Experimental Analysis of Specific Fuel Consumption Using Taguchi's Analysis Method on C.I Diesel Engine Fueled with Diesel and WPO Biodiesel

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Abstract: The purpose of Experiment study is to check the performance of Diesel Engine using WPO and Diesel blend. Then after optimize the Value of Specific Fuel Consumption by applying Taguchi's analysis method with the parameter of percentage of blend ratio, Load and Exhaust Gas Recirculation at various levels and verify the optimum value of SFC. For verification of SFC it has to be Compare the Experimental value with Predicted value. And also by Taguchi's method we can analyze individual as well as combined effect of all parameters examined under this experiment.

Keywords: SFC optimization; Waste Plastic Oil bio diesel; EGR

I INTRODUCTION

Day by day increase demand of energy. These requirements of energy are fulfill by use of fossil fuel. This fuel use produce lot of harm full gas into atmosphere. This harmful gas changes earth scenario. This exhaust gas produced green house effects so that increases earth temperature and change different natural process like uneven rain etc. If we can try to reduction in pollution then try to reduction in use of fossil fuel or other petroleum fuel. Renewable energy resources have best option to reduce effect of global warming but it has some limitation. So one way possible an d it was try decrease quantity of fuel without change in quality means no change in energy supply for satisfy the demand of energy. Now day use of bio-diesel is another way for reduction of fossil fuel dependency. In this technique bio-diesel add in diesel fuel directly. In this experiments waste plastic pyrolysis oil use as bio-diesel. This alternative oil is produces by pyrolysis process. This fuel is directly convert from Low density poly ethylene (LDPE), High density poly ethylene (HDPE), Poly ethylene Teri-phthalate (PET), Polypropylene (PP), Polystyrene (PS), Poly vinyl chloride (PVC) etc to WPO easily. It can be produce 99 % Waste plastic oil from plastic waste by this process. The objective of study is to reduce the fuel consumption and optimize the fuel consumption value with using blending of diesel and Waste plastic pyrolysis oil. Experiment is performed on the CI Diesel engine with Rope break dynamometer.

II MATERIAL AND MODEL

The experiment analysis held on 5 hp CI engine with rope break dynamometer with Diesel and Jatropha biodiesel blend a single-cylinder, 4-Stroke, water-cooled diesel engine of 5 hp rated power is considered for the experimentation. The Engine is connected with the Rope Brake Dynamometer which is used to measuring Load. A stationary, 5 hp direct injection diesel engine is used to conduct experiments. Its specifications are given in table 1. Exhaust Gas Recirculation system is attached with Engine to control emission temperature. This engine specification and set up shown in table 1 and figure 1 respectively.

Table 1 Engine specifications

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

Fig.1 Engine Set up

III METHODOLOGY

Taguchi's method is used to find Optimum value from the relationship between Factors and Responses. In this study Taguchi's method is applies to find optimum Input Parameter gives maximum efficiency, minimum fuel consumption and less emission. The work investigates the influence of Load, Blend Ratio (%) and Exhaust Gas Recirculation (EGR) on the performance of Diesel Engine fueled with Jatropha Biodiesel (0%, 50% and 100%). The Experiment was designed using statistical tool DESIGN OF EXPERIMENT (DOE) based on Taguchi's analysis method. The Taguchi's method was given predict value such as specific fuel consumption, break thermal efficiency and mechanical efficiency etc. Optimization of parameters was performed using the desirability approach of the response surface methodology for better performance. It's full flow chart shown in figure 2 below.

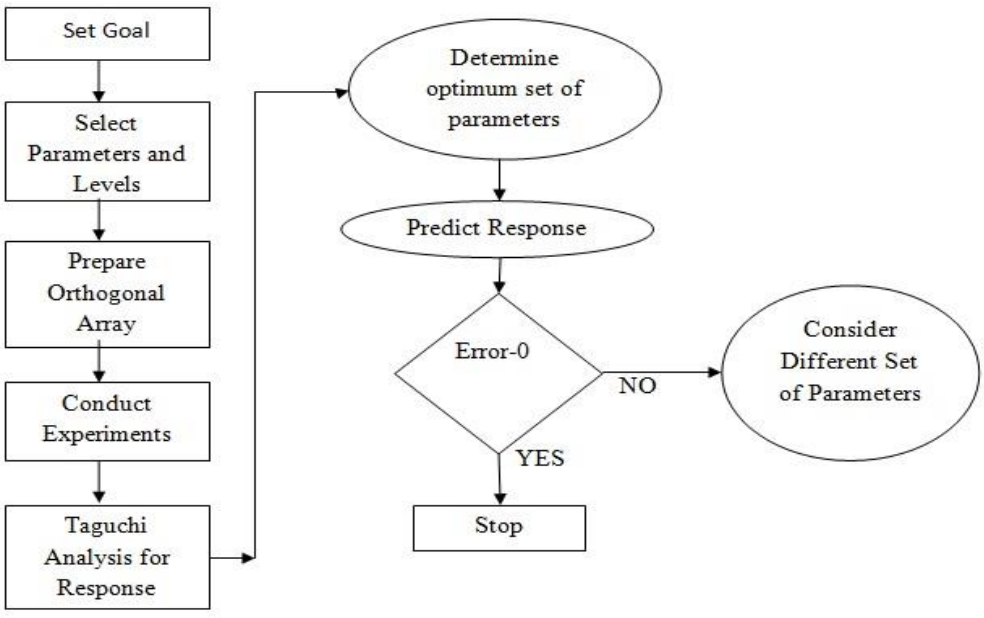

Fig.2 Flow Chart of Experiment

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 SFC

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	SFC (kg/ kWh)
1	0	1	0	1.473751974
2	0	6	25	0.365790972
3	0	11	50	0.213454084
4	50	1	25	1.668394381
5	50	6	50	0.321373497
6	50	11	0	0.192626865
7	100	1	50	1.831241055
8	100	6	0	0.337433652
9	100	11	25	0.206272459

Mean is average value for reading taken for SFC and it Shown in table 4. Now we can Shows in figure 3 for mean value and it is maximum (0.791) for 100 % of WPO and minimum (0.684) for diesel fuel. Now mean maximum value is (1.657) for load 1 kg and minimum value is (0.204) for load 11 kg and Now mean maximum value is (0.788) for 100 % of EGR and minimum value (0.667) for 0 % of EGR. Delta is difference between maximum value and minimum value. Delta value has maximum for load (kg) and minimum for % of blends. Delta value for % of EGR is (0.120). So it can be define that load and % of blends are maximum effect produce on SFC.

Table 4 Response Table for Means of Specific Fuel Consumption

Level	% of Blends by Volume	Load (Kg)	% of EGR by Volume
1	0.684	1.657	0.667
2	0.727	0.341	0.746
3	0.791	0.204	0.788
Delta	0.107	1.453	0.120
Rank	3	1	2

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%), 1 kg engine load and 50% rate of EGR by volume which are optimum parameters setting for highest indicated thermal efficiency.

Table 5 Response Table for Signal to Noise Ratios for SFC

Level	% of Blends by Volume	Load (kg)	% of EGR by Volume
1	-6.260	4.356	-6.791
2	-6.573	-9.344	-6.000
3	-5.964	-13.810	-6.006
Delta	0.609	18.167	0.791
Rank	3	1	2

Fig.3 Main effects plot for means of Specific Fuel Consumption

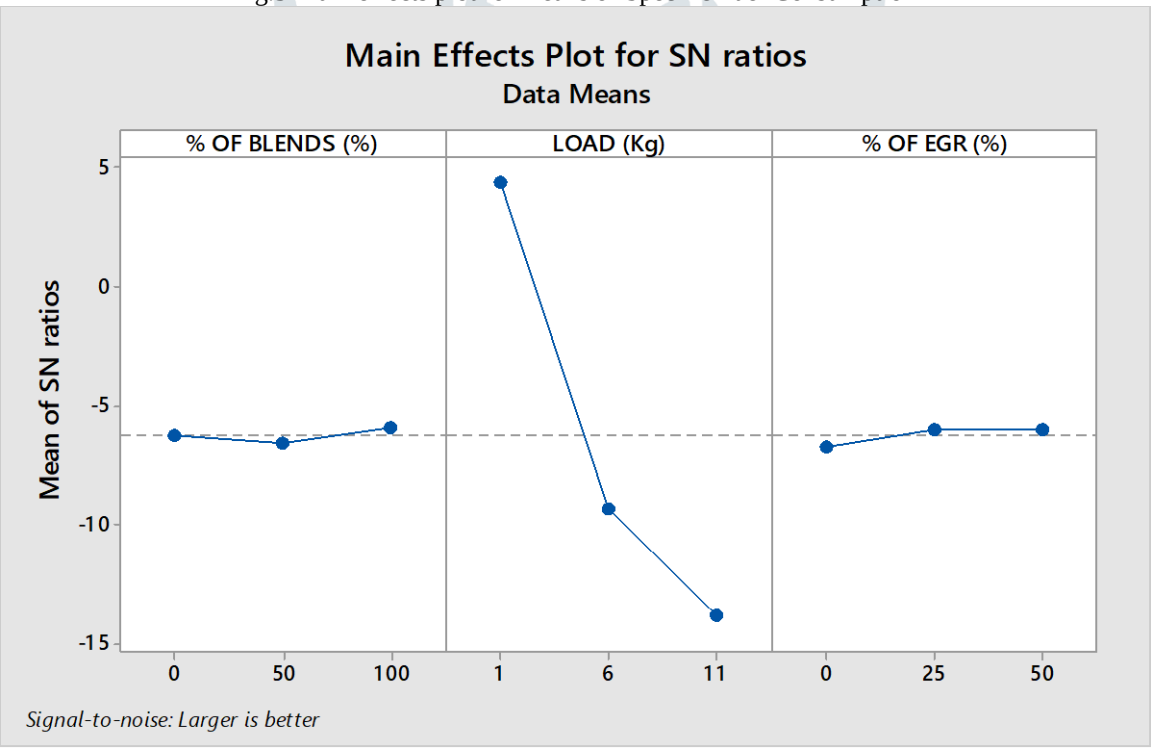

Fig.4 Main effects for s/n ratio for Specific Fuel Consumption

Table 6 Optimum set of parameters of SFC

% of Blends by Volume	Load (Kg)	% of EGR by Volume	SFC (kg/ kWh)	S/N ratio
100%	1	0 %	0.192	14.642

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 3) the response curve for S/N ratio, the highest S/N ratio was observed at diesel (100%), 1 kg engine load and 50% rate of EGR by volume which are optimum parameters setting for highest indicated thermal efficiency. From delta values as mention as shown in table 5, maximum delta (4.71) for engine load and minimum delta (0.32) for % of EGR. Parameter % of blends is significant parameters and least significant for indicated thermal efficiency. Optimum set of parameters set shown in table 6. Experiment has been carried out

using optimum set of parameters. Experimental SFC value is 0.192 kg/kWh. This experiment value is nearer to predictive value as shown in table 7.

Table 7 Validation results for SFC

Predicted Value (%)	Experimental Value (%)	Error (%)
0.130	0.192	6.20

V CONCLUSION

The Taguchi's method is used to find out optimum sets of parameter for specific fuel consumption. The test has been conduction with the percentage of blend(0,50,100), load at(1.6,11) and EGR (0,25,50).After the optimization of Taguchi's optimum value of the Specific Fuel Consumption is 0.192626865 kg/ kWh at 1 kg of load, 100% blend and 0% EGR with error of 6.20%.

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