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Performance and Emission Characteristics of Pyrolysed Fuel of Tyre Blended with Diesel in Diesel Engine

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ABSTRACT
The waste management of scrap tyre causes impact on environment due to its non-degradable property. Therefore the recycling of tyre scrap is to be considered for improving the energy conversion from solid waste management. The objective of this project is to investigate the performance and emission characteristics of diesel blended with Tyre Prolysis Oil(TPO) in direct injection(DI) diesel engine. The tyre oil obtained at 713 K through pyrolysis process of waste tyre. The synthesized oil is then processed by desulphurization to reduce the sulphur content and transesterification for blending it with diesel. The various blends of composition 10%TPO and 90% diesel, 20%TPO and 80% diesel is prepared. Through these blends the improvement of performance and emission characteristics such as NOX, CO2, HC were identified and compared with conventional diesel fuel.

Keywords: *Fin; Waste management; Tyre Pyrolysis Oil; Desulphurization; Emission Characteristics.*

I. INTRODUCTION
Day-to-day, the fuel economy of engines is getting improved and will continue to improve. However, the enormous increase in number of vehicles has been meeting the current demand for fuel. Gasoline and Diesel will become scarce and more costly in the future. With the increased use and depletion of fossil fuels, alternative fuel technology will become in the coming decades. By motivating the development of alternate fuels for the IC engine is the concern over the emission problems of gasoline and diesel engines. Combined with other air polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. Another reason for the development of alternate fuel technology is the fact that a large percentage of crude oil must be imported from various countries which control the larger oil fields.

2. Natural Air Cooling

2.1 PRIMARY ENERGY SOURCES

Primary energy sources can be defined as sources which provide a net supply of energy. Coal, oil, uranium etc. The energy required to obtain these fuels is much less than what they can produce by combustion or nuclear reaction. Their energy yield ratio, which is the energy fed back by the material to the energy received from the environment is very high.

The primary fuels only can accelerate growth but their supply is limited. It becomes very essential to use these fuels sparingly. Primary fuels contribute considerably to the energy supply.

2.2 SECONDARY FUELS

They produce no net energy. Though it may be necessary for the economy, these may not yield net energy. Intensive agriculture is an example wherein terms of energy the yield is less than input.

2.3 SUPPLEMENTARY SOURCES

These are defined as those whose net energy yield is zero and those requiring highest investment in terms of energy. Insulation (thermal) is an example for this source. Coal, natural gas, oil and nuclear energy using breed or reactor are net energy yielders and are

primary sources of energy. Secondary sources are like solar energy, wind energy, water energy etc.

3. PROBLEM IDENTIFICATION

- Nowadays, the cost of fuel is increased due to increase in demand of fuel and hence it is important to reduce the cost.
- The emissions of NOx, HC, CO, CO_2, etc causes environmental pollution.
- The viscosity of the fuel used is high.
- There is an incomplete combustion of fuel in the engine.

4. EXTRACTION OF OIL FROM PYROLYSIS SET UP

- The waste tyre is cut into small pieces. It is then washed with water to remove dust and impurities. The wet tyre is then dried to remove water content.
- After 20 minutes vapour is starts produced at the temperture of 370°C. The water supply is provided to condenser in the cross flow direction. The water starts to condense the hot vapour into liquid(TPO) at 440°C.
- The oil is collected in the separate chamber and total yield from 2 kg of waste tyre is about 820 ml. The pyrolysis set up is shown in figure 4.1below.

Figure 4.1 Pyrolysis Set-Up

4.1. DESULPHURIZATION

- Desulphurization is a chemical process to remove the sulphur from a liquid. TPO of 750 ml is heated at 60°C for 20 minutes in an electric heater.
- Sulphuric acid (H2SO4) of 150 ml is added to the heated TPO and stirred continuously. After 3 hours it is then allowed to cool.
- After 48 hours the sulphur and impurities are precipitated in the bottom layer. The top layer is the required TPO and the yield is about 620 ml.

4.2 TRANSESTERIFICATION

- The process of exchanging the organic group of an ester with an organic group of alcohol often catalyzed by the addition of acid or base catalyst.
- A mixture of KOH (1.4g) and methanol (240ml) is prepared.
- The TPO (520ml) is heated around 333 K for 20 minutes in magnetic stirrer.
- After 20 minutes, 104 ml of methanol and KOH mixture is added to TPO.
- Maintain temperature at 333 K for one hour and allow it to cool.
- The processed oil is kept for 48 hours in room temperature without any disturbances.
- The biodiesel (ester) obtained at top layer and the glycerol obtained at bottom layer.

Figure 3.6 Fuel Blends - B10 and B20

5. PROPERTIES OF TPO AND FUEL BLEND

FUEL	DENSITY (Kg/m^3)	DYNAMIC VISCOSITY (Ns/m²)	KINEMATIC VISCOSITY (m²/sec)	FLASH POINT °C	FIRE POINT °C
TPO	838.6	0.0185	$2.21x10^{-5}$	65	68
B10	837.08	0.0192	$2.34x10^{-5}$	56	59
B20	835.54	0.0204	$2.48x10^{-5}$	54	56

6. PERFORMANCE CHARACTERISTICS

Fuel : Diesel

POWER (kW)	TFC (kg/hr)	BP (kW)	FP (kW)	IP (kW)	SFC (kg/kW-hr)	ηmech %	ηoverall %	ηthermal %
0.5	0.516	1	2.65	3.65	0.516	27.39	15.86	57.89
1	0.562	1.35	2.65	4	0.416	33.75	19.66	58.27
1.5	0.673	2.18	2.65	4.83	0.308	45.13	26.5	58.75

Fuel: Diesel (90%) and TPO(10%)

POWER (kW)	TFC (kg/hr)	BP (kW)	FP (kW)	IP (kW)	SFC (kg/kW-hr)	ηmech %	ηoverall %	ηthermal %
0.5	0.502	1	1.25	2.25	0.502	44.44	19.03	42.83
1	0.547	1.5	1.25	2.75	0.3652	54.54	26.09	47.83
1.5	0.641	1.667	1.25	2.917	0.384	57.14	24.77	43.4

Fuel : Diesel (80%) and TPO (20%)

POWER (kW)	TFC (kg/hr)	BP (kW)	FP (kW)	IP (kW)	SFC (kg/kW-hr)	ηmech %	ηoverall %	ηthermal %
0.5	0.501	1	1.5	2.5	0.501	40	15.49	38.72
1	0.567	3	1.5	3	0.189	50	20.53	41.07
1.5	0.639	3.6	1.5	5.1	0.1775	70.58	43.7	61.95

7. EMISSION CHARACTERISTICS

7.1 EMISSION COMPARISON OF CARBON DIOXIDE

S.NO	POWER (W)	CO2 (% vol)		
		DIESEL	B10	B20
1	0	1.2	1.1	1.1
2	500	1.2	1.2	1.3
3	1000	1.5	1.4	1.5
4	1500	1.9	1.9	2.1

7.2 Emission Comparison of Hydrocarbon

S.NO	POWER (W)	HC (ppm vol)		
		DIESEL	B10	B20
1	0	11	9	17
2	500	13	14	14
3	1000	13	14	14
4	1500	12	16	18

7.3 Emission Comparison of Nitrogen Oxide

S.NO	POWER (W)	NO (ppm vol)		
		DIESEL	B10	B20
1	0	24	18	19
2	500	32	35	34
3	1000	44	42	47
4	1500	67	68	68

8. CONCLUSION

The objective of this project is to improve the performance and emission characteristics and the better results were observed in fuel blend B20 than B10 through this experiment.

- In comparison of performance characteristics between diesel and fuel blend B20, the fuel blend B20 has maximum çmechanical of (70.48%),□çoverall(43.7%),çthermal(61.95%) is greater than diesel performance and also the total fuel consumption B20 is lesser than the diesel.
- The increase in performance of B20 over diesel is about çmechanical(56.17%), çoverall(64.9%), çthermal(5.44%), BP(65.13%), TFC(5.05%), SFC(42.37%).
- In comparison with emission characteristics between diesel and B20, the emission is increased in very low content for B20 than diesel. The various emissions in B20 are CO - 0.2(% vol), CO2 - 2.1 (% vol), HC - 18 (ppm vol), NO - 68 (ppm vol). The increase in emission of B20 over diesel is about CO (0%), CO2 (9.52%), HC

(50%), NO (1.49%).

- Though the fuel blend B20 has finite increase in HC emission and other negligible emission because of its better performance than diesel, thus the TPO blended in diesel of composition B20 can be also used in diesel engines as an alternative by reducing the HC emissions using some additives.

- For better performance and good emission control fuel blended with the diesel (B20) TPO is suggested.

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