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Specific Fuel Consumption and Exhaust Emission Test on Single Cylinder Four-Stroke Diesel Engine using Polyethylene Extract Biodiesel as Fuel

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ABSTRACT:

More than 70% of the plastic wastes come out the packing materials. This causes heart problems and cancer too in the later stages. The plastics started to blend in drinking water in a major percentage. Recycling of the existing waste plastic is the only major way so that we can reduce this harmfulness to the globe. Here we have made use of polythene which plays a part of 33.5 percentage of the total plastic waste and is the highest waste among them. These wastes are mechanically separated and converted to plastic oil through pyrolysis. These oils are blended with the existing diesel in about 6 to 12 percentage for conversion to biodiesel and tested on a single cylinder four-stroke diesel engine for its performance. The exhaust gas which comes out is tested for its emissions and compared with diesel specific fuel consumption (SFC) and emissions.

KEYWORDS:

Biodiesel; Polyethylene; Emission; Specific fuel consumption

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1. Introduction

The amount of increase in private vehicles leads to the increase of air pollution in our environment. This creates an enormous pressure for protecting the entire earth [1, 2]. The diesel-powered vehicle exhibits higher performance when compared to petrol vehicles and it is durable and reliable for a long-term usage with a very mere running cost. On the other hand, it is also one of the major reasons for the global pollution as it exhibits a large proportion of hydro carbons, oxides of nitrogen, particulate matter and finally carbon monoxide when compared to gasoline powered engines [3]. Most of the biodiesel is mostly free of toxins and the normal emissions produced by the diesel are comparatively less in case of biodiesel. Because of some of its friendly nature it can also be used as an alternative to the diesel [4].

Basically, there are three generations on biodiesel produced, the first one is produced from the seeds of plants, the second one is produced from bio wastes and non-edible oils and the last one is made from microbes and algae [5]. The plastic-based fuels are away from all the three generation fuels, yet they are different form of biodiesel. In this work the work is done to recycle PE waste. The boiling point of this biodiesel has increased boiling point when it is compared with the pure diesel and hence the presence of the liquid phase length is also more [6]. The energy output for diesel fuel is higher than any other fuel of that form and hence it is preferred in most of the operations [7-11]. Most of the tests show that at full load condition the biodiesel exhibits only low amount of hydrocarbon and carbon monoxide and relatively more or less equal oxides of nitrogen [12]. Blending of bio fuel with diesel has reduced HC and CO emission, further increase in bio fuel also led to a huge reduction of NOx emissions too [13]. The biodiesel performs in a very different manner on a different engine and henceforth it should be clearly verified before recommending them on vehicles [14]. Most of the reviews from various works reveal that the addition of bio fuel with diesel has reduced most of the emissions to a very large scale [15]. The addition of neat polymer oil increases the cylinder compression pressure and also leads to increased delay time in ignition [16]. This makes the plastic fuel as a more appropriate blend to be added along with the diesel to be utilized for a long time run on the roads.

2. Experimental details

The test is conducted on a single cylinder 4-stroke water cooled diesel engine fitted with an electrical type dynamometer. This is also attached to computerized Engine Soft Labview software. This software helps in evaluation of the performance parameters of the engine such as Specific Fuel Consumption (SFC) of the fuel. Gas analyser and smoke meter is the setup used for evaluating the emissions which comes out of the exhaust gas after burning. The specification of the diesel engine is given in Table 1. The SFC and emission test is conducted on the engine with the composition and combination as given in Table 2.

Table 1: Specification of Kirloskar diesel engine

Parameter	Value
Bore and stroke	87.5 mm × 110 mm
Compression ratio	17:5:1
Rated power	5.2 kW
Rated speed	1500 rpm
Injector open pressure	210 bar

Table 2: Composition of polymer fuel

Fuel composition	Fuel composition
BD6	PE 6%, diesel 94%
BD12	PE 12%, diesel 88%
BD18	PE 18%, diesel 82%
BD00	Pure diesel 100%

3. Results and discussion

SFC for different fuels with respect to different combinations at varying loads is shown in Table 3. The biodiesel with 18% (BD18) polymer oil exhibited a high SFC of at a loading of 4.4 kg, 9.03 kg and 12.6 kg. When the plastic fuel addition is 6% (BD6) at 17.04 kg it exhibited high SFC. Always the pure diesel shown a considerable SPC followed by 12% (BD12) polymer oil addition. AVL DIGAS 444N type gas analyzer and AVL smoke meter is used for the emission tests. The smoke test is conducted and the values are displayed in Table 4. The emissions such as CO in percentage, HC in PPM, and CO_2 in percentage, O_2 in % and NO_X in PPM thus obtained are compared with each combination of fuels. The CO emissions were found increasing to a very small percentage for BD12 when compared to BD6. When the polythene oil blend increases to BD18, a drastic fall of CO in percentage was found. It is also found that the overall CO emission for this bio fuel is found very less than diesel at this operating condition. The hydrocarbon emission was found to increase with increase in biodiesel. But a very low biodiesel addition in BD6 emits a very low hydrocarbon even when compared to diesel itself. Further increase in biodiesel leads to drastic increase when the blend reaches to BD18.

Table 3: Load vs. SFC

Load (kg)	BD6 SFC (kg/kWh)	BD12 SFC (kg/kWh)	BD18 SFC (kg/kWh)	BD00 SFC (kg/kWh)
0.04	22.27	24.50	27.66	17.13
4.40	0.46	0.47	0.49	0.46
9.03	0.33	0.34	0.37	0.32
12.60	0.28	0.29	0.30	0.27
17.04	0.36	0.28	0.29	0.26

Table 4: Emissions test results

Fuel	CO%	HC PPM	CO_2%	$O_{2\%}$	NO_XPPM
BD6	0.031	2	1.90	18.04	192
BD12	0.032	5	1.96	18.07	189
BD18	0.018	9	3.9	15.15	692
BD00	0.045	5	2.02	17.90	172

The CO_2 emission peeks up at BD18 and found to be optimum at BD6 and BD12 when compared to BD00. Hence it is always desirable to maintain the fuel compositions in BD6 and BD12 in order to maintain a much-desired value of CO_2 emission by the engine in the atmosphere. The O_2 emission was found to decrease a lot with increased addition of the polythene oil. At BD18, the observed oxygen level is not found to be desirable to be used in the diesel engine. The NOx emission is found to be very higher at BD18 and most desirable at BD6 when compared with BD00.

4. Conclusions

The usage of polythene blended bio fuel has been tested in the diesel engine to obtain the SFC and the emission characteristics from it at various levels of combination of bio fuel such as BD6, BD12, BD18 and pure diesel BD00. The biodiesel with BD12 always provides a reasonable SFC at all varying load conditions. The overall CO emission was found to be very low at BD18. This proves that increase in polythene bio-oil leads to increased combustion. This leads to a reduced quantity of CO emission at higher level blending. The HC content was found to be very low at BD6 which is lesser than BD00. The CO_2 emission found to be increased with increase in bio fuel addition as the oxidation of fuel is found to be more in case of BD18 when compared to BD6 and BD12. The NOx emission is found to be more in case of BD18 at higher operating temperatures which is said to be the main set of this fuel. But at the lower combination it proves to be considerable with the diesel fuel. The above results prove that the polythene blend fuel BD12 can be used as an alternative to diesel as a purpose to replace diesel and recycle the polythene wastes.

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