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DETERMINATION OF OPTIMUM BLEND OF DIESEL AND TYRE PYROLYSIS OIL IN 4-STROKE C.I ENGINE BASED ON EMISSION PARAMETERS

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Abstract: Environment pollution is a great hazard to our ecosystem which is greatly affected by the emissions from internal combustion engines. Also with the degradation of fuel it is high time that we find alternative source for generation of power from internal combustion engines. The modern thrust of the research is to obtain three blends of diesel with tyre pyrolysis oil in 10:90, 20:80and 30:70 ratios and analyse the engine emissions like Carbon-mono-oxide (CO) and HydroCarbons(HC).In doing so, it was found that CO emission is 0.16%. 0.15%, 0.15% and 0.16% by volume for the blends mentioned above and for diesel respectively.
Keywords: Pollution, Emission, Diesel, Tyre-Pyrolysis oil, Blends

1. INTRODUCTION

Automotive pollution is one of the banes of the modern society. Diesel and petrol engines are the most efficient prime-movers from the point of view of protecting global environment. Concerns of long term energy security have led to the development of alternative fuels with the property comparable to petroleum based fuels. Unlike rest of the world, India’s demand for diesel fuels is roughly six times that of gasoline, hence seeking alternative to mineral diesel is a natural choice. Alternative fuels should be easily available at low cost, be environment friendly and fulfil energy security needs without sacrificing engine’s operational performance. Conversion of waste energy is the recent trend in selection of alternative fuels. Alcohol, bio-diesel, liquid fuels from plastics and tyres etc. used in vehicles are some of the alternative fuels for internal combustion (I.C) engines. Utilization of biomass as an alternative fuel for compression ignition (C.I) engines has a great scope especially in developing and underdeveloped countries.

Disposal of waste rubber products is becoming an environmental challenge in many developing countries due to their non-biodegradable characteristics. Majority of waste rubber products are generated from worn or damaged automotive tyres and industrial conveyor belts. Scrap tyre disposal is also a major environmental hazard. Waste plastics do not biodegrade in landfills, are not recycled and degrade in quality during the recycling process. Pyrolysis of the scrap tyres will produce Tyre Pyrolysis Oil (TPO) which has volatile capability. If the scrap tyres are not managed well, the scrap tyres can give bad effects to the environment and people’s health. One of the solution is the pyrolysis process. As waste disposal is also a major problem, tyre pyrolysis can be adopted as a method to replace the conventional fuel. Pyrolysis is the chemical decomposition of organic substances by heating. The word is originally coined from the Greek-derived elements pyro meaning “fire” and lysys meaning “decomposition”. Pyrolysis is usually the first chemical reaction that occurs in the burning of many solid organic fuels, cloth, wood and paper and also some kind of plastics. The present work is carried out based on the feasibility and cost analysis of pyrolysis oil in forging industry. Cost analysis can also be achieved by using pyrolysis oil, as it is cheaper than diesel and has almost same properties of diesel.

2. PREVIOUS RESEARCH

Highlights of some of the research works undertaken are listed below, which show evidences of successful utilisation of bio-diesel in I.C Engines: C. Wongkhorsub et.al studied Pyrolysis oil from waste tyre and waste plastic and applied with one cylinder multipurpose agricultural diesel engine. It is found that without engine modification, the tyre pyrolysis offer better engine performance. The economic analysis shows that the pyrolysis oil is able to replace the diesel in terms of engine performance and energy output if the price of the pyrolysis oil is not greater than 85% of diesel oil[1].

The TPO blended with diesel of 10 to 90% exhibited longer ignition delay, as a result of the lower cetane number of the TPO, as well the blends. In the experimental investigation, TPO was blended with Jatropha Methyl Ester(JME), whose cetane number is higher than that of diesel, and used as an alternative fuel in a single cylinder, four stroke, air-cooled, direct injection (DI) diesel engine developing 4.4kW. Five different blends of varying TPO, from 10 to 50% at steps of 10% on a volume basis are considered for the investigation. Interestingly the combustion and emission behaviour of the diesel deviated after 20%TPO in the blend. There is a reduction in the efficiency with 30, 40 and 50% TPO in the blend at full load[2].

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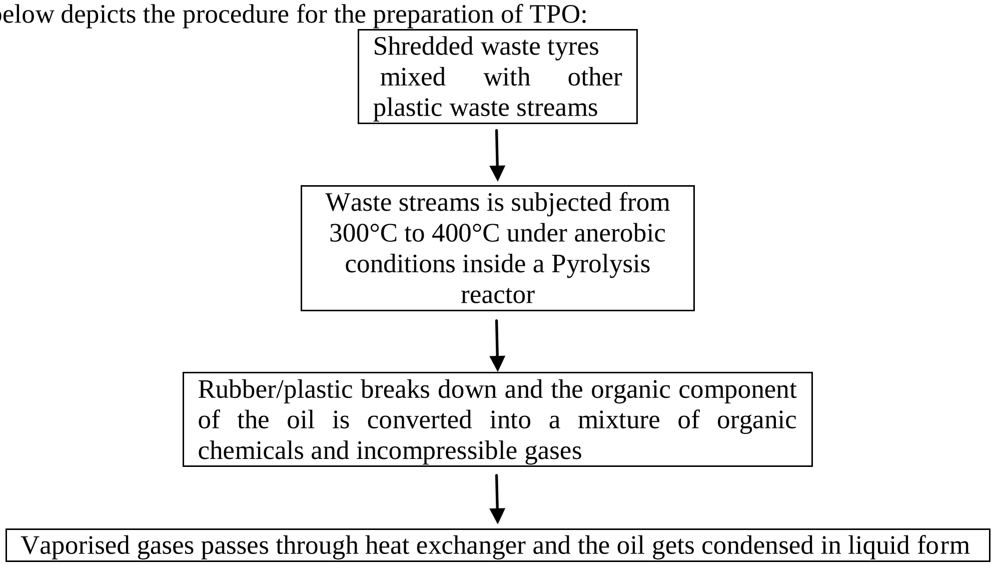
The pyrolysis oil is obtained by the pyrolysis of the waste automobile tyres. In the initial stage the test is conducted on four stroke single cylinder diesel engine by using diesel and the base line data is generated. Further in the second stage experimental investigations are carried out on the same engine with same operating parameters by using the TPO blended with diesel in different proportions such as T10, T20 and T30 to find out the performance parameters and emissions. It is observed that the Brake Thermal Efficiency increases in proportion to the blend percentage and CO, HC and NOX emissions are decreased when compared to neat diesel [3].
Pyrolysis oil was tested for the required specifications and compared with the existing fuel. As because of its low flash point an attempt was done to blend pyrolysis oil and furnace oil to get the required flash point. Satisfactory results were found and cost analysis on the basis of results was made. Cost analysis proves that using Tyre Pyrolysis oil instead of current furnace oil will be beneficial for the forging industry[4].

3. RESEARCH METHOD

The flow chart below depicts the procedure for the preparation of TPO:



Taking diesel as the pilot fuel, TPO was mixed with it in three beakers containing 450ml of diesel and 50ml of TPO (10:90), 400ml of diesel and 100ml of TPO (20:80) and 350ml of diesel and 150ml of TPO (30:70) respectively.

Table 1: Calorific value of the blends(kJ/kg)

Blend1 (10:90)	47265.81
Blend2 (20:80)	47095.51
Blend3 (30:70)	46793.23
Diesel	43000

Description of the engine: The engine set for the experiment shown in fig.1 is the four cylinder, four stroke water cooled, compression ignition engine. The engine consists of a fuel tank of 10litres. The variable input to the engine is the load. By rotating a wheel in clockwise direction, the load can be varied and different engine parameters can be measured. Cooling water is circulated throughout the whole set-up and a water-flow meter is attached to it. Digital display boards are attached to the unit which shows the temperature of the exhaust gas at outlet, calorimeter water inlet and outlet temperatures, water inlet and outlet temperatures and air inlet temperature. The engine specifications are listed in table 2.

Table 2: Engine specifications

Make and Type	Mahindra & Mahindra, four cylinder, four stroke, water cooled diesel engine
Displacement volume(cc)	1895
Density of fuel(kg/mm3)	720-780
Diameter of a cylinder(mm)	85
Stroke length(mm)	80

Fig.1 4-stroke, water cooled C.I Engine

4. EXPERIMENTAL PROCEDURE

Fuel is supplied to the engine through a standardised calibrated burette which is attached to the side of the tank. The cooling water supply is kept on at no load before the engine is started. Load is adjusted manually by a hand operated lever when the engine is started from no load to 10Kg in steps of 2Kg and the emission gases like unburnt Hydro-carbons (HC) and Carbon-mono-oxide(CO) are measured by a flue gas measuring device in terms of % vol and ppm respectively.

5. RESULTS AND INFERENCES

Carbon-mono-oxide (CO) and Hydro-Carbon (HC) emissions were noted with the flue gas measuring instrument and the observations of CO and HC emissions for different load conditions are shown in the tables 3 and 4 respectively.

Table 3: CO emissions of diesel and the blends for different loads

Load (kg)	Diesel (%vol.)	Blend 1(%vol.)	Blend 2(%vol.)	Blend 3 (%vol.)
2	0.13	0.15	0.18	0.22
4	0.11	0.13	0.15	0.19
6	0.12	0.17	0.16	0.18
8	0.14	0.16	0.14	0.17
10	0.16	0.15	0.15	0.16

Table 4: HC emissions of diesel and the blends for different loads

Load (kg)	Diesel (ppm)	Blend 1(ppm)	Blend 2(ppm)	Blend 3 (ppm)
2	6	9	7	9
4	9	8	6	6
6	11	6	9	10
8	13	8	10	12
10	15	9	12	14

The observations of CO and HC emission with respect to load are depicted on the fig. 2 and fig.3 respectively.

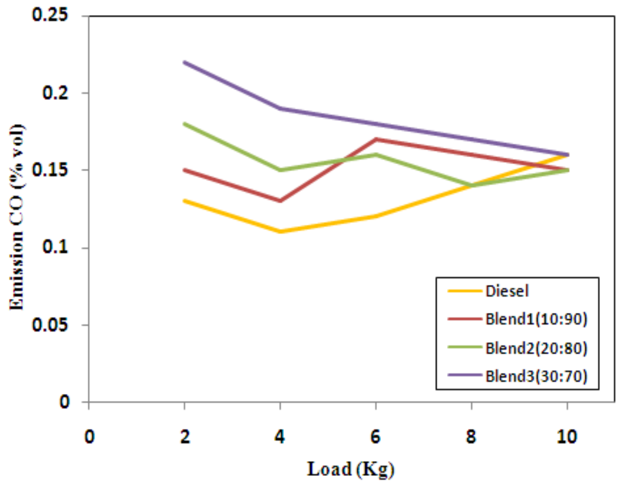


Fig. 2 Load vs. CO emission curves for diesel and the three blends

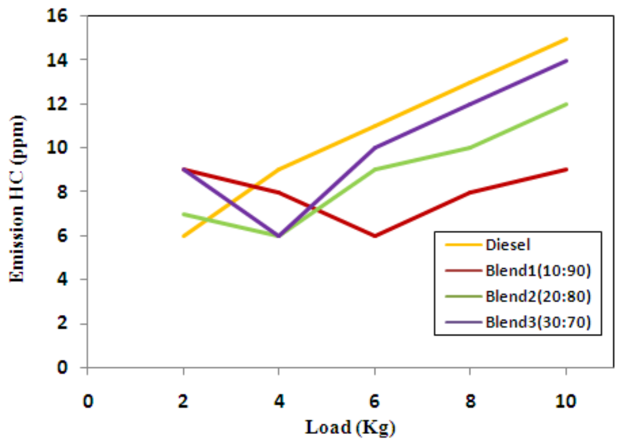


Fig. 3 Load vs. HC emission curves for diesel and the three blends

5.1 Inferences drawn from the results:

It is evident from the from the figures that HC and CO emissions increases with increase in load when diesel is taken as the fuel With Blend 1 CO emission increases with load and then decreases whereas HC emission first decreases with load and then increases for the same marginallyBlend 2 shows marginal decrease in HC emission with load whereas CO emission increases with load CO emission decreases with load for Blend 3 whereas HC emission increases marginally with load for the same

6. CONCLUSION

The maximum CO and HC emission for Blend 1is 0.15% vol. and 9ppm respectively which is remarkably lower compared to the other blends as is evident from the tables 3 and 4 respectively. Blend 3 shows a decrease in CO emission at high loads to a minimum of 0.16% vol. but HC emission is appreciably higher at high load to a maximum of 14ppm at 10Kg load. CO and HC emissions shows a maximum of 0.15%vol. and 12ppm respectively at 10Kg load for blend 2 but at an increasing trend as is evident from the figures 2 and 3. Taking into considerations the trend of emission of CO and HC, Blend 3 can be chosen as the ‘optimum blend’ for reducing exhaust emissions.

7. REFERENCES

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