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EXPERIMENTAL INVESTIGATION ON INJECTION PARAMETERS USING TAGUCHI

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ABSTRACT : *Biodiesel has become a best alternative fuel for diesel engines. Using of biodiesel in diesel engine raises more difficulties for neat combustion of fuel. However, injection parameters plays major role in engine performance and combustion characteristics. Injection parameters include injection pressure and Number of holes was optimized with L9 orthogonal array with suitable biodiesel blends. In the present work, the injection pressure and number of holes are varied at three levels with the fuels diesel, waste cooking oil and rape seed oil. Optimization technique was made by Taguchi method and suitable orthogonal array L9 was selected for a design of experiments. Injection pressure and Number of holes includes 190,200,210bar and 1, 3,4holes respectively. Hence, the experiments were conducted to analyse the performance characteristics to improve brake thermal efficiency.*

Keywords - *Brake thermal efficiency, Injection parameters, Optimization technique, orthogonal array, Taguchi*

1. INTRODUCTION

Biodiesel is renewable environmental and oxygenous fuel with similar physical and chemical characteristics of diesel[1-3]. Moreover it produces lower combustion emissions and rarer greenhouse gas emissions than fossil fuel diesel. As a result, biodiesel has become a attention of alternative fuel research and application in recent years [4-5]. There are some differences in physical parameters between biodiesel and diesel and it is therefore necessary to study the Injection parameters of the internal combustion engines.

2. TAGUCHI METHOD

Taguchi method reduces the number of trails in the experiment to provide a optimum level with minimum number of experiments [6]. However, the approach on the basis of thermodynamic model application was extended to investigate the aptness of various types of biodiesel for optimization of engine performance [7]. The orthogonal array (OA) shows the total number of experimental runs and it includes number of parameters and to their corresponding levels. In the present work, the parameters and levels selection are shown in the table1. However, L9 OA was selected in this present work.

parameters	Level 1	Level 2	Level 3
Injection Pressure (bar)	190	200	210
Number of Holes	1	3	4
Fuel	Diesel	RO	WCO

Table 1 Parameters and their levels

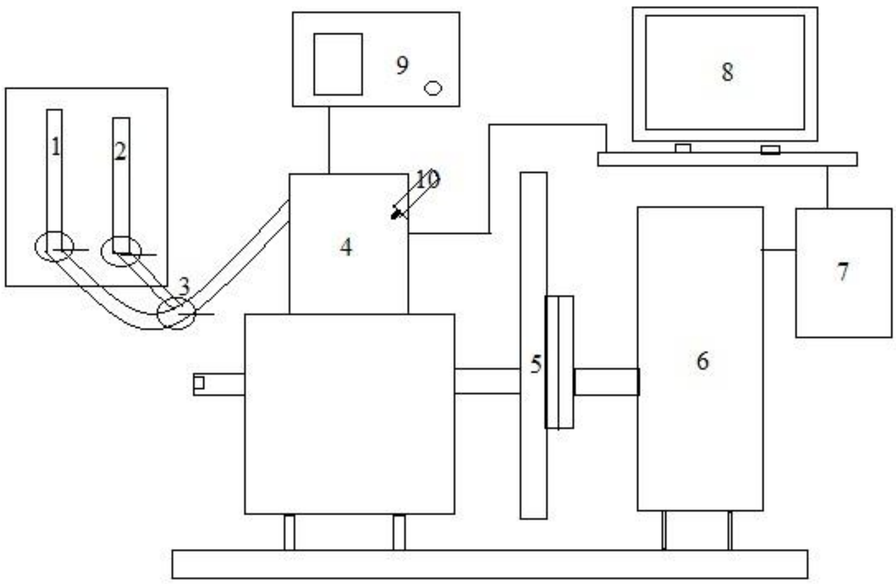
Orthogonal array selection was made by using degrees of freedom. However, degrees of freedom depend on parameters which involves in the experiment. The primary advantage of the Taguchi method for optimization is using orthogonal arrays for design to shorten the task of planning experiments greatly [7]. The experimental orthogonal layout was shown in the table 2.

Runs	INJECTION PRESSURE (bar)	NUMBER OF HOLES	FUEL
1	190	1	D
2	190	3	RO
3	190	4	WCO
4	200	1	RO
5	200	3	WCO
6	200	4	D
7	210	1	WCO
8	210	3	D
9	210	4	RO

Table 2. L9 Orthogonal layout

3. EXPERIMENTAL SETUP AND PROCEDURE

An experiment was carried out in the single cylinder four stroke diesel engine with water cooling. The compression ratio of the engine was 16.5 : 1 and the loading was eddy current dynamometer. However, the speed sensors, pressure sensors and the crank angle encoders are fitted with their corresponding points their outputs are coupled to the data acquisition system to acquire the signals from the sensors. The schematic experimental setup as shown in figure 1.



1.Measuring Burette Diesel, 2.Measuring Burette Biodiesel, 3.Three way Cock, 4.Diesel Engine, 5.Flywheel, 6.Eddy current dynamometer, 7.Dynamometer control, 8.Data acquisition system, 9.Gas analyser, 10.Fuel Injector.

Fig.1 Schematic Experimental Setup

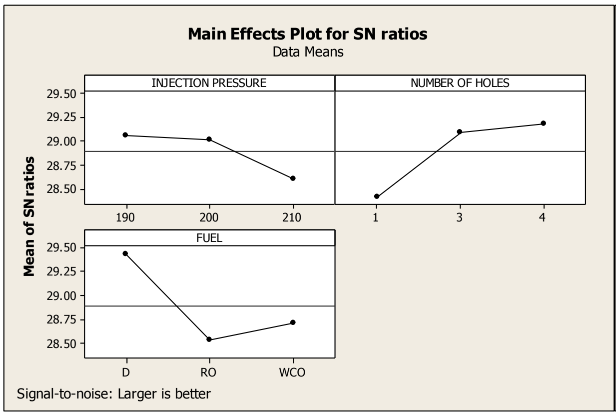
Using the experimental orthogonal layout the experiments was carried out in the engine. The injection pressure was varied by using fuel injection pump. For every experiment suitable blends and injectors are varied to observe the readings. The experimental readings are stored in data acquisition system. It stores PV diagram, heat release rate, mass fraction burnt are stored in the data acquisition system.

4. RESULTS AND DISCUSSION

The response parameters observed was brake thermal efficiency (BTE) and it influences the signal to noise ratio(S/N ratios) mostly in the experiment. Experimental results (BTE) for 25% load are shown in table 3. The quality characteristics, larger the better was selected in Taguchi method. The response graph were also drawn and shown in figure 2 & 3.

Runs	INJECTION PRESSURE	NUMBER OF HOLES	FUEL	Brake thermal Efficiency (%)
1	190	1	D	29.49
2	190	3	RO	27.15
3	190	4	WCO	28.54
4	200	1	RO	25.43
5	200	3	WCO	29.23
6	200	4	D	30.28
7	210	1	WCO	24.32
8	210	3	D	29.13
9	210	4	RO	27.56

Table 3 Experimental results for 25% load



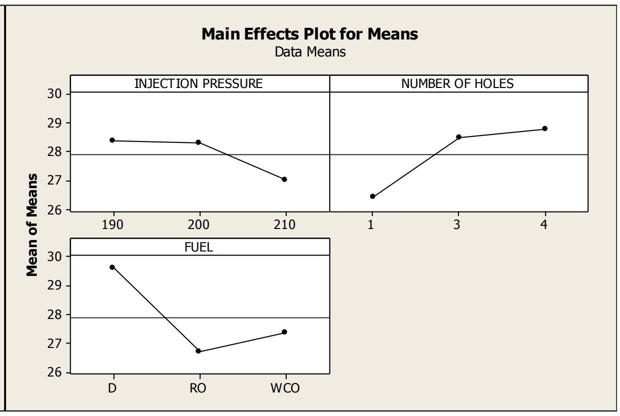


Fig.2 Mean effect plot of SN ratio **Fig.3 Mean effect plot of means**

The figure 2 shows the effect of plot for SN (signal to noise) ratios and figure 3 shows the effect plot for means and larger the better was selected for the response parameter brake thermal efficiency. The maximum point shows the optimum level of input parameters. By selecting maximum point at all three input parameters from the graph provides the suitable level of input parameters which obtain maximum brake thermal efficiency. The best optimum level was identified as Injection pressure (IP) 190 bar, Number of holes (Nh) 4 and fuel as diesel. The results obtained from the validation experiment were 30.31% of brake thermal efficiency. Hereby, the optimum parameters provide high brake thermal efficiency.

5. CONCLUSION

From the experimental investigation the injection parameters involved in the engine performance characteristics. The optimum level of parameters was identified by using different injection pressures, Number of holes and fuel. Thus, validation experimental proves that optimum parameters provide high brake thermal efficiency. Taguchi design approach provides the limitation of one response parameters. The Brake thermal efficiency was 30.31% in better optimum levels were the injection parameters are IP 190 bar, Nh 4 and fuel as diesel. Thus, the response graph provides the better optimum levels to obtain high brake thermal efficiency.

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