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ENVIRONMENTAL ASPECT OF KEROSENE BLENDED WASTE PLASTIC OIL WHEN FUELED IN DIESEL ENGINE

RAJAN KUMAR[1] & M.K.MISHRA[2]

[1]*Department of Mechanical Engineering, BIT Sindri, Dhanbad, India.*
[2]*Department of chemistry, BIT Sindri, Dhanbad, India.*

ABSTRACT

The aim of the present work to study the effect of the addition of kerosene oil on the emission 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 emission characteristics like unburned hydrocarbon, CO, NOx and CO_2 *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 emission characteristics.*

KEYWORDS: Alternate fuel; Diesel; Emission; Waste plastic oil, kerosene oil.

1.INTRODUCTION

It is becoming increasingly difficult to ignore the increasing impact of air pollution caused by using fossil fuels, fossil fuels depletion, being concentrated in certain places in the world and their high costs. In recent time, the world is facing problems with energy crises due to depletion of conventional energy sources and increase environmental problems. This situation has led to the search for an alternative energy resources, which should be not only in exhaustible but also less harmful to environment. For developing countries, fuels of bio origin such as alcohol, vegetable oils, bio-mass, bio-gas, etc. are becoming most popular. These fuels need some modification before they are used as fuel.

Exhaust emission from motor vehicle have a main role in this air pollution. It is not enough to change the design of engine of vehicle to cope with the legal regulation, so it is quit necessary to focus on alternative fuels. Conversion of waste to energy is one of the recent trends in minimizing not only the waste disposal but also could be used as an alternate fuel for internal combustion engines. Waste plastics are indispensable materials in the modern world and application in the industrial field is continually increasing. In this context, waste plastics are currently receiving renewed interest. As an alternative, non biodegradable, and renewable fuel, waste plastic oil is receiving increasing attention [1-2]. In the present paper we study the environmental or emission effect of adding kerosene to the waste plastic oil.

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.

TABLE I
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.

TABLE II
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

FIGURE 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.

TABLE III
CHARACTERIZATION OF FUEL SAMPLES

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

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.

3.2 Emission Characteristics of fuel samples on Test Engine

The variation of hydrocarbon (HC) emission with load for different test fuels is shown in Fig.2. This can be observed from the figure that the HC emission of all the test fuels increases with the increase in load. The high HC emission at higher loads may be due to the improper mixing of fuel and dissociation. The lacks of oxygen in the fuel is responsible for reduced oxidation rate, which leads to incomplete combustion therefore higher HC emission [3]. The HC emission indicate the fuel that is not completely burn and in general means these are organic compound in gaseous state and solid hydrocarbon are the part of particulate matter[4]. Almost for all the loading conditions the HC emission for WPO-KO blended fuel were found to be lower than WPO30D70. The higher HC emission of WPO30D70 and diesel as compare to WPO-KO bended fuel may also attributed to the high viscosity and density of the diesel and WPO30D70 which leads to improper spray and atomization and hence poor combustion[5].

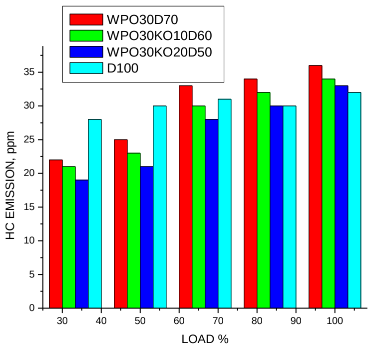

FIGURE II
VARIATION OF HC EMISSION WITH LOAD

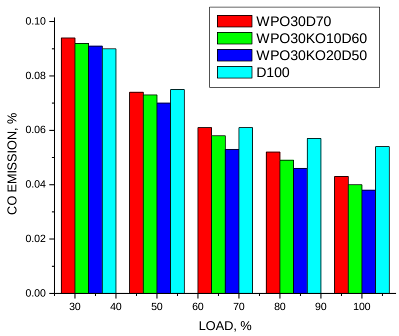

FIGURE III
VARIATION OF CO EMISSION WITH LOAD

The variation of carbon monoxide (CO) emission with load of different test fuels is shown in Fig.3. This can be observed from the figure that the CO emission of all the test fuels decreases with the increase in load. This might be due to better performance of engine at higher loads. As with increase in load more amount of fuel is injected and hence the temperature increases, which results in relatively better burning of fuel, therefore CO decreases with the increase in load [6]. CO is colorless and poisonous gas and not desirable in exhaust. Emission of CO from an engine mainly depends on the physical and chemical properties of fuel, air-fuel ratio and engine temperature[7.8,9]. This has been found that the WPO-KO blended fuel have lower CO emission as compare to WPO30D70 and diesel. This may be attributed to the high viscosity and density of WPO30D70 and D100 as compare to WPO-KO blended fuel because high viscosity results in the poor atomization and high density results in less turbulence of fuel [10].

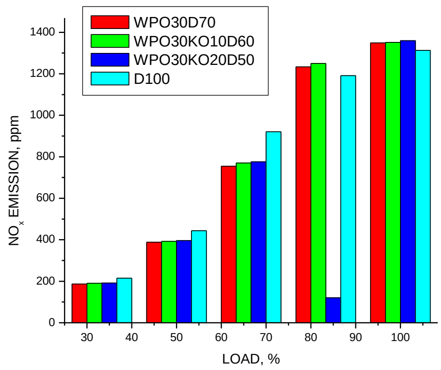

FIGURE IV
VARIATION OF NO$_X$ EMISSION WITH LOAD

The variation of NO_x emission with brake power for different test fuels is shown in Fig. 4. For ideal combustion, it is essential that there should be no NO_x and all the nitrogen present in the fuel and air should be converted into N_2 in the product during the process [11]. NO_x emissions are sensitive to spray characteristics of the fuel depend on droplet size, penetration rate, evaporation rate, degree of mixing with air etc. A change in any of these properties may change NO_x production [12]. This can be observed from the figure that the NO_x emission increases with the increase in load. As the load increases due to the increase in the amount of fuel injected and turbulence heat release increases which results in the increase in temperature and hence NO_x emission, because the important factor that causes NO_x formation is high combustion temperature, availability of oxygen and residence time **[**5]. For low to medium load range D100 has higher NO_x and for higher load range the NO_x emission for WPO-KO blended fuel have slightly higher than diesel.

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The variation of carbon dioxide (CO_2) emission with load for different test fuels is shown in Fig.5. This can be observed from the figure that the CO_2 emission of all the test fuels increases with the increase in load as expected. Because at higher loads there is more turbulence and also more amount of fuel is injected, which results in proper combustion and hence CO_2 emission. The higher amount of CO_2 in exhaust indicates complete combustion [6]. The proper combustion of any hydrocarbon fuel results to produce only CO_2 and H_2O vapor [14]. The formation of CO_2 is an exothermic reaction therefore it supplies the higher value of exhaust gas temperature (EGT) [15]. it is observed that except at full load for most of the cases the CO_2 emission of WPO-KO blended fuel are found to be lower than diesel. Almost for all the cases the CO_2 emission of kerosene blended fuel have higher than WPO30D70.

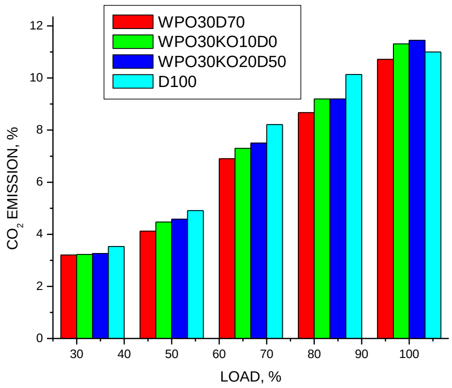

FIGURE V
VARIATION OF CO_2 EMISSION WITH LOAD

4. CONCLUSION

The following conclusion can be made from the present work. The increase in the amount of kerosene oil in waste plastic oil-diesel blend decreases the viscosity and density. The kerosene oil (KO) blended fuel have lower HC emissions as compared to WPO-Diesel and Diesel. The KO blended fuel has lower CO emission as compare to WPO-Diesel and diesel. The NO_x emissions for WPO-KO blended fuel have slightly higher than diesel. As NO_x emission is function of temperature, this indicate the high heat evolution due to better combustion of KO blended waste plastic oil. The CO_2 emissions of WPO-KO blended fuel are found to be higher than WPO30D70 and lower than diesel. This implies that there is improvement in the combustion characteristics with the addition of kerosene oil in waste plastic oil.

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