# Experimental Analysis of Mechanical Efficiency for Diesel Engine fueled with Waste Plastic Oil by using Taguchi's Method

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*Abstract:* Today world has largely faced Global warming effects. Automobile vehicle or industries are produce larger amount of carbon dioxide or other pollutes gases mixed into atmosphere and these are produced Global Warming effects. In this study analysis of mechanical Efficiency is observed by using Load, Blend Ratio and Exhaust Gas Recirculation as input parameters. In this study observed of mechanical Efficiency is observed and input parameters are Load, Blend Ratio and Exhaust Gas Recirculation. Aim of Experiment is to study decreasing polluted gas and check the performance of Diesel Engine fueled with Waste Plastic oils as alternative fuel.

Keywords: C.I Engine; Waste Plastic Oil; EGR

## I    INTRODUCTION

In past century to now days human develop many new techniques for satisfy their requirement of energy. In simple words before engine not in market or not develop this time human use animal or other human effort technique for satisfy travelling or other requirements of energy. They used axe in farm work also in some case for travelling and Horses used in travelling and war. Then after a long time human develop first engine or mechanism for reduce human work or work without human energy. Like steam engine, bicycle etc. Then certain times after they develop combustion engine and find some useful resources of energy from environment. This fuel used in industries and automobile widely. Now I talk about automobile vehicle fuel requirement and price. In automobile most of vehicle fuels are diesel and petrol widely used. If fuel use is this engine called Diesel Engine and working fuel is petrol so this engine called Petrol engine. Now day this conventional fuel availability is limited and these are non-renewable energy recourses. So lake of availability and increase consumption rate of fuel also increase price. The combustion of fuel produces harmful gases in environment and Greenhouse effect in environments. This Greenhouse effect is make changes in our earth ecosystem and its effects on human, animals, Trees and all Earth. The use of car, two wheeler, truck, buses, boat, submarine, Plan etc all travelling or luggage vehicle are mostly working fuels is diesel or petrol. Daily use of petroleum product increased production of harmful gases.  Also production of petroleum product industries or refining produces toxic and harmful materials. This primary pollution from the conventional hydrocarbon fuel are unbound incompletely burned Hydro Carbon (HC), Carbon Monoxide (CO), Nitrogen Oxide (NOx), Smoke and particular matter. This contain produces Greenhouse effect and this effect change in ecosystem like Uncontrolled rain, Increase earth temperature, Acid rain etc. So researchers are working on reduces engine emission and find alternative fuels for replacement of petroleum product. This alternative fuels are Plasto oil, Biodiesel, Vegetable seed oil etc. Vegetable oils are mostly used in eating but Plasto oil is produce by pyrolysis process from waste plastic oil. Plasto oil viscosity and other parameters are near about Diesel fuel. Plasto oil production reduces waste plastic pollution and easily disposed plastic waste. Use of plastic polyethylene bag, PVC pipe etc. are increase production of plastic bags or other related product. Now only consider The India plastic product use scenarios only The India produced approximately 15342 Ton per day and also increased continue. So by proper utilization of this waste plastic many litter of Plasto oil produced easily and waste major problem reduced easily. So finally fuel select and now some changes in Diesel engine like IC engine largely depend on Intake system. To effective work done produced so must be attach EGR. EGR main function is it helps in complete combustion in chamber by exhaust gas heat. India produced largely amount of plastic per day. Waste Plastic Oil are produced from Plastic polymer, Poly-thin bag etc. This oil can be easily produced by Plastic Pyrolysis process. A main benefit of this fuel is it reduce Waste plastic material disposal.

## II    EXPERIMENTAL SET UP

In this experiment use single cylinder 4 stroke Diesel engine also some attachment provide for major better results like Dynamo meter, Exhaust Gas Recirculation pipe, Tachometer, Fuel measurement Instrument, Stop Watch etc. Exhaust Gas Recirculation (EGR) set up is used to controlling the recirculation of exhaust gas and it is help to mix outlet gas to intake air. This mixture sends into combustion chamber by use of intake manifold. This mixture helps to reduce the combustion chamber temperature so finally reduced the NOx in exhaust gas. This effects reduce combustion speed so finally reduce the peak combustion temperature then the exhaust gas temperature reduce but take more time to release same amount of energy. Exhaust gas produce opposite effects on oxygen it reduce quantity of oxygen in combustion chamber so incomplete combustion occur. The other Parts is tachometer it help to major the RPM of engine. In this

experiment touch type tachometer use for major the RPM of flywheel. Rope brake Dynamometer use in this set up it help to how much load apply on engine by use of rope. In this experiment continue water spray apply on rope for reduction of heat on rope. For fuel measurement simple 50 ml tube fit on the display board with measuring scale. Also provide temperature measurement sensor and its display on dashboard. Before starts this experiment check fuel tank of diesel and approximately 10 to 15 min ideal run the Engine its called Prime step of experiments. After every reading takes 15 min run engine and then measures all these parameters. Experiment set up and specification are shown in figure 1 and table 1 at below respectively.



Fig.1 Engine set up

Table 1 Engine specifications

| Parameter | Details |
|---|---|
| Engine | Single Cylinder High Speed Diesel Engine |
| Cooling | Water cooled |
| Bore $\times$ Stroke | 80 mm $\times$ 110 mm |
| Compression ration | 16 : 1 |
| Maximum Power | 5 hp or 3.7 kW |
| Rated speed | 1500 rpm |
| Capacity | 553 CC |

## III METHODOLOGY

Taguchi's analysis method is used to find Optimum value of parameters. In this study Taguchi's is applies to find optimum Input Parameter for gives maximum efficiency, less emission and minimum fuel consumption. The work investigates the influence of Load, Blend Ratio (%) and Exhaust Gas Recirculation (EGR) on the performance of Diesel Engine fueled with Waste Plastic oil (0%, 50% and 100%). The Experiment was designed using statistical tool DESIGN OF EXPERIMENT (DOE) based on Taguchi's analysis in MINI TAB software. The Taguchi's result model was helpful to predict the responses parameter such as Break Specific Fuel Consumption, Break thermal Efficiency and Mechanical Efficiency etc.

**Observed parameter**

This Experiment performs on three main parameters gives below.

(1) Load (2) % of Blend (3) % of EGR.

**(1) Load**: Load is directly affects on Mechanical efficiency of engine. If we can increases the load than the RPM of the engine effect.  In this setup we vary load 1, 6 and 11 kg.

**(2) % of Blend**: Blend ratio is largely effect the mechanical efficiency because calorific value of different fuel is not same so its change the Mechanical Efficiency, Brake Thermal Efficiency etc. In this setup % of blends by volume are (0% Diesel), (50% WPO & Diesel) and (100% WPO).

**(3) % of EGR**: Exhaust Gas Recirculation reduces combustion chamber temperature or exhaust gas temperature so finally reduction NOx in Exhaust gas. In this experiment take % of EGR is 0%, 25% and 50%.
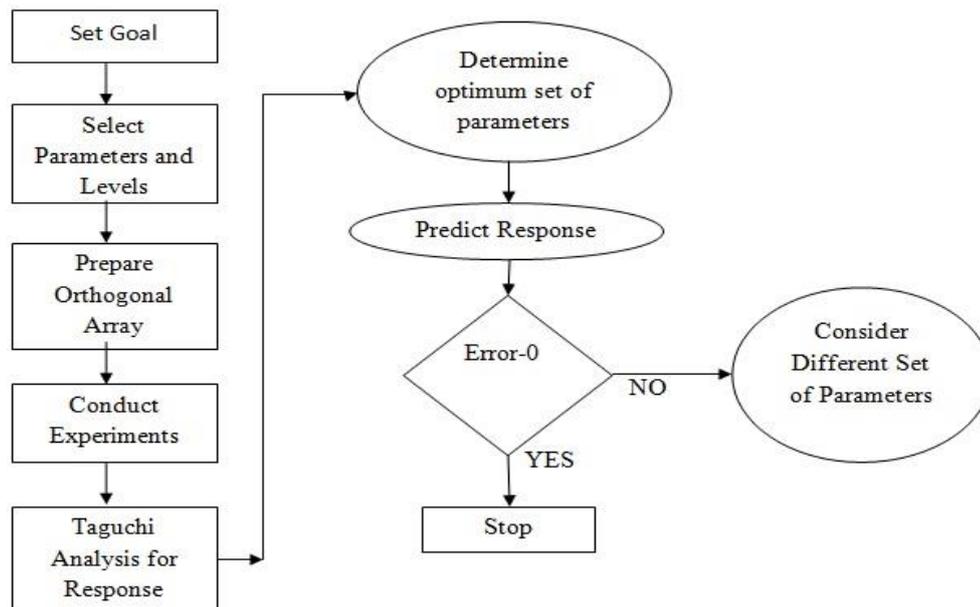
Fig.2 Flow chart of experiment

## IV  RESULT &  DISCUSSION
The selected variables are on 3 levels with orthogonal array method

Table 2 Parameters and their levels

| Process Parameter | -1 | 0 | 1 |
|---|---|---|---|
| Percentage of Blend (%) | 0 | 50 | 100 |
| Load(Kg) | 1 | 6 | 11 |
| Percentage of EGR | 0 | 25 | 50 |

### 4.1 Taguchi's analysis for mechanical efficiency
Experiment analyses according to central composite design. Analysis conducted for all the data sets with process parameter levels set as Table 2

Table 3 All the process parameter over output parameter

| Run order | A | B | C | Mech. Eff. (%) |
|---|---|---|---|---|
| 1 | 0 | 1 | 0 | 17.0892 |
| 2 | 0 | 6 | 25 | 54.6182 |
| 3 | 0 | 11 | 50 | 69.4067 |
| 4 | 50 | 1 | 25 | 11.8610 |
| 5 | 50 | 6 | 50 | 44.7188 |
| 6 | 50 | 11 | 0 | 59.8011 |
| 7 | 100 | 1 | 50 | 11.4586 |
| 8 | 100 | 6 | 0 | 43.5569 |
| 9 | 100 | 11 | 25 | 58.4067 |

A.B and C represented the all process parameter Percentage of blends, Load and Percentage of EGR respectively. The entire coefficients are to be estimated using experimental data as on table 3.

Table 4 Response Table for Means of Mechanical Efficiency

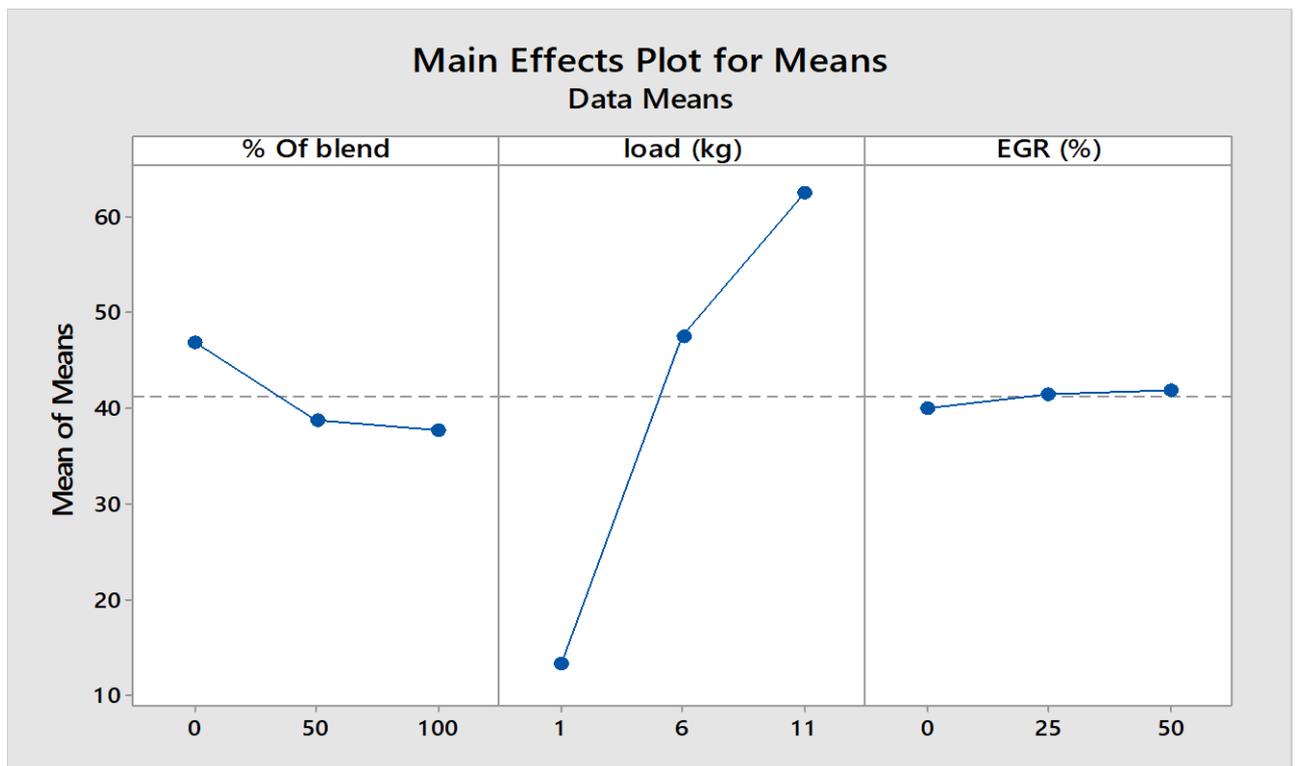| Level | % of Blends by Volume | Load (Kg) | % of EGR by Volume |
|---|---|---|---|
| 1 | 47.04 | 13.47 | 40.15 |
| 2 | 38.79 | 47.63 | 41.63 |
| 3 | 37.81 | 62.54 | 41.86 |
| Delta | 9.23 | 49.07 | 1.71 |
| Rank | 2 | 1 | 3 |

Fig 3 Main effects plot for means of Mechanical Efficiency

Delta is difference of maximum value and minimum value. Delta value has maximum for Load (kg) and minimum for % EGR. Delta value for % of Blend is (9.23). So that load and % of EGR are maximum effect produce on Mechanical Efficiency. The term optimum setting is reflects only optimum combination of the parameters defined by this experiment. The optimum setting is determined by choosing the level with the highest s/n ratio. Referring (figure 4) the response curve for S/N ratio, the highest S/N ratio was observed at Diesel (100%), 11 Kg engine load and 0% rate of EGR by volume which are optimum parameters setting for highest Mechanical Efficiency. From delta values as mention as shown in table 5, maximum delta (13.46) for engine load and minimum delta (0.65) for rate of % of EGR. Parameter % of blends is significant parameters and least significant for Mechanical Efficiency. Optimum set of parameters set shown in table 6.

Table 5 Response table for signal to noise ratios for mechanical efficiency

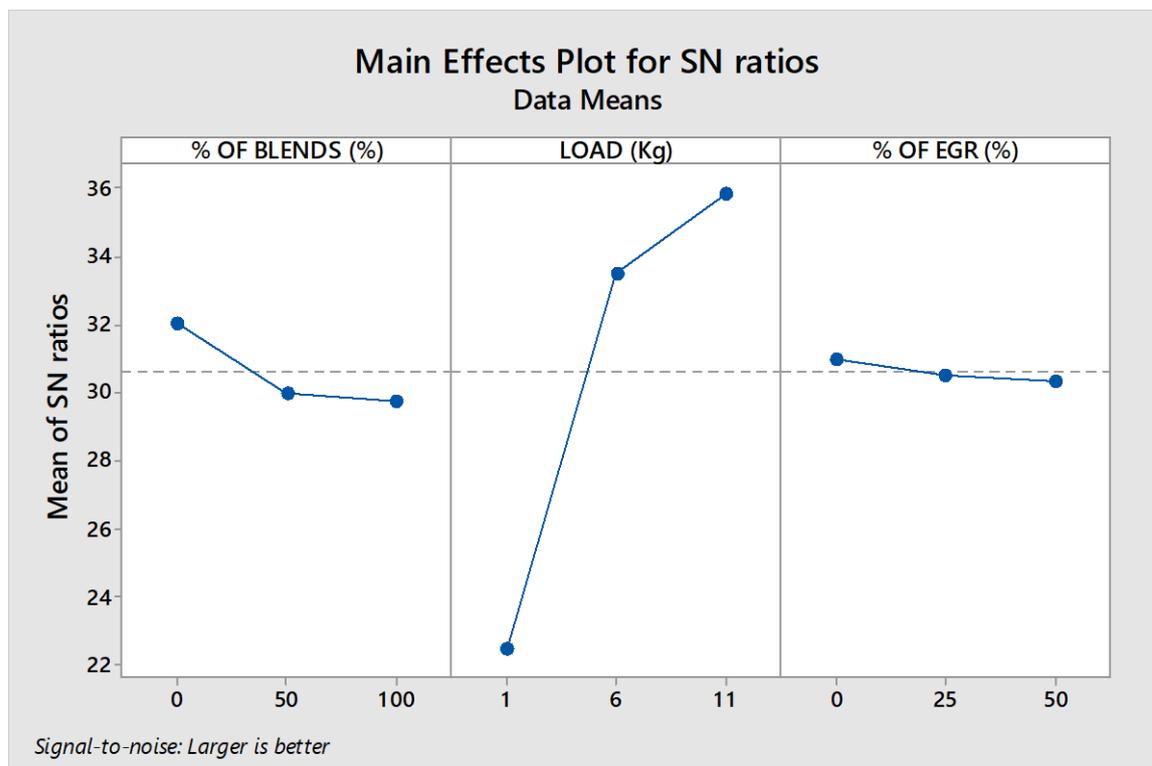| Level | % of Blends by Volume | Load (Kg) | % of EGR by Volume |
|---|---|---|---|
| 1 | 32.08 | 22.44 | 30.99 |
| 2 | 30.01 | 33.51 | 30.52 |
| 3 | 29.76 | 35.90 | 30.34 |
| Delta | 2.31 | 13.46 | 0.65 |
| Rank | 2 | 1 | 3 |

Fig.4 Main effects for s/n ratio for mechanical efficiency

Table 6 Optimum set of parameters of mechanical efficiency

| % of Blends by Volume | Load (Kg) | % of EGR by Volume | $\eta_{mech}$ (%) | s/n ratio |
|---|---|---|---|---|
| 0 % | 11 | 0 % | 69.406 | 37.080 |

Table 7 Validation results for mechanical efficiency

| Predicted Value | Experimental Value | Error % |
|---|---|---|
| 69.011 | 69.406 | 0.395 |

Experiment has been carried out using optimum set of parameters. Experimental Mechanical Efficiency value is 69.406 %. This experiment value is nearer to predictive value as shown in table 7.

## V  CONCLUSION

The present experiment is to check the performance analysis of Diesel engine by use of blends of Waste Plastic oil and Diesel mixture. This optimization analysis carried out by use of Taguchi's analysis in MINITAB Analysis software. This software used to find out optimum solution parameters and also use to find out predictive value of mechanical efficiency. Finally take Practical Mechanical Efficiency value of experiment and Predictive value of Mechanical Efficiency. This process used to find out experiment is useful or not. And finally analysis above Main effects plot for means of mechanical efficiency, Main effects for s/n ratio for mechanical efficiency, optimum set of parameters of mechanical efficiency and validation results for mechanical efficiency. So finally result is near about predictive results.

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