"PERFORMANCE ANALYSIS OF SINGLE CYLINDER COMPRESSION IGNITION ENGINE WITH SUPERCHARGER , 2 ETHYL HEXANOL & DIESEL BLEND FOR BRAKE THERMAL EFFICIENCY USING TAGUCHI ANALYSIS METHOD "

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ABSTRACT: In this study use diesel and 2 ETHYL Hexanol biodiesel for determine the combination of supercharger ,injection pressure ,blend ratio and load of a diesel engine the previous researchers had done research on combined effect of injection pressure, exhaust gas recirculation and blend ratio but in this research work has been done on combined effect of supercharger, injection pressure and diesel- biodiesel blend hexanol is a high-carbon alcohol with higher cetane number and higher energy density than the popularly researched 2-ethaly hexanol which makes it an attractive fuel for diesel engines. Studies are rapidly emerging on high-yield bio-synthesis of 2ethaly-hexanol from glucose and ligno-cellulosic biomass feedstock using engineered micro-organisms like E. coli and Clostridium species. Despite its favorable properties and promising prospects for production in bio refineries, 2ethaly-hexanol has been barely investigated. This study utilized three blends of 2ethaly hexanol viz., hex10 and hex20 obtained by mixing 10% and 20% by vol. as blend component with diesel respectively. Engine tests were carried out at all loads to study the effects of 2ethaly hexanol addition on performance characteristics of a direct injection diesel engine. Results indicated that addition of 2ethaly hexanol to fossil diesel resulted in this experiment is at 0% blend ULSD diesel are more effecting performance with supercharger. Exhaust emissions temperature increased at high loads supercharger is use for the oxidation of hexanol atoms and supercharger run by electric power it will not drive by engine power

Keyword: Supercharger, Brake thermal efficiency, Taguchi analysis, CI Engine

I. INTRODUCTION

In light of the recent events such as decreasing fossil fuel resources, hiking crude oil price and pollution has made many researchers check the viability of biodiesels as potential alternative fuels. At this juncture a lot of research has been done on improving the efficiency of the engine by using different blends of biodiesels, using additives, advancing the injection timing, etc internal combustion engines has considerably increased because of its clean burning nature and fossil-fuel independence Diesel engines offer un-paralleled fuel conversion efficiency, torque capability and durability despite emitting high levels of NOx and particulate matter (PM) into the atmosphere which are proven to be detrimental to human and environmental health . In this context, the bio-fuel trio of bio-diesel, bio-gas and bio-alcohol present promising potential for developing clean diesel engines. However bio-diesel from vegetable-based oils opens up the "food vs. fuel" debate and bio-gas is considered to be impracticable due to its high storage and distribution costs further, low carbon bio-alcohols
(hexanol , methanol and ethanol) that are popularly researched in gasoline engines are incompatible for use in diesel engines owing to their low energy density and low cetane number. Higher carbon bio-alcohols like butanol (C4), pentanol (C5) and hexanol (C6) can be suitable candidates for diesel engine technology. These alcohols can be produced from glucose by fermentation using engineered micro-organisms or by processing ligno-cellulosic biomass using enzymatic hydrolysis & fermentation, anerobic digestion, gasification, pyrolysis and bio-catalysis alcohol is an alternative, renewable, environmentally and economically attractive fuel, considered to be one of the most favorable alternative fuels to conventional fossil-based fuels. Nowadays, in order to meet the various emission regulations and improve the atmospheric environment, hexanol fuel has been used as a clean fuel to replace conventional fuels for the internal combustion (IC) engine. Compared with the conventional fossil-based fuels such as gasoline, methanol has better fuel conversion efficiencies due to larger vaporization heat and much better resistance to knock. Because of a large number of studies and applications that have been ongoing recently, much progress has been made that is worth reporting. This systematically describes the applications such as hexanol-gasoline, 2ethaly hexanol-

diesel, or other blends that can be used in the IC engines. Finally, it puts forward some new suggestions on the weakness in the studies of Supercharger Diesel And 2 Ethyl Hexanol blends engine(Rajesh Kumar, . (2016).

II. LITERATURE REVIEW

Melvin Victor De Pours, A.P. Sathiyagnanam, S. Saravanan investigate **1**- hexanol as a sustainable biofuel in DI diesel engines and its effect on combustion and emissions under the influence of injection timing and exhaust gas recirculation (EGR), 1-hexanol is a high-carbon bio-alcohol with higher cetane number and higher energy density than the popularly researched 1-butanol which makes it an attractive fuel for diesel engines. Studies are rapidly emerging on high-yield bio-synthesis of 1-hexanol from glucose and ligno-cellulosic biomass feedstock using engineered micro-organisms like E. coli and Clostridium species. Despite its favorable properties and promising prospects for production in bio refineries, 1-hexanol has been barely investigated. This study utilized three blends of 1-hexanol viz., HEX10, HEX20 and HEX30 obtained by mixing 10, 20 and 30% by vol. as blend component with diesel respectively. Engine tests were carried out at all loads to study the effects of 1-hexanol addition on combustion and emission characteristics of a direct injection diesel engine. Results indicated that addition of 1-hexanol to fossil diesel resulted in longer ignition delays with enhanced premixed combustion phase characterized by higher peaks of pressures and HRRs at the engines standard injection timing without EGR. NOx emissions increased at high loads while smoke density reduced at all loads with increasing 1-hexanol content in the blends. Later tests were extended to investigate the effects of CA bTDC) and exhaust gas recirculation (EGR) rates (10, 20 and 30%) on engine° and 25°, 23°injection timing (21 CA bTDC under 30% EGR presented the°characteristics for all blends at high engine loads. HEX30 injected at 25 2% increase in peak pressure and peak heat release rates (HRR) when compared to≈longest ignition delay with baseline diesel operation. HEX30 at similar conditions was also beneficial in terms of reduced smoke density by 3%. Biomass-derived 1-hexanol could be a promising and viable≈35.9% with a slight penalty in NOx emissions by biofuel for existing diesel engines with some modifications. [10]

Chockalingam SUNDAR RAJ(AVC College of Engineering, Mannampandal, Mayiladuthurai, India b Annamalai University, Chidambaram, Tamil Nadu, India) was investigate influence of hexanol-diesel blends on constant speed diesel engine As an attempt to suggest an alternate fuel for diesel with less emission, the effects of diesel-hexanol blends, blended in different percentage ranging from 10%-50% by volume were experimentally investigated on a single-cylinder, water-cooled, direct injection Diesel engine developing a power output of 5.2 kW at 1500 rpm and the results show improved performance with blends compared to neat fuel with substantial reductions in smoke and increase of NOx emissions. Combustion analysis show peak pressure and rate of pressure rise were increased with increase in hexanol. For this reason it is examined the use of hot exhaust gas recirculation to control NOx emissions. From the analysis of experimental findings it is revealed the use of exhaust gas recirculation causes a sharp reduction of NOx with a slight reduction of engine efficiency which in any case does not alter the benefits obtained from the oxygenated fuel. . [13]

III. 2 ETHALY HEXANOL

Hexanol is one of the most attractive alternative fuels for compression ignition engine with a chemical formula of C8H17-OH. It can be readily made from widely available fossil raw materials including coal, natural gas, and bio substances. And glucose hexanol is also a clean fuel when judged by regular emission standard. Hexanol has many desirable combustion and emission characteristics. It has a lower viscosity compared to diesel fuel, which enhances the atomization process. Higher oxygen content and low sulphur content results a lesser amount of pollutant emission. The higher laminar flame propagation speed leads to finish the combustion earlier, thus improves the thermal efficiency of the engine. Lower heating value (LHV) of hexanol has an average value of 38400 kJ/kg according to ASTM D240 which is lower than that of diesel, thus increases the fuel consumption of the blended fuel. The high stoichiometric fuel/air ratio, higher oxygen content enhances the combustion process thus the soot and smoke emission reduced The thermo-physical properties of HEXANOL compared to the gasoline are listed in Table 1 below.

Table -1: Comparison of Thermo-Physical Properties of 2ETHALY hexanol & diesel [10]

Properties	2-Ethaly Hexanol	Diesel
chemical Formula	C8H17OH	C10~H15
Molecular weight (g mol−1)	32	190-220
Density@ 20ºC (kg/m3)	834	835-840
Viscosity @ 25ºC (m Pa S)	3.32	2.72
Auto ignition temperature (ºC)	254℃	290℃
Flash Point (ºC)	75	>55
Cetane number	23	45

Table-2 calorific value

BLEND %	CV	BLEND
0	42630	ULSD
10	41710	HEX10
20	41420	HEX20

Hexanol can be used potentially as transportation fuel, alone or mixed with gasoline. Respect pure gasoline or other fuels is considered safer and less toxic and the emission coming from its use in combustion engines are reduced in term of NOx, SOx, and particulate. Hexanol is also one of the reactants in the production of biodiesel fuel manufactured from vegetable oils and MTBE via esterification. Based on its use as a hydrogen carrier, methanol can also be used in the automotive field in the development of fuel cell vehicles (McNicol et al., 1999). Moreover, liquid hexanol is becoming an increasingly attractive option for the storage of energy, as an alternative to hydrogen. In fact, the hexanol economy, based on hexanol produced by green synthetic procedures, can be proposed as an alternative to the hydrogen economy, which requires new storage and transportation technologies. Hexanol is considered a suitable substance to promote the transition from fossil to renewable sources both on the basis of its intrinsic chemico-physical properties and on its ability to be produced by biomass technology

IV. EXPERIMENTAL SET UP

Experiments were conducted with different blend of 2ethaly hexanol Bio-diesel and Diesel (hex0, hex10, hex20) for investigation of performance and characteristics of single cylinder four stroke diesel engine. . In this experiment, diesel engine is used and connected with the Rope brake with spring balances and loading screw dynamometer varies the load on the engine The reading takes by varying the load on the engine using the dynamometer. Engine performance such as specific fuel consumption, brake thermal efficiency, brake specific fuel consumption etc. found from the experiments. At full load we get minimum Specific fuel consumption(SFC) for hex0 blended fuel (ultra low sulfur diesel 100%).Taguchi optimization approach to determine engine design parameter (blend, load, supercharger and injection pressure) and operating parameter for hex10 and hex20 blended fuel.L9 orthogonal array was used to collect data for specific fuel consumption related data at low ,average, full load (1,6,11, kg) and same compression ratio and different injection pressure manually electric drive blower pump us as supercharger

Fig. 1 Engine set up [1]

Table-3: Specification of Engine [1]

Item	Specification
Model	TV1
Make	Kirlosker oil Engines
Type	4 stroke ,water cooled ,Diesel
No of cylinder	One
Bore	87.5 mm
Stroke	110 mm
Compression ratio	18:1
power rating	5 hp or 3.7 Kw
Dynamometer	Rope brake with spring balances and loading screw

Fig. 2 air Blower pump [12]

V. TAGUCHI METHOD OF OPTIMISATION

Taguchi method is a simplest method of optimizing experimental parameters in less number of trials. The number of parameters involved in the experiment determines the number of trials required for the experiment. More number of parameters led to more number of trials and consumes more time to complete the experiment. Hence, this was tried in the experiment to optimize the levels of the parameter involved in the experiment. This method uses an orthogonal array to study the entire parameter space with only a small number of experiments .To select an appropriate orthogonal array for the experiments, the total degrees of freedom need to be computed. The degrees of freedom are defined as the number of comparisons between design parameters that need to be made. The present study uses three factors at three levels and hence, an L3 orthogonal array was used for the construction of experimental layout According to this layout, 18 experiments were designed and trials were selected at random, to avoid systematic error creeping into the experimental procedure. For each trial the mechanical efficiency was calculated and used as a response parameter. Taguchi method uses a parameter called signal to noise ratio (S/N) for measuring the quality characteristics. There are three kinds of signal to noise ratios are in practice of which, the higher-the better S/N ratio was used in this experiment because this optimization is based on brake thermal efficiency. The taguchi method used in the investigation was designed by statistical software called „Minitab18‟ to simplify the taguchi procedure and results. A confirmation experiment for the optimum set of parameters was also conducted for validation of the predicated value obtained by Minitab software. This is mainly to compare the mechanical efficiency of predicated value and experimental value of optimum set of parameters.
Following Step are taken in Minitab software for Design of Experiment By taguchi [1]

Fig 3. Flow chart of Taguchi design (Minitab 18)

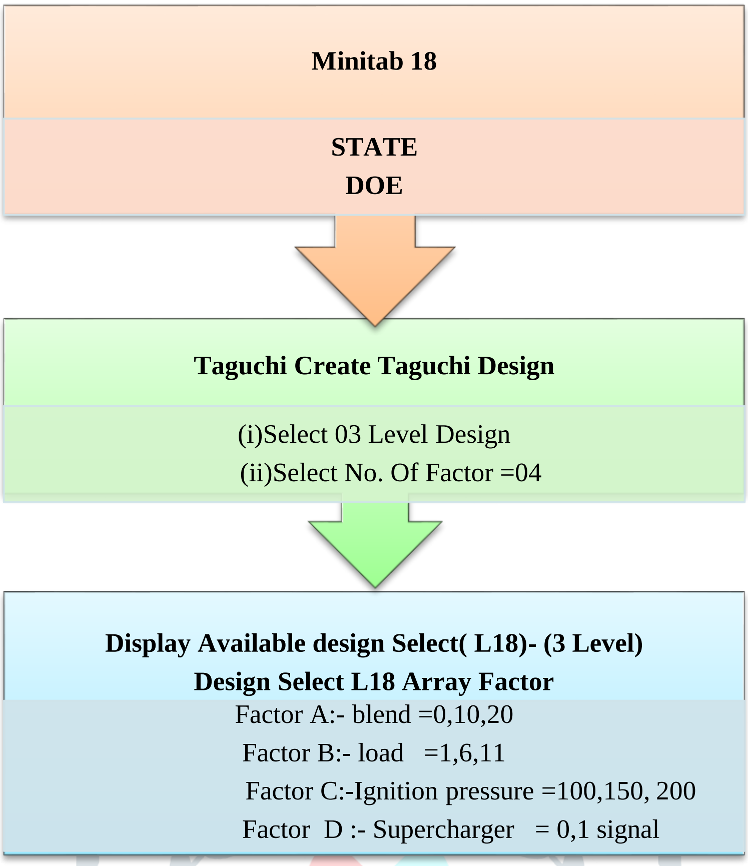

Table -4: Selected input parameters at 3 -levels.

Controlled factors	**level 1**	**level2**	**level3**
Blend Ratio	0	10	20
Load	1	6	11
injector pressure	100	150	200

Table-5: Supercharger signal

signal level	ON	OFF
supercharger	0	1

VI. RESULTS AND DISCUSSION

Table-6: Result data

Sr. No	**Blend%**	**Supercharger**	**IP (Bar)**	**Load (Kg)**	**SFC (Kg/Kw.Hr)**	**BP (Kw)**	**Mechanical Efficiency%**	**BTHE %**	**Exhaust Gas Temperature(°C)**
1	0	1	100	1	1.297778037	0.307725966	21.3453333	6.507089	150.85
2	0	0	100	11	0.171930857	3.339016685	64.65758263	49.11717	224.25
3	0	0	150	1	2.295196964	0.304496743	21.16875586	3.679317	159.24
4	0	1	150	6	0.014038464	1.777972248	50.41513955	6.015442	235.24
5	0	0	200	6	0.22308079	1.834958538	51.20362546	37.85515	224.25
6	0	1	200	11	0.155810308	3.364090653	64.82835461	54.19896	294.38

7	10	1	200	11	0.180824745	3.37453814	64.89902351	46.70134	294.38
8	10	0	200	1	1.418588353	0.304686697	21.17916471	5.95293	150.85
9	10	0	150	11	0.135033276	3.389164621	64.99748422	62.53834	289.55
10	10	1	150	6	0.26424685	1.828120183	51.11033373	31.95783	174.97
11	10	0	100	6	0.265239016	1.821281828	51.01668459	31.83829	235.24
12	10	1	100	1	1.404577604	0.307725966	21.3453333	6.012311	170.23
13	20	1	100	6	0.260447209	1.828120183	51.11033373	32.42406	237.90
14	20	0	100	11	0.150566692	3.364090653	64.82835461	56.08649	290.38
15	20	1	150	11	0.143038357	3.364090653	64.82835461	59.03841	396.63
16	20	0	150	1	1.163700297	0.304686697	21.17916471	7.256815	150.85
17	20	1	200	1	1.399108452	0.307725966	21.3453333	6.035813	150.85
18	20	0	200	6	0.251195431	1.834958538	51.20362546	33.61828	224.25

5.1 Response curve analysis

Response curve analysis is aimed at determining influential parameters and their optimum levels. It is graphical representations of change in performance characteristics with the variation in process parameter. The curve give a pictorial view of variation of each factor and describe what the effect on the system performance would be when a parameter shifts from one level to another Figure-3 shows significant effects for each factor for three levels. The S/N ratio for the performance curve were calculated at each factor level and average effects were determined by taking the total of each factor level and dividing by the number of data points in the total. The greater difference between levels, the parametric level having the highest S/N ratio corresponds to the parameters setting indicates highest performance

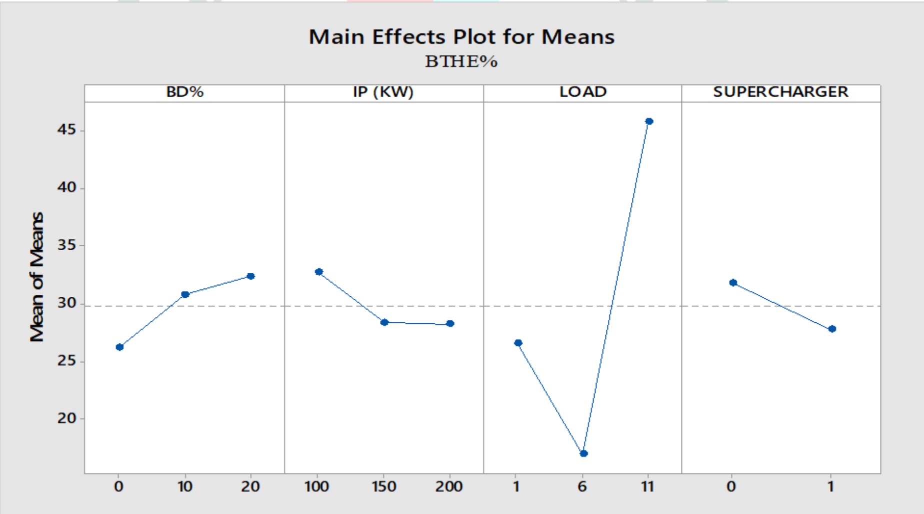

Fig. 4 Main Effect Plot for Means break thermal efficiency

According to graph of main effect plot for BTHE. In this graph values for blend ratio, injection pressure, load and supercharger are plotted. As BTHE of any engine should be less for better fuel economy the smaller values in mean graph will give optimum result SFC are calculated from the fuel consumption and break power ratio

Table -7: Response Table for Means BTHE

Level	Bd%	Ip (Bar)	Load(Kg)	Supercharger
1	26.23	32.80	26.63	31.85
2	30.83	28.41	17.00	27.80
3	32.41	28.26	45.84	-
Delta	6.18	4.54	28.84	4.04

Rank	2	3	1	4

Responses for means for BTHE in table Delta are average difference between maximum and minimum value in graph and rank is given based on the ascending order of delta values. It means highest value will have 1st rank and lowest value will have last rank response table for means have highest value of load is 28.84 kg and lowest value of Supercharger both value consider value of delta and rank

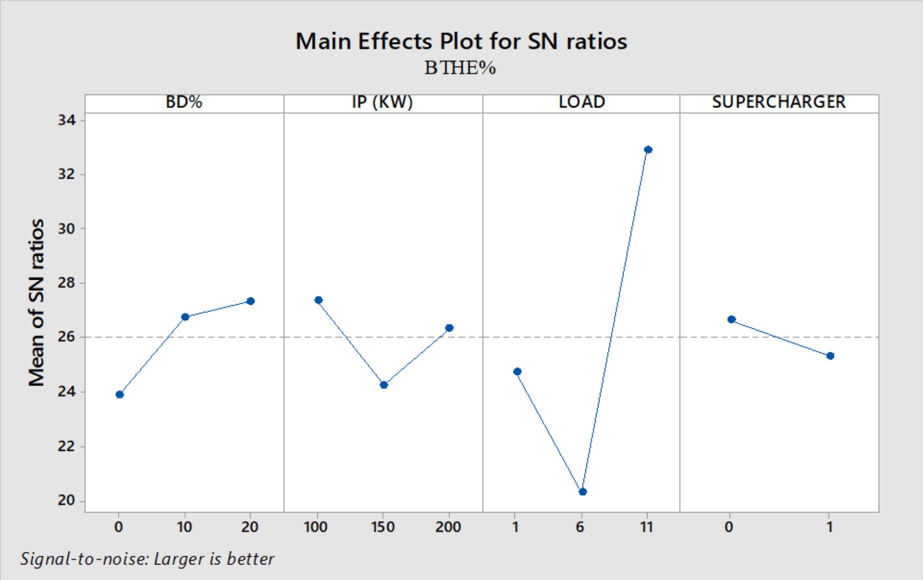

Fig 5 Main Effect Plot OF SN Ratio for break thermal efficiency

Graph of main effect plot for SN ratio for BTHE in this graph value for blend ratio, injection pressure ,load and supercharger are plotted As SFC of any engine should be low for better fuel economy the smaller values in means graph will give optimum result , but in SN ratio highest value plotted on graph will give optimum result by taking these optimum values as optimum set and doing experimental lowest BTHE value will be noted

Table-8: Response Table for Signal to Noise Ratios for BTHE

Level	Bd%	Ip (Bar)	Load(Kg)	Supercharger
1	23.87	27.36	24.73	26.64
2	26.76	24.26	20.32	25.33
3	27.33	26.34	32.91	-
Delta	3.46	3.10	12.59	1.31
Rank	2	3	1	4

Table 8 shows responses for SN ratio for BTHE In which Delta is average difference between maximum and minimum values on graph and rank is given based on the ascending order of Delta value It means highest value will have 1st rank and lowest value will have last rank response table for means have highest value of load is 12.59and lowest value of supercharger that is 1.31 This indicates that load is affecting more on performance of BTHE and supercharger is less affecting on performance

Table-9: Optimum set of parameter for BTHE

Blend%	Ip (Bar)	Load (Kg)	Super Charger	Experiment Break thermal efficiency	Predicted Value (Kg/Kw.Hr)	Error
0% 2Ethaly	100	1	0	6.507089	28.02947	21.52238

hexanol ,100% diesel						

Shows optimum set of parameter for specific fuel consumption these values are obtained from SN ratio graph highest value of parameter on that graph is taken as optimum value and based on that optimum values optimum set is generated the optimum set mechanical is obtained with supercharger, blend ratio,0% 2ethaly hexanol and 100%diesel in blend injection pressure is 100bar and load is 1 kg for this set of predictive value is 28.02947 and BTHE error is 21.52238

VII. CONCLUSIONS

1. The taguchi method was found to be an efficient technique for quantifying the effect of control parameter.
2. The highest performance at set hex 0% blend (100%ultra low sulfur diesel) , engine load 1kg, And injection pressure100 bar,
   Which is optimum parameter setting for highest BTHE.
3. Engine performance is least influenced by supercharger and is more influenced by LOAD in Performance results
   Obtained from the confirmation experiment using optimum combination showed excellent agreement with the predicated result.

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NOMENCLATURE

BD	Bio-diesel

BP	Brake Power
BTHE	Brake Thermal Efficiency
CI ENGINE	Compression Ignition Engine
Ip	Injection Pressure
HC	Hydrocarbon
VCR	Variable Compression Ratio
CO	Carbon monoxide
S/N RATIO	Signal to Noise ratio
HEX	Hexanol , 2ethaly hexanol
MECH EFF	Mechanical Efficiency
FP	Friction power
CV	Calorific value
100D0Hex	100%Diesel,0% 2ethaly hexanol
HEX10D90 or(hex10)	10% 2ethaly hexanol,90% diesel
HEX20D80 or (hex20)	20%2ethaly hexanol,80% diesel
SFC	Specific Fuel Consumption
IP	Indicated power