Performance Test of Tyre Pyrolysis Oil in Different Blended Ratio with Diesel

S. Prakash¹, M. Prabhahar², C. Thiagarajan², A. Amith³, & S. Mohanbabu³

¹ Assistant Professor, Department of Mechanical Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Mission Research Foundation, Deemed to be University, Tamil Nadu, India.
² Associate Professor, Department of Mechanical Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Mission Research Foundation, Deemed to be University, Tamil Nadu, India.
³ UG Scholar, Department of Mechanical Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Mission Research Foundation, Deemed to be University, Tamil Nadu, India.

Abstract. Waste tyre involves natural issue that is some were pre arranged illegally in open terrains, at last causing an environmental issue. Pyrolysis is one of the significant strategies for reprocess of scrap Tyres by utilizing gases, steel wires and Carbon dark. The fundamental inconvenience in utilizing Tyre Pyrolysis Oil (TPO) as a vitality source is unpredictable in its synthetic arrangement. The following results gives about the methods of oil can be effectively take benefit. 1.5 Litre of TPO gives 350 ml of distilled oil at temperature of 200-270°C. The TPO has viscosity, high fire point and high pour point. The methanol to diesel proportion of 10:90 showed the most reduced fumes tempera
ture and accomplished an improvement in the yield intensity of roughly 70% contrasted with different proportions. Additionally, the brake warm proficiency improved at all the blending proportions utilized. Moreover, the BSFC of unadulterated diesel fuel enrolled a lower an incentive than some other blending proportion. It has been appeared in this examination that the expansion of 10% methanol to the diesel fuel may greatly affect the motor execution and the earth.

Keywords: Tyre oil, Diesel, Blend ratio, Performance and Emission.

1. Introduction:
Wastes are materials for which a user doesn’t find any primary use and wants to dispose the product [1]. On basis of their effects on Human health and Environment, wastes are classified into 7 different categories (i.e) composed of vulcanized rubbers (including styrene butadiene (SBR), natural rubber (NR) and polybutadiene (BR)), carbon black, steel, textile cord and small amount of other additives [2]. They are created in huge volumes and have a low lifespan. Its shows the NOx Emission, slow that they have an imperceptible effect on mixture composition (the mixture composition is necessarily frozen), accelerated that the mixture state changes and the composition remains in chemical equilibrium, the rate governing processes that determine how the formation of the mixture changes with time [3]. There is an appropriate case when the fragrant content of a fuel can hike the Cetane number [4]. It arrives when an aromatic ring is connected to a long tie up alkyl group. The reaction of this alkyl group furnishes sufficient energy to break the aromatic ring delivering large amount of energy [5]. The enhance in the aromatic content with increase in magnitude of TPO the kinetics of reaction favours alkyl aromatics evolution for 40TPO and 60TPO and gives rise to the following situations [6]. At low fraction (20TPO) amalgam Cetane number remains constant with increase in aromatic content. At medium fraction (40TPO) combination Cetane number is enhanced due to condensation of aromatics with long chained alkanes. At higher fraction (60TPO) prepare Cetane number decreases along with increase in aromatic content [7]. Thus in
40LFPO we get exceptional performance and emissions compared to 20LFPO and 60LFPO blends.

The objective of the paper is discussion on 20TPO as a fuel. Based on combustion, Conduct and emission characteristics of the three types of blends of TPO (20, 40 and 60) it was found that 20TPO gave the best conclusion. All data obtained for 20TPO were end to that of diesel. It delights the emission standards required. Thus it is a latest blend of fuel is employed to operate a DI diesel Engine.

2. Materials and Methods

Waste tyres seem to be intractable scrap and cause significant environmental concern mostly with regard to the resource usage from used tyres. The tyre was originally sliced into a variety of parts, and removed the steel wires and fabrics. The thickness of the tyre chips now sliced into small particles such as varied between 0.5 inches and 2 inches. Few chips are control very smaller is better to use in the chamber spectrum and is readily fused. After washing and separate the feedstock was dried out naturally such as carbon black and fuel oil. Figure 1 presents the process block diagram for tyre pyrolysis. The fuel properties of tyre pyrolysis oil test result and diesel result as shown in Table 1.

![Fig 1: Process block diagram for tyre pyrolysis [5]](image)

Table 1: Properties of TPO and Diesel.

| PROPERTIES                  | TPO TEST RESULTS | Diesel Test Result |
|-----------------------------|------------------|--------------------|
| Flash point (°C)            | 36               | 56                 |
| Fire point (°C)             | 41               | 65                 |
| Calorific value (MJ/Kg)     | 37500            | 44500              |
| Cloud point (°C)            | 11               | 5                  |
| Kinematic viscosity (cSt)   | 2.9              | 3.2                |
| Cetane number               | 51               | 40                 |

3. Experimental Engine Setup

Fig 2 shows the engine setup consists of a single cylinder, four strokes, variable compression ratio connected to eddy current dynamometer. A kirloskar engine is 5.3 kw brake power, 1500 rpm rated speed, 87.5 mm bore, Bowl-in-piston type, modifying to variable compression ratio diesel engine [8].
4. Tyre Pyrolysis Oil and Diesel Test Result

4.1 VCR Engine- Performance Test Readings

Brake thermal efficiency is characteristics as how fuel energy is converted to the effective power. Fig. 3 shows the effects of diesel, TPO20, TPO40 and TPO60 on brake thermal efficiency (BTE) versus engine load [9]. Lower BTE was computed with TPO20, TPO40 and TPO60 due to lower calorific value of waste tyre oil. Maximum BTE was obtained as 29.5% for TPO20 and pure diesel at 31.4 full engine loads. However BTE decreased by about 11.1% with TPO20 at the same engine load.

Fig 4 shows the BSFC of Diesel, TPO20, TPO40 and TPO60 versus engine load; fuel consumption is increase due to the viscosity and density of the waste tyre pyrolysis oil. For diesel 0.19 Kg/Kw-hr and TPO20 which gives 0.28 Kg/Kw-hr respectively. Consequently, fuel consumption is increases with TPO20, TPO40 and TPO60 compared to diesel.

4.1 VCR Engine- Emission Test Readings

Fig 5 shows the CO emission of diesel, TPO20, TPO40 and TPO60 versus engine load; CO, which is a combustion process substance, is developed at high engine loads due to insufficient oxygen and temperature Combustion chamber

CO emission based on the TPO, the percentage volumetric of the CO emission as noted for pure diesel and TPO20, 40 and 60 with different blend is 0.23, 0.24, 0.22 & 0.2 (%) Vol respectively. Similarly the Fig 6 shows the Hydro Carbon (HC) emission noticed that parts per million is 135, 125, 130 and 120 (PPM) respectively. Fig 7 shows the Nitric oxide (NOx) emission for pure biodiesel and Blended tyre oil is 1180, 1220, 1280 and 1300 (PPM). With an increase in load TPO20 fuel compared to diesel fuel due to higher Nitric oxide content, the NOx
emissions for TPO20 and other blends increased compared to the other emission levels. Similarly Fig 8 shows the smoke opacity emission is noticed that 70, 68, 67 & 64 (BSU). The above noticed value for the emission result for full load condition. From the calculated value it observed the carbon monoxide, unburnt hydrocarbon smoke is reduced, and however the Nitric oxide NOx is increased with all setup[10]. As further as compared to the other emission the NOx poisonous gas is increased, so the other experimental setup is focused to decrease the NOx emission.

Fig5: CO for Diesel and TPO  
Fig6: HC for Diesel and TPO  
Fig7: NOx for Diesel and TPO  
Fig8: Smoke Density for Diesel and TPO

5. Conclusion:
The results obtained show the high probable of tyre pyrolysis oil of being used in different fields. As an outcome scrap tyres won’t be partial of into the environmental surroundings in formation of wastes; rather they will be well processed and converted to pragmatic products.
- The evidence that pyrolysis of waste tyres is considered to be a fine solution to protect the environment, it can also be made cost-effective. The sulphur fulfilled present in it means that it is almost unattainable for the fuel to pass inflexible emission standards.
- By distilling it we produce a very clean fuel which is free from sulphur and Lubricants endure combustion and rarely come to direct human exposure. So the risk of surrender harmful toxic gases is greatly diminished contrast to all other technique of disposing scrap tyres.
- The distillation can be utilised to manufacture low grade lubricants. There were some new discoveries related to the combustion of TPO and the typical results its blends with diesel fuel give. Tentative studies on combustion helped immensely to solve this problem. During combustion due to which 20TPO gives enhance combustion and emission characteristics compared to other fuel blends.
6. References

[1] A. Uyumaz, et al., 2018, Production of waste tyre oil and experimental investigation on combustion, engine performance and exhaust emissions, Journal of the Energy Institute, https://doi.org/10.1016/j.joei.2018.09.001.

[2] Rok Vihar et.al., 2015, Combustion characteristics of tire pyrolysis oil in turbo charged compression ignition engine, Fuel, 150 226–235

[3] A.S.M.Rezaun Nabi et.al, 2014, Purification of TPO (Tire Pyrolytic Oil) and its use in diesel engine, IOSR Journal of Engineering, Vol. 04, Issue 03

[4] Akhil Mohan et.al, 2018, Investigation on tire pyrolysis oil (TPO) as a fuel for cook stove and lamps, IOP Conf. Series: Materials Science and Engineering 376, 012036

[5] https://www.recyclingpyrolysisplant.com/FAQ/recycling_machine/tyre-to-diesel-machine-78.html

[6] Prabahar M, Sangeetha Krishnamoorthi et.al. 2008, Experimental Investigations on Dual Bio-Fuel (Pine Biodiesel and Palm Biodiesel) Blended with Diesel on a Single Cylinder Diesel Engine. International Journal of Mechanical and Production Engineering Research and Development, 8(2) 87-92.

[7] Krishnamoorthi S, Prabahar M & Saravana Kumar M et al. 2018, Yield characteristic of biodiesel derived from used vegetable oil methyl ester (UVOME) blended with diesel, in the presence of sodium hydroxide (NAOH) and potassium hydroxide (KOH) catalyst, as alternative fuel for diesel engines. International Journal of Mechanical and Production Engineering Research and Development 8(1) 9-16.

[8] Prakash S, Prabahar M, Saravana Kumar M, 2020, Experimental analysis of diesel engine behaviours using biodiesel with different exhaust gas recirculation rates, International Journal of Ambient Energy, DOI: 10.1080/01430750.2020.1712281.

[9] Prabahar M, Sendivelan S, Prakash S et al. 2017, Investigation of pine oil methyl ester blends with diesel on a compression ignition engine to control oxides of nitrogen and soot particles. Rasayan Journal of Chemistry 10(4) 1075-1079. DOI: 10.7324/RJC.2017.1041847.

[10] Prakash S, Prabhakar S, Saravana Kumar M, 2015, Experimental study of using vegetable oil as renewable fuel in diesel engine, Journal of Chemical and Pharmaceutical Sciences, Special Issue 9, 252-255, ISSN: 09742115.