method. The calorific value of the oil was determined by Bomb calorimeter as standard ASTM D808/240 method. Acid number test of oils was measured by the standard ASTM D664-09a method on acid number test (REMI equipments).

2.3 Experimental Set-up

The engine was coupled to an electrical dynamometer to provide the engine load. An air box with U-tube manometer connected to the intake of the engine. The air consumption of the engine was measured with the help of U-tube manometer. Fuel consumption was measured with the help of a burette fitted along the side of especially designed cylindrical tank fixed on a wooden stand of suitable height. When it was required to measure the fuel consumption, the valve was closed so that the fuel could flow into the engine through filter from the graduated burette. Engine speed was measured using Tachometer and the time for a known volume of fuel (10cc.) consumption was measured using stop watch. The fuel flow rate was measured on volumetric basis using a stopwatch. Automotive emission analyzer (HG-540 mode) was used to measure the exhaust emissions. A probe was used to receive sample of exhaust gas from the engine. All the experiments were conducted at the rated engine speed of 1500 rpm. All the tests were conducted by starting the engine with diesel only and then switched over to run with waste plastic oil and their blends. The different performance parameters were measured at the loads of 33%, 50%, 66%, 83% and at full load (100%). The load variation has been provided by Electrical Swinging field type Dynamometer.

Table: 2 Specification of CI Engine

Type of engine	**Kirloskar Diesel Engine**
Model:	AV1
Description	Cold starting, vertical, water cooled, totally enclosed.
Fuel injection timing	26^0 before Top Dead Centre
Fuel tank capacity	1 Gallon (4.6 Liters)
Nozzle	Bosch type DLL. 110 S 32
Fuel Pump	Bosch type H-PFR 1A 90/1
No. of stroke	4
No. of cylinder	Single
Bore diameter	80 mm
Stroke length	110 mm
Rated power	5 HP
Speed	1500 rpm
Cooling	Water
Loading Device	Electrical Swinging field type Dynamometer

Fig. 1. Experimental Test Engine setup

3 Results and Discussion

3.1 Characterization of Oil

The various characteristics of the fuel samples are shown in Table 3.The viscosity of the waste plastic oil and its blends are found to be lower than diesel. It is found that increasing the amount of kerosene oil in the waste plastic oil decreases the viscosity of waste plastic oil.

Density is an important property of oil. As the density increases the energy content increases per unit volume, on the other hand volumetric fuel consumption increases as density decreases. The density of WPF100 is found to be lowest. This is also found that the density of waste plastic oil decreases with increasing the amount of kerosene oil in waste plastic oil. Density is an important property of oil. As the density increases the energy content increases per unit volume, on the other hand volumetric fuel consumption increases as density decreases.

Flash point is the temperature at which fuel vapor can be ignited by externally supplied ignition. It is important for determining the fire hazard and subsequent measures in the storage and distribution system. The flash point of the waste plastic oil and its blends is found to be higher than diesel; this indicates that waste plastic fuel and their blends are better fuel as per transportation point of view. The calorific value of waste plastic fuel and blends are found to be slightly lower than diesel. This is also observed that increasing the concentration of kerosene oil in waste plastic oil decreases the calorific value .

One of the important parameter for the low temperature application of fuel is pour point (PP). The PP is the lowest temperature at which fuel can flow. Cold filter plugging point (CFPP) defines the fuel limit of filterability. The CFPP and PP of waste plastic oil is found to be higher than diesel.

S. No.	Characteristic	WPO30D70	WPO30KO10D60	WPO30KO20D50	WPO100	D100
1	Viscosity (Poise)	0.0604	0.059	0.054	0.0457	0.0618
2	Density (g/ml)	0.815	0.805	0.790	0.78	0.80
3	Flash Point (^{0}C)	69	-----	------	72	61
4	Calorific value (MJ/kg)	45.58	44.57	43.86	42.90	45.35
5	Pour point	------	------	------	15	6
6	CFPP	------	------	------	12	1
7	Acid number (mgKOH/g)	1.89	------	------	8.92	0.03

Table: 3 Characterization of fuel samples

3.2 Performance Characteristics of fuel samples on Test Engine

The variation of Brake thermal efficiency (BTE) with load for different test fuels is shown in Fig.2. This can be observed from the figure that the BTE of all the test fuels increases with the increase in load. From the graph it is observed that at full load the BTE of WPO30KO10D60 and WPO30KO20D50 were almost same. The BTE of WPO30KO10D60 is found to be 3% and 4.5% higher than diesel WPO30D70 respectively. So addition of kerosene oil in waste plastic oil improves the brake thermal efficiency. The higher BTE for kerosene oil blended fuel may be attributed to the lower viscosity and density of kerosene oil blended fuel as compare to the diesel and WPO30D70 [6,7].

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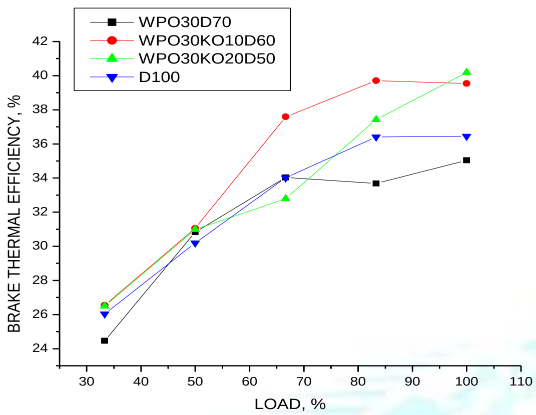

Fig. 2 Variation of Brake Thermal Efficiency with load

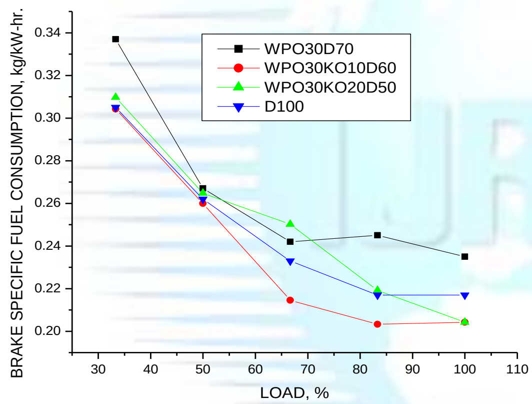

Fig. 3 Variation of BSFC with load

The variation of Brake specific Fuel Consumption (BSFC) with load of different test fuels is shown in Fig.3. This can be observed from the figure that the BSFC of all the test fuels decreases with the increase in load. Among all the fuels tested, the BSFC of WPO30D70 is found to be highest and for WPO30KO10D60 it is lowest. Again it can be observed that the kerosene oil blended waste plastic oil have lower BSFC as compare to diesel and WPO30D70. This may be attributed to the higher BTE of kerosene oil blended fuel and also higher calorific value and lower density of WPO-KO blended fuel as compare to the diesel and WPO30D70 [8,9].

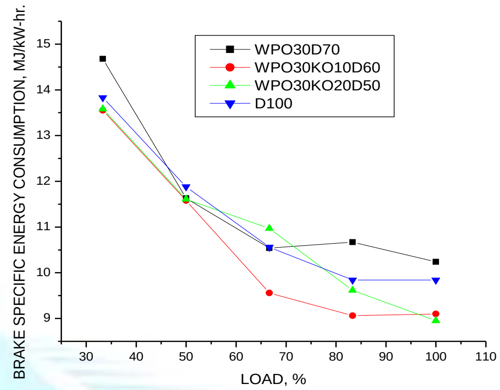

Fig. 4 Variation of BSEC with Load

The variation of Brake Specific Energy Consumption (BSEC) with load for different test fuels is shown in Fig. 4. BSEC does not depend on fuel and compare the energy needed for producing unit power from the fuel [10]. The BSEC of WPO30KO10D60 and WPO30KO20D50 are found to be lower than diesel and WPO30D70. This may be attributed to the higher viscosity and volatility of WPO30D70 and diesel as compare to WPO-KO blended fuel.

The variation of Air-Fuel (A/F) ratio with load for different test fuels is shown in Fig.5. This can be observed from the figure that the A/F ratio of all the test fuels decreases with the increase in load as expected. Because as the load increases more amount of fuel is needed to meet the load at constant speed (rpm) of the engine. Higher A/F ratio in exhaust is the indication of efficient combustion. A/F ratio for WPO-KO blended fuel is found to be higher than diesel and WPO30D70. This may be due to the paraffin structure of Kerosene oil which is found to be more suitable for diesel due to its lower diesel index [11].

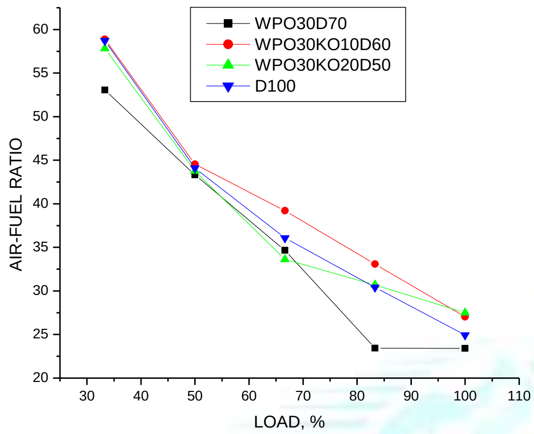

Fig. 5 Variation of Air- Fuel Ratio with Load

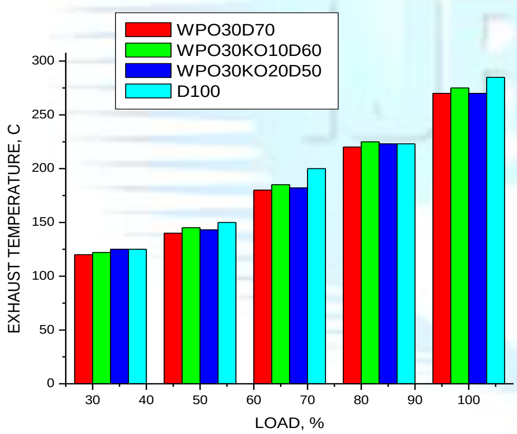

Fig. 6 Variation of Exhaust Temperature with Load

The variation of Exhaust Gas temperature (EGT) with load for different test fuels is shown in Fig.6. This can be observed from the figure that the EGT of all the test fuels increases with the increase in load, because of high amount of heat release due to higher consumption of fuel at higher load. High EGT in exhaust is not desirable because this can cause high heat transfer and also decreases the thermal efficiency of engine [12]. Also high EGT in exhaust indicate higher peak pressure. Among all the fuel tested, the EGT of D100 is found to be higher as compare to other fuel.

4. Conclusion

The following conclusion can be made from the present work.

The viscosity and density of neat (100%) Waste plastic fuel (WPF) is found to be lowest among all the fuels tested. The viscosity of kerosene oil blended waste plastic oil fuel is found to be lower than diesel. The flash point of waste plastic oil and their blends is found to be higher than diesel so this implies that the WPO blends are safer fuel as per storage and transportation point of view as compare to diesel. The heating value of kerosene oil blended WPO are slightly lower than diesel.

The Brake Thermal Efficiency (BTE) of kerosene oil blended WPO is higher than diesel and WPO30D70. The BSFC, fuel consumption for unit power output of kerosene oil blended WPO is found to be lower than diesel and WPO30D70. The BSEC, energy consumption for producing unit power output of kerosene oil blended WPO is found to be lower than diesel and WPO30D70.

Air-Fuel ratio for kerosene oil blended WPO is found to be higher than diesel and WPO30D70. This implies better combustion of kerosene oil blended fuel as compare to others. The Exhaust Gas Temperature (EGT) of kerosene oil blended WPO is found to be lower than diesel. As the formation of NO_x is function of temperature, so this implies that there is lower chance of NO_x formation of kerosene oil blended waste plastic oil as compare to diesel

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References

[1] E.C. Quaye, Energy demand in the 21st century: The role of biofuels in a developing country, *Renewable Energy*, 9(6) (1996) 1029-1032.

[2] Pouya Mohammadi et al, Experimental investigation of performance and emission characteristics of DI diesel engine fueled with polymer waste dissolved in biodiesel blended diesel fuel. *Energy*, 46 (2012) 596-605.

[3] Z. Xiangxue, A. Jie, W. Yuzhong et al, Progress of producing vehicle fuels from cracking waste plastics, *Chemical Industry and Engineering Progress*, 31 (2012) 389-401.

[4] L. Guangyu, L. Jian, M. Xiaobo et al, Pyrolysis of MSW plastics: technologies and their reactors, *Environmental Engineering*, 27 (2009) 383-388.

[5] D.M. Zheng, Q.F. Lu, M. Liu, Y.X. Chen, Study on the catalytic cracking of waste plastics and waste lubricating oil for producing fuel oil, *Modern Chemical Industry*, 31(8) (2011) 47-49.

[6] M.V. Nagarhalli, V.M. Nandedkar. Performance of diesel engine using blends of esters of jatropha And karanja- A novel approach, *International Journal of Advanced Engineering Technology*, 3(3) (2012) 51-54.

[7] M. Loganathan, A. Anbarasu and A. Velmurugan, Emission characteristics of jatropha – Dimethyl ether fuel blends on a DI diesel engine, *International Journal of Scientific & Technology Research*, 1 (2012) 8.

[8] K. Pramanik, Properties and use of jatropha curcas oil and diesel fuel blends in compression ignition engine, *Renewable Energy*, 28 (2) (2003) 239-248.

[9] Y.V. Hanumant Rao, Voleti Ram Sudheer.V.S. Hariharan, A.V. Sitaram Raju, P. Nageshwara Reddy. Use of Jatropha Oil Methyl Ester and Its Blends as an Alternative Fuel in Diesel Engine, *Journal of Brazilian Society of Mechanical Science & Engineering*, 31(3) (2009) 25-31.

[10] R. Kumar, M.K, Mishra, S.K. Singh, and A. Kumar, Experimental evaluation of waste plastic oil and its blends on a single cylinder diesel engine, *Journal of Mechanical Science and Technology , Springer, 30*(10) (2016) 4781-89.

[11] https://en.wikipedia.org/wiki/Kerosene.

[12] O. Arpa, R. Yumrutas and Z. Argunhan, Experimental investigation of the effects of diesel- like fuel obtained from waste lubrication oil on engine performance and exhaust emission, *Fuel Processing Technology*, 91 (2010) 1241-1249.