Emission Analysis of Diesel Engine for Tyre Pyrolysis Oil & Diesel Blend

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Abstract— Reduction of biological fuel resources and stringent environmental laws have forced researchers to develop methods to sustainingly manage resources. The focus has been shifting towards energy recovery from waste materials which can solve the problems. One of the biggest wastes in the automobile sector is automobile tires. These have an unfavorable impact on the atmosphere if they are not disposed properly. Further, tires are a source of energy so it's not suitable disposal means wastage of energy. Some methods have been developed to extract energy from waste tires. One of them is pyrolysis of tires which produces Tyre Pyrolysis Oil (TPO) by thermal decomposition of tires. The properties of TPO with diesel were analyzed and compared with diesel and found that it is also used as a fuel in diesel engines. Tests are carried out on a diesel engine running with dissimilar blends of TPO 15% on a volume basis. The value of the Taguchi identifies that compression ratio 18, injection pressure 160 bar and engine load 9 kg are optimum parameters for lowest specific fuel consumption. Engine performance is mostly influenced by engine load and is least influenced by injection pressure.

Key words: Pyrolysis Oil, CI Engine, Diesel, Blended Fuel, Engine Performance

I. INTRODUCTION

In the current situation of the world, energy crisis due to fast depletion of fossil fuel is the main problem. Increase in fuel price day by day, continuing development of automobile industry, rapid growth in individual mobility and improved living standard, a continuous gathering of greenhouse effects are the main causes for development of alternative fuels. In current conditions, there is more chance of more in the research on biodiesel, vegetable oils and other alternate fuels. Taking everything in mind bio fuels as a diesel, Researchers are finding best alternative fuel, which gives the better efficiency and fuel properties. Best of alternative fuels used today are biodiesel or bio ethanol, which can be utilized in existing engines. The basic advantage of this kind of fuel is that they are renewable and eco-friendly. The different techniques for fuel and combine of alternate fuel with diesel. Recently in this field, the researcher work has gone on to add a maximum share of equivalent fuel in blend with diesel. With the utilization of alternate fuels, main issue is the qualification required in IC engines. To lower the cost of conversion some optimization techniques must be utilized. So performance and efficiency may not be lower. In such problem, utilization of non-linear methods like Design of Experiments, fuzzy logic and neural network is suitable to explore the linked effects of input parameters. The optimum performing parameters for a given system can be determined using experimental techniques, but experimental procedure will be slow and costly when the parameters are in the order of 30, 40 etc., in IC engines. In specific conditions mathematical will be a very useful tool for optimizing the parameters.

A. Pyrolysis Oil

Pyrolysis oil is produced from waste tire by a process which is called pyrolysis process. It is a decomposition of chemical, biological matter in the absence of oxygen. Pyrolysis of tires with the meaning of the production of fuel for the regulation as a fuel in a diesel engine can be seen as environmentally pollution free and efficient way of preparing them. In study, it was found that, samples of 3–4 cm wide, whole tire, have been pyrolysis at 700 °C. At over 500°C no result of temperature on gas and liquid which were about 18% and 37%, respectively. Tire pyrolysisoil derived from waste tires of automobiles were compared with the petroleum brand and was found that it is utilized as a fuel for diesel engine. It was noticed that waste tires pyrolysis produced oil in properties to a light fuel oil, with same calorific value, and sulfur and nitrogen constituents. The oil is find to contain 1.5% sulphur and 0.46% nitrogen by mass, and had similar properties to diesel fuel. A single oil drop combustion studied and also the oil is evaluated in detail for its content of polycyclic hydrocarbons. The oil is combusted in 18.4 kW oil-fired, spray warmer furnace, 1.5 m length and 0.6 m diameter. The emissions of NOx, CO2, grainy and unburned hydrocarbons were found in excess oxygen levels. Throughout the combustion method, the similarity of the emissions is made to the combustion of diesel. The oil is find to contain 1.5% sulphur and 0.46% nitrogen and have comparable fuel properties to those of DF.

Property	Tire Pyrolysis Oil	Diesel
Density at (gm/ml)	0.950	0.833
Kinematic viscosity at 40°c (cSt)	6.52	3.0
Flash point °C)	28°	74°
Calorific value (KJ/kg)	47362.88	42850

Table 1: The fuel Properties of Tire Pyrolysis Oil and Diesel

II. EXPERIMENTAL SETUP

The setup subsists of one cylinder, 4-stroke and research engine with dynamometer for loading. The operating mode of the engine is from Petrol to Diesel from Diesel to Petrol with some changes. In dual modes the compression ratio is diverse when stopping the engine and altering the combustion designed with cylinder block tilting arrangement. The injection point and spark point are to be changed for research tests. Setup is arranged with some instruments for combustion pressure, Diesel line pressure and crank-angle measurements. That indicator is interfaced with CPU for pressure crank-angle diagrams. The instrument is organized to interface fuel flow, temperatures, and airflow and load measurements. The setup has panel box consisting of air box, two fuel flow measurements, method hardware and indicator interface. Rota meter is provided for cooling water flow measurement. A battery, starter and battery charger are arranged for engine electric start arrangement. The setup study of Variable Compression Ratio engine performance for indicating power, brake power, BMEP, frictional power, IMEP, Brake thermal efficiency, Mechanical efficiency, indicated thermal efficiency, volumetric efficiency, A/F ratio, specific fuel consumption, combustion analysis and heat balance. Lab based Engine Performance Analysis software package "Engine soft" is given for performance evaluation. Table.1 shows Technical specification of C. I Engine.

Item	Specification
Model	TV1
Make	Kirlosker Oil Engines
Type	Four stroke, Water cooled, Diesel
No. of cylinder	One
Bore	87.5 mm
Stroke	110 mm
Compression ratio	12 to 18
Power rating	7.5 HP
Injection timing	$\leq 25^0$ BTDC

Table 2: Engine Specifications

Fig. 1: Exhaust Gas Analyzer

5 Gas Analyser	Model: GA4050
Year of Manufacture	2012
CMVR Type Approval Certificate No	ARAI/TA (4G) CORAL/GA4040, 2005-05
Serial Number	0501300
Serial Number Of the Measuring transducer	006474
Minimum and Nominal flow rate	0.5LPM-6LPM
Voltage	100-300V/AC/1ϕ/50-60Hz
Gas Component and respective maximum measured value	
CO	10.0%VOL.
CO2	20.0%VOL.
O2	21.7%VOL
HC	20000ppm as propane
Oxygen fuel cell	Electrochemical/PTB 18.10
PEF	0.542

Table 3: Technical specification of Exhaust gas analyzer

III. METHODOLOGY

Bi-fuelling or blending is the easiest technique to low cetane fuels in high compression ratio engines. According Mitesh Parmar et.al, 15% blend of pyrolysis oil in diesel gives best performance in the match. Efficiency. In this practical the pyrolysis oil was blend with regular diesel in 15% and its properties such as viscosity and calorific value were calculated before an experiment. The effects parameters, i.e. load, injection pressure and compression ratio are variable for optimization. A method named "Taguchi" is used in the practical for optimization of parameters of engine such as load, injection pressure and compression ratio.

Taguchi method is the easiest method of optimizing the parameters in a small number of tests. The parameters included in the practical determines the number of tests required for the experiment. Many NUM. Of parameters led to a number of tests and use up more time to complete the practical. So a method called "Taguchi" was selected to optimize the levels of parameter contained in the practical. Taguchi method utilized an orthogonal array to finish a small number of practical. The study uses three components at five levels and hence, an L25 orthogonal array with twenty five rows was used for the construction of experimental design. According to taguchi, twenty five practical's are carrying out and tests were selected at random, to avoid systematic error creeping into the experimental procedure. For each test the SFC (specific fuel consumption) was calculated and used as a response parameter. Taguchi procedure utilized a parameter named S/N ratio (signal to noise ratio) for measuring the quality property. There are three types of S/N ratios is in the method. Of which, the smaller-is-better S/N ratio was utilized in this practicals a result of this optimization is placed on lower SFC. The Taguchi procedure used in the analysis was designed by software called "Minitab 17" to facilitate the Taguchi procedure and results. A full area of practical for the selected blend is also conducted after modifying the engine operating parameters. This is generally to optimize the performance characteristics of pyrolysis oil-diesel blend.

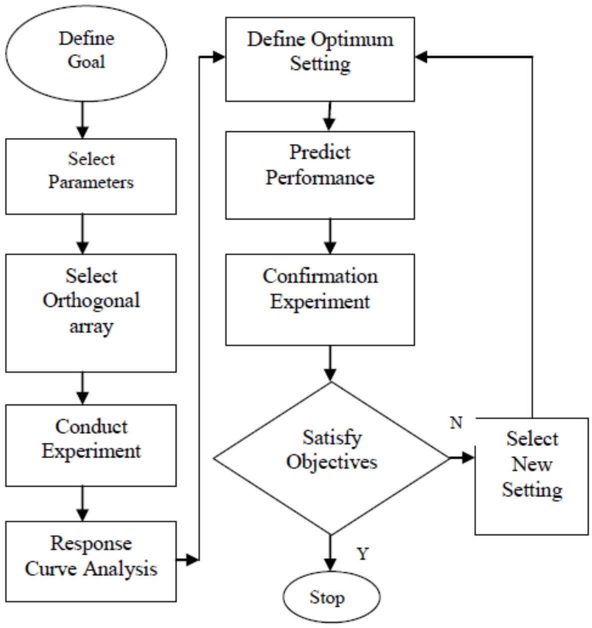

Fig. 2: Flow chart (Taguchi Method)

IV. RESULT AND DISCUSSION

According to the observed data collected from the experiment and the calculations are made following the analysis are being done. Graphical comparison of different emission characteristics like HC, CO, CO_2, and NO_X for tire pyrolysis oil and diesel blend with varying load is being done.

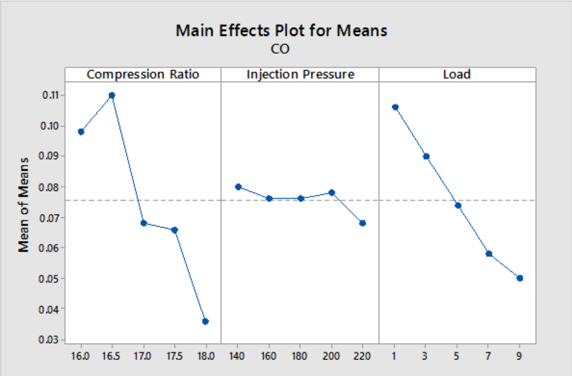

Fig. 3: Variations of CO EMISSION with Comp. Ratio, Injection Pressure and Load

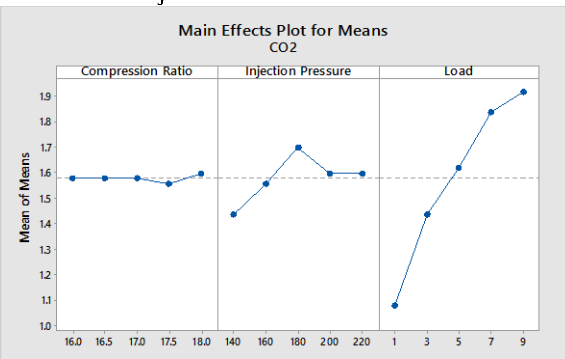

Fig. 4: Variations of CO_2 EMISSION with Comp. Ratio, Injection Pressure and Load

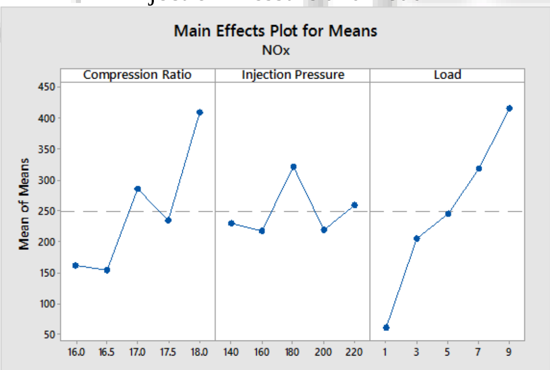

Fig. 5: Variations of NO_x EMISSION with Comp. Ratio, Injection Pressure and Load

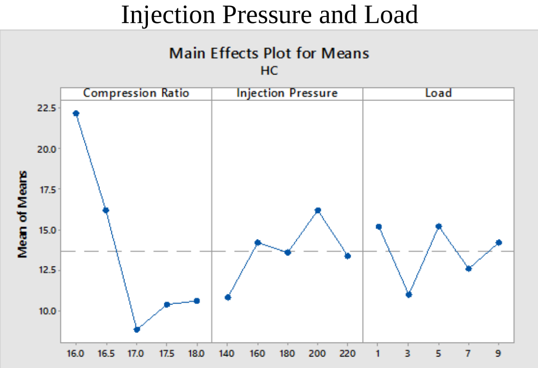

Fig. 6: Variations of HC EMISSION with Comp. Ratio, Injection Pressure and Load

The effect of their pyrolysis oil and diesel blend with varying Comp. Ratio, Injection Pressure and Load on Carbon monoxide emissions are shown in fig. 3. From the figure it is being observed and concluded that the CO emission for 18 comp. Ratio, 220 Injection Pressure and 9kg Load are considerably lesser than all other set of parameters.

The effect of tyre pyrolysis oil and diesel blend with varying Comp. Ratio, Injection Pressure and Load on Carbon Dioxide emissions are shown in fig. 4. From the figure it is observed that the CO2 Emission for17. 5 comp. Ratio, 140 Injection Pressure and 1kg Load are considerably lesser than all other set of parameters.

The effect of tyre pyrolysis oil and diesel blend with varying Comp. Ratio, Injection Pressure and Load on Nitrogen Oxides emissions are shown in fig. 5From above graph it is being concluded that the NOx Emission for16. 5 comp. Ratio, 160 Injection Pressure and 1kg Load are considerably lesser all another set of parameters.

The effect of tyre pyrolysis oil and diesel blend with varying Comp. Ratio, Injection Pressure and Load on Hydrocarbon emissions are shown in fig. 6 From above graph it is being concluded that the Hydrocarbon emission for17 comp. Ratio, 140 Injection Pressure and 3kg Load are lesser than all other set of parameters.

V. CONCLUSION

Tire pyrolysis oil and diesel blend fuel seems to have a potential for use as alternative fuel in diesel engines. Blending with diesel decreases the viscosity significantly. The following results are made from the experimental study-

All the set of parameters of blends of tyre pyrolysis oil with diesel have considerable lesser Emission of HC, CO, CO_2, NO_X.

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