IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 21, Issue 6 Ser. 1 (Nov. – Dec. 2024), PP 09-14
www.iosrjournals.org

Study Of Optimum Parameters In Enhancing The Performance Of VCR Engine Using Taguchi Method

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Abstract:
Biofuels are in present days are known commonly to the peoples which is considered to be as alternative fuel to the various types of engines in automobile sectors. The commonly used engine is variable compression ratio engine which is available in market. The fuel type is diesel. Moreover, to run the engine using alternative fuel has made challenging to researcher in present scenario, due to depletion of traditional fuel i.e. fossil fuel. In the present work biofuel namely turmeric leaf oil (TLO) with various percentages of blends is used in VCR engine along with traditional fuel to evaluate the performance based on their output parameters like brake thermal efficiency and volumetric efficiency and their emissions from the exhaust. The blend with various percentages like B70 (i.e. 70% diesel and 30% turmeric leaf oil), B60 (i.e. 60% diesel and 40% TLO) and B50 (i.e. 50% diesel and 50% of TLO) were considered in the present work. As the type of engine is variable compression ratio, therefore three compression ratios are considering i.e. 17.5:1, 18.5:1 and 19.5:1, by maintain constant speed rate of 1500rpm in the current work. The finding reveals that 19.5:1 compression and B70 has performed better when compared with other ratios and blends. The performance is determined based on the load applied on the VCR engine.

Keywords: *Blends, Turmeric Leaf Oil (TLO), Variable compression Ratio (VCR), Diesel Engine, Compression Ratio (CR).*

Date of Submission: 25-10-2024 Date of Acceptance: 05-11-2024

I. Introduction

In sight of the rapid diminution of fossil fuels, the quest for substitute fuels is charming unpreventable, observing at massive mandate for gas for conveyance part, imprisoned power creation and agricultural trade, the biodiesel is presence realized as a standby of petrol [1]. Improved quantity of vehicles globally has triggered a vertical upsurge to the requirement aimed at petroleum-based energies. Fuels are found from partial reservations. These determinate reserves are vastly focused in certain extents of the creation. Accordingly, those republics not accomplishment these tackles are in front of an energy predicament in to foreign argument crisis, primarily due to the significance of petrol. Henceforth there is a requirement to pursuit for alternate fuels that can be twisted from properties accessible at any dwelling in the nation such as vegetable oils, alcohol, and biodiesel, etc. [2]. Bio-diesel is the superlative alternate fuel for petrol and diesel and is furthermost valuable over Petro-diesel for their ecological characters [3]. The excellence of bio-diesel fuels was initiate to be imperative for its effective custom on Compression Ignition (CI) engines and sub-sequent auxiliary of non-renewable fossil-fuels [4]. Biodiesel are derived from quite a lot of dissimilar animals fats and vegetable oils uncooked or cooked ingredients. The unswerving tradition of vegetable-oil and animal-fat as alternate fuel in diesel-engines is restricted due their low instability and high viscosity that results in unembellished engine deposits, injector harsh and sticking piston ring. These explanations have barred triglycerides from existence cast-off direct fuel in diesel-engines. Entirely assortments of vegetable oils can be used to substitute the diesel-oil, nevertheless the rapeseed-oil and palm oil can be the utmost superlative apt vegetable oils which can be rummage-sale as diesel fuel, chemical or diesel fuel protract [5]. The viscosity as an important distinctive of bio-diesel fuels in the meantime it has enormous effect on the manoeuvre of fuel booster apparatus. Particularly at minor temperatures, increase in viscosity will impact the changeability of the fuel [6]. The role of consuming bio-diesel in diesel locomotives for everyday activities has countless compensations. The primary rewards of consuming bio-diesel is that it is bio-degradable, and can be used lacking varying current engine and harvests less damaging gas secretions such as sulphur-dioxide [7]. Bio-diesel cuts carbon-dioxide secretions by 78% linked to obsolete diesel fuels.

A fuel made from oil and petrol that naturally comes from petro diesel is called biodiesel [8]. The chemical name for biodiesel is methyl ester fatty acid [9], and it comes from fatty acids found in food or animals. India is thought to be able to make about 55,000 tonnes of Kranja oil. The quality of the soil will get better with cultivation, and even the worn-out soil can be used for farming. A lot of work has been done to find ways to use Karnja oil as a biofuel in food [10]. There are more unsaturated fatty acids in the oil than in other oils. India is expected to grow about 30,000 tonnes of latex seeds each year (2006), which can be used to make 5,000 tonnes of rubber seed oil. Rubber trees make a long, thin shell with three seeds inside it. Each seed has its own capsule. There are cylindrical latex seeds that are 2.5 to 3 cm long, mottled brown, glowing, and vary in size, weighing 2 to 4 grammes each [11]. Jatropha bark plants can be used in rural areas for cooking, lighting, and powering vehicles. There was also talk about its pros, cons, and uses in the form shown. It was suggested that Jatropha plants could definitely create work, make the weather better, and make village life better [12].

Solvent-free method and did experiments to see how methanol and water affected the process of making biofuel from soybean oil using a lipase base catalyst. How much biodiesel is made Based on Rugosa and P. When the water content dropped, Lipazi fluorescence went down, but the diesel generation rate stayed the same when P was present. It was also found that Cepacia lipase could be used as a reaction method for methanol [13] when the water level was low. Wasted edible oils could be used to power the Candida Antarctic lipase-driven biodiesel-making process by enzymatic alcoholism. The lipase catalyst can be used for about 100 days [14], and more than 90% of the biodiesel fuel has been changed in all of these processes. Performed science tests to find the best way to get the most biodiesel out of animal oil. It was found that 50ºC and 2 hours were the best times and temperatures for the process [15]. The centre of Pongamiapinnata and its physical features while taking its moisture levels into account. It has been found that different physical properties change depending on how much wetness is present [16]. These include the geometric mean diameter, spherical density, bulk density, true density, porosity, angle of relaxation, surface area, and static friction. Compared the fuel use and exhaust features of heavy-duty diesel engines that are four-stroke, six-cylinder, direct-injection, and heavy-duty diesel engines that are turbocharged, water-cooled, and used for work. Biodiesel (BD) and green diesel (HRD) made from Jatropha Corax oil were used as fuel. The study was done quickly and with different loads (0%, 25%, 50%, 75%, and 100%). Biodiesel (BD) was made using a transesterification reaction, and renewable diesel fuel was made using hydro-treatment (HRD) processes that made hydro-dioxide [17-20].

II. Performance Analysis Of Turmeric Leaf Oil (TLO)

Parameters that are considered in the present work on VCR engine is compression ratio of 17.5:1, 18.5:1 and 19.5:1, TLO blends B70, B60 and B50, and load of 7kg, 8kg and 9kg maintaining constant speed rate of 1500rpm. The following notation describes the Compression Ratio, different Blends, and different loads that are used in the planning process to make the engine work better in DOE using MINITAB software as shown in table 1.

Table 1: Parameters considered for DoE

Parameters	Level – 1	Level – 2	Level – 3
Compression Ratios	17.5:1	18.5:1	19.5:1
% of Blends	50	60	70
Load (kg)	7	8	9

III. Methodology

To govern the superlative blend of TLO Biodiesel on VCR engine performance and secretion appearances, three major parameters, i.e., Blend, Compression ratio and the Load are selected as the main design constraint with 3 levels each for Taguchi L9 orthogonal array. The selected levels and parameters are entered in Minitab software to perform the optimization test. In these CR, blends and load responses are taken as based input parameters considering larger is better in signal-to-noise ratio as shown in figure 1.

Table 2: Response Table for Signal to Noise Ratios

Level	Load	CR	Blends
1	31.07	31.07	32.16
2	32.56	32.56	32.28
3	33.34	33.34	32.53
Delta	2.26	2.26	0.36
Rank	1.5	1.5	3

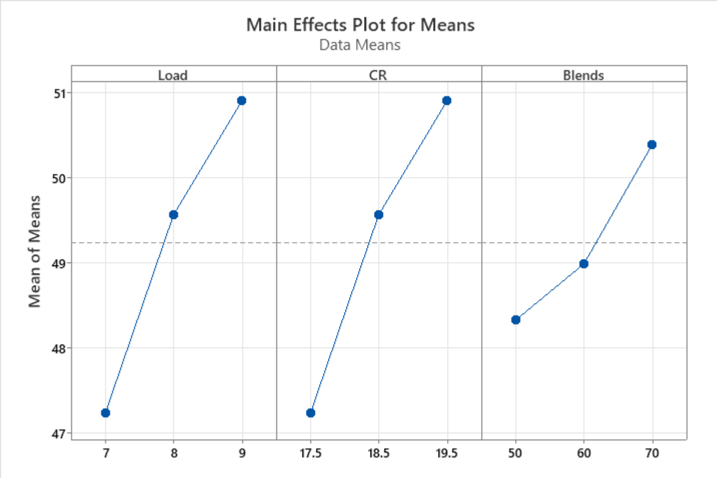

Figure 1: Mean plot to predict the optimum parameter

IV. Results And Discussion

The main effect of S/N ratio in optimization of various factors in determining the effectiveness of the VCR engine using TLO as a biofuel mixed with diesel. From the figure 2 it states that S/N ratio using Taguchi methods (Minitab software) larger is better. Processing parameters that affect the performance of the VCR was the load, compression ratio and blends. In figure 2 the higher values that obtained at each parameter are considered to be favourable to the present work. In terms of blends the S/N ratio shows superior at B70 (70% diesel and 30% TLO) when compared with other blends, in terms of load at load 9kg the S/N ratio shows higher, and at compression ratio the optimum i.e. larger values are shown CR 19.5. Therefore the mentioned optimum parameters using Taguchi methods may play an vital role in enhancing the performance of the VCR engine.

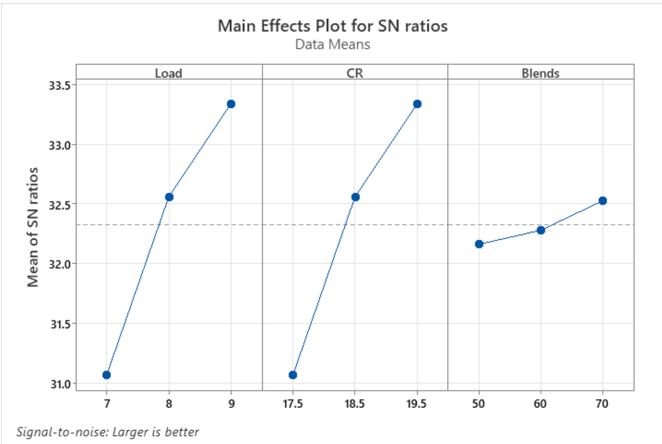

Figure 2: S/N Ratio to predict the optimum parameter

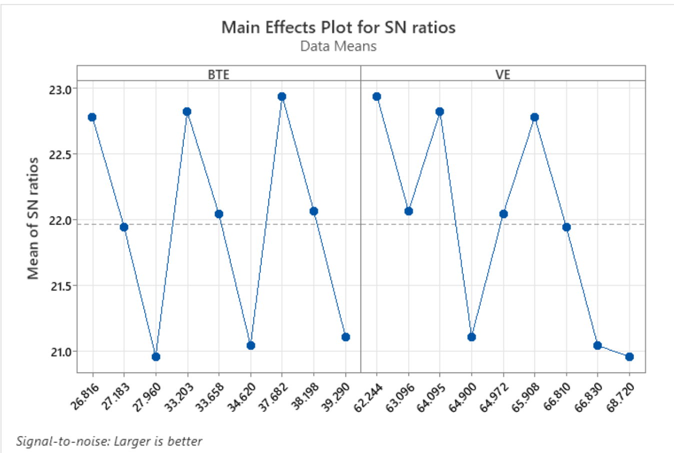

Figure 3: S/N Ratio of BTE and VE

From the Table 2 it indicates the optimum level of input parameter, i.e. Blend, CR and Load, using Taguchi analysis. Figure 3 shows a graph of mean values of Brake Thermal Efficiency (BTE) and Volumetric Efficiency (VE) versus blend, compression ratio and load. From that, we can find the optimum level of each parameter. It is a signal of operative utilization of heat energy provided for making power yield. For determined BTE, once diesel is used as fuel, CR of 19.5:1, and load 9kgs can be used so that the amount of fuel required to be supplied in the combustion chamber decreases. Load and Blends are the main factor affecting BTE. Blend of 30% TLO and 70% diesel should be used as the fuels respectively for enhancing the performance of the VCR engine. If we increase blend more than 30% the BTE will decrease. The same performance is also observed with VE also.

The highest S/N ratios are appeared at trails 1,4,5,7,8 i.e. maximum values (S/N Ratio 22.7) are attained above the mean level of 22.0, whereas (S/N Ratio 20.9) other trails 2,3,6,9 are below the mean values. The values above the mean level are considered to optimum value which might improves the performance of the engine. When considering volumetric efficiency the same pattern of results was observed, i.e. with the increase in S/N ratios at trial 1,2,3,5,6 shows better results than other trails 4,7,8,9. Optimizing the factors blends, load and CR would improve the performance of the VCR in terms of BTE and VE.

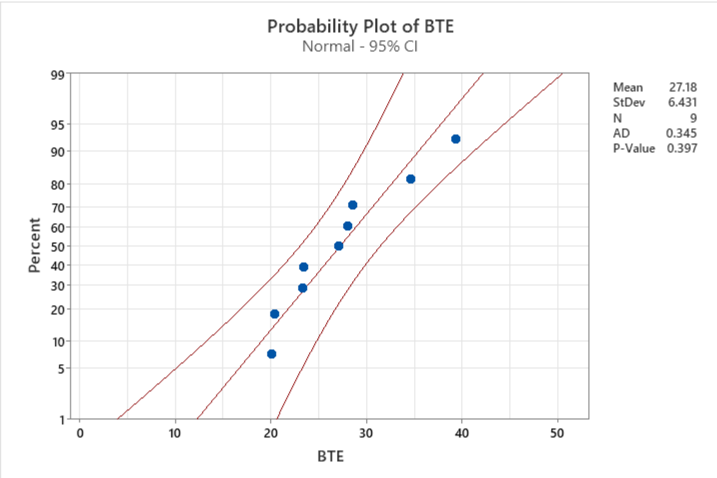

Figure 4: Probability of BTE

Figure 4 and 5, shows the probability graph of BTE and VE performance of engine w.r.t normal distribution shown at 95% confidence level. The blue dots represents the experimental data of BTE are red lines are fitted normal distribution lines. The values within this red line shows that values are optimum i.e. normal distribution. If the dots are beyond the red line indicates the values are not normal distribution. In the current work all the values of BTE and VE are within the red line which represent all the values follows normal distribution.

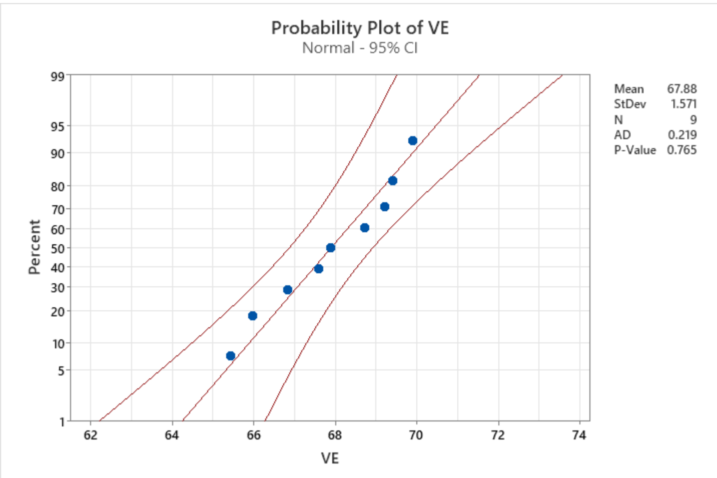

Figure 5: Probability of VE

The mean value of BTE is observed to 27.18 and standard deviation is 6.431 and p-value is 0.397, where as for VE the mean is 67.88, standard deviation is 1.571 and p-value is 0.765. The P-value 0.397 and 0.765 implies there is no substantial parting from the ordinariness, representing that any statistical evaluates pretentious normality are effective for the statistics.

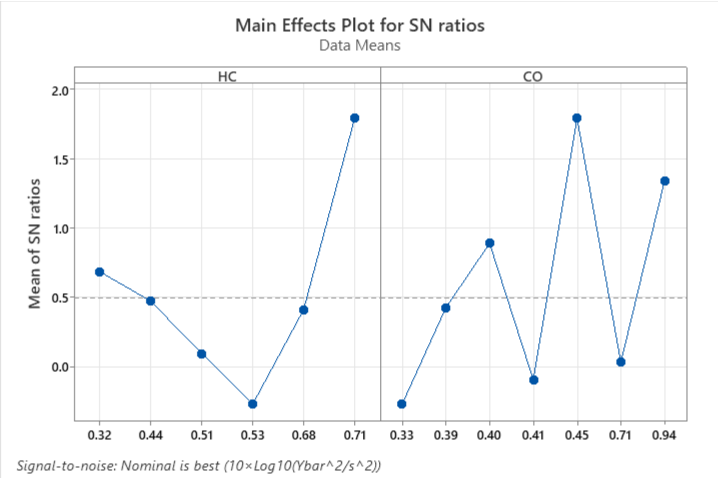

Figure 6: S/N Ratio of emissions, HC and CO at 19.5 CR

Hydrocarbons (HC), and Carbon Monoxide (CO) criteria based on S/N ratio with nominal is best as shown in figure 6. The values S/N ratio of HC is around 0.6 at 0.32 and increases 0.6 to 1.8 at value 0.71, for CO the value is zero at 0.33 and increases to 1.3 at 0.94. this indicates the HC factors yields at 0.71 better S/N ratio and CO factor yields at 0.45 better S/N ratio. These levels 0.45 and 0.71 which attains highest S/N ratio in both cases of HC and CO are optimal values which improves the performance of the VCR engine by reducing the emissions.

V. Conclusions

From the above finding the following are conclusions drawn:

- Optimal load of VCR engine is found to be 9 kg and 30% blend of turmeric leaf oil bio-diesel marks the ideal performance restrictions, and emission levels.
- The engine' load at 9kg represents most substantial controlled parameter with a compression ratio of 19.5:1, and 17.5:1 is the minimum significant constraint.
- The blend B70 contribution is higher and B50 is lower. The same is higher values may be seen in the load criteria.
- The comparison, revealed that BTE, VE, emissions like CO and HC enhance the engine performance when B70 blend i.e. 70% diesel and 30% turmeric leaf oil is used in VCR engine. They're seen a reduction of about 3% in HC and CO emission when compared with other blends.

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