TYRE PYROLYSIS OIL: A REVIEW

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Abstract

Scrap tyre consists of organic matter that is often disposed illegally in open lands, ultimately causing an environmental problem. Pyrolysis is considered as a useful technique for recycling of scrap tyres by using which liquid, gases, carbon black and steel wires are obtained. The difficulty in using Tyre Pyrolysis Oil (TPO) as an energy source is its complex chemical composition. The following report discusses about how the oil can be effectively utilized by separating it according to composition using the process of fractional distillation.

Keyword- *Material, Technology, Oil*

INTRODUCTION

Tyre consists of vulcanized rubbers (including styrene butadiene (SBR), natural rubber (NR) and polybutadiene (BR)), carbon black, steel, textile cord and small amount of other additives .They are produced in huge volumes and have a low lifespan. Durability of waste tyres is especially low in India due to poor road conditions and harsh climate. Owing to large number of vehicles and low lifespan of tyres it is estimated that 190 million tons of waste tyres are being generated each year in India alone.

1.1 Methods of Waste Tyre Recycling

Waste tyres are recycled in different ways which are:

1. Retreading
2. Landfills
3. Using as construction Materials
4. Incarnations
5. Tyre Derived Fuel

Retread is a manufacturing process designed to extend the lifespan of worn out tyres. The old tread is removed and a new tread is applied to the bare casing using specialized tools. This procedure is regularly carried out in airplane tyres as they are worn out very frequently and the necessity for them to be in good condition. On an average 4.5 gallons of oil is saved through this process compared to manufacture of a new tyre. In case of commercial vehicles, the savings can go upto 12.5 gallons of oil. Land filling is the most common way of disposing waste tyres, accounting up to 53% of the total waste tyre generated. But it has a serious impact on land usage, fertility of land and is a potential hazard as it is prone to fires. Tyres are very difficult to extinguish when they catch fire. Citing this many countries have banned this form of disposal of waste tires. Incineration and TDF are two waste to energy technologies that are available for the treatment of waste tyres. In incineration, energy recovery systems are used to recover the energy. TDF or tyre derived fuel the energy remains in a liquid form that can be used in combustors, IC engine etc. The importance of finding use for waste tyres can be deduced from the fact that we produce nearly 1 billion waste tyres each year. The composition of passenger vehicle tyres is approximately 85% carbon, 10–15% fabric materials and 0.9–1.25% sulfur. The typical percentages of the rubber mix are 55% synthetic rubber (polybutadiene) and 45% natural rubber (latex) in passenger vehicle tyres. Thus, the abundant organic matter (OM) contents of tyres can be converted into useful products for energy sources. Pyrolysis is one of the methods to derive alternative fuels, in which organic substances are converted into useful energy. One of the methods to derive alternative fuels is pyrolysis in which waste substances are converted into useful energy. Pyrolysis is a thermo chemical conversion process in which an irreversible chemical change is caused by the action of heat in absence of oxygen. This process yields value added products such as fuels or chemicals in the form of solid, liquid or gas. Without oxygen, the process splits the chemical bonds and leaves the energy stored in the organic substance. The

main advantages of pyrolysis include compactness, simple equipment, low pressure operation, negligible waste product and high energy conversion efficiency of the order of 83%.

LITERATURE REVIEW

Tyre Pyrolysis Oil is one of the product of pyrolysis of tyres. For the past 20 years it is being used as a fuel. Researchers have successfully blended TPO with diesel to run CI engines. Researchers have also characterized the fuel to understand the constituents present in it. Their research and findings are listed below.

2.1 Tyre Pyrolysis Oil

Bhatt et al have studied the suitability of TPO as a fuel to be used in IC engines. According to their research about 190 million tonnes of tyres are produced each year in India alone. They analyzed the properties of TPO and concluded that it can be used as fuel for industrial furnaces and boilers in power plants due to their high calorific value, low ash and sulphur content. But TPO has higher density, kinematic viscosity and lower cetane value compared to that of diesel. This limits its use as a fuel in IC engines. They proposed to use TPO blended with diesel fuel in various proportions by volume keeping the blend quality under permissible limits. During early years of work, Murena et al did a study on the product produced by hydrogenative pyrolysis of waste tyres. They investigated the temperature ranges between which solid phase and liquid phase products are formed. In order to maximize gaseous products, the temperature of the plant was proposed to be kept at 4000C. They studied the compounds present in both phases and also the residual char left after pyrolysis. GC-MS analysis of TPO was extensively done by Islam et al . Their report revealed that fixed bed fire-tube heating pyrolysis is a viable option for producing the fuel. The TPO yields from such a plant has fuel properties like diesel, viscosity and hydrogen content similar to that of diesel. For the present work TPO produced from such a setup was taken and the properties were verified. One of the major problems of TPO is its sulphur content. Before it can be used as a fuel the sulphur content has to be minimized. Curmali et al reported different methods of desulphurization. They found that pyrolysis done at 5000C yielded low sulphur TPO.

TPO as a Fuel in IC Engines

Williams et al studied the compounds present in TPO along with its combustion in a ceramic lined furnace. Their investigation revealed that TPO has PAH in high concentrations. They found high SO2 and NOx emissions. To avoid PAH, they proposed combustion under excess oxygen conditions. Sharma and Murugan created an oxygen rich environment by blending TPO with an oxygenated fuel i.e Jatropha Methyl Ester. They reported NOx and SO2 emissions comparable to that of diesel when used in an IC engine. S. Murugan et al found that TPO when blended with diesel showed anomalous combustion and performance characteristics. They reported that TPO when blended with diesel in ratio of 30 - 40 % by volume gives better combustion and performance than all other blends.

Ramaswamy et al in their research work tested that CI engines can run upto 90% distilled TPO blend, above which the engine fails becomes dysfunctional. They carried out distillation <2000C which the kerosene range. Findings of their research showed higher smoke, HC emissions but lower NOx emissions compared to that of diesel when used to run a DI diesel engine.

MATERIAL AND METHODOLOGY

An electrical dynamometer connected to a resistive load bank, was used to load the engine. The fuel measuring system consisted of a burette fitted with two optical proximity sensors, one at the top and other at the bottom. As the fuel passed through the higher level optical sensor, the sensor gave a signal to the data acquisition system (DAS) to start the counter. Once the fuel reached the lower level sensor, the sensor gave a signal to the DAS to stop the counter time and refill the burette. From this, the time taken for the consumption of fuel for a fixed volume was calculated. A differential pressure sensor fitted in the air box measures the air consumption. The differential pressure sensor was used to measure the pressure difference between the orifice plates. The differential pressure sensor also gave a proportional voltage output with respect to the difference in pressure. A schematic representation of the system is given in Figure 1

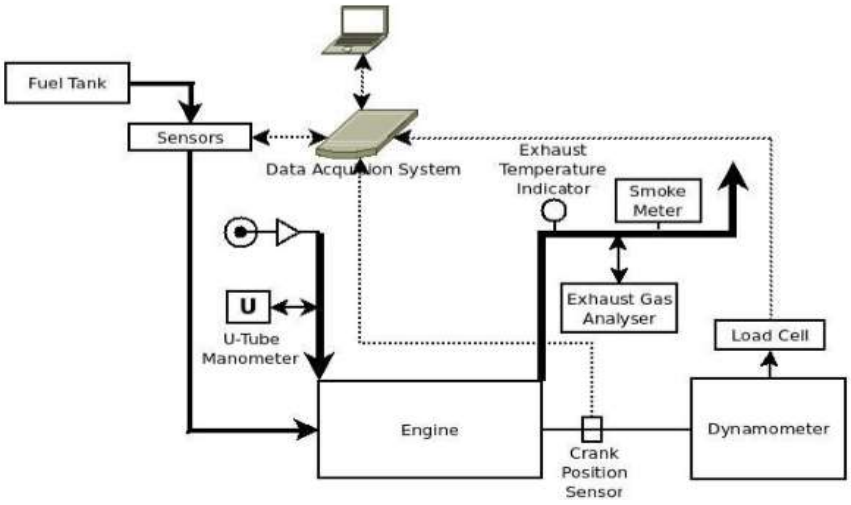

Figure 1 Schematic Representation of Test Engine

Conclusion

Fractionating the TPO by distillation is a very important procedure that is often overlooked. If TPO is directly used as a fuel, the presence of PAHs and aromatic compounds release many harmful anthropogenic gases into the atmosphere. The sulfur content present in it means that it is almost impossible for the fuel to pass stringent emission standards when used in IC engines in future. By distilling it we obtain a very clean fuel which is completely free from sulfur and PAHs. Lubricants don't undergo combustion and seldom come to direct human exposure. So the risk of releasing harmful toxic gases is greatly reduced compared to all other methods of disposing scrap tyres. Thus the remains of the distillation can be used to manufacture low grade lubricants.

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