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INFLUENCE ON VIBRATION OF ENGINE BY USING BIO-DIESEL BLENDS

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ABSTRACT

Vibrations lead to fatigue failure or damage which is harmful to engine supporting structures. The impact introduces large forces and thus large stresses, which can cause both vibrations and early failure of the mechanisms. Each of the components in an assembly also has their own vibration characteristics that can be problematic. Biodiesel as an environmentally friendly fuel has the potential to provide comparable engine performance results. Biodiesel is a renewable fuel produced from vegetable and seed oils, animal fats or waste edible oils. One of the important characteristics of diesel fuels is high noise and vibration. The present paper study is to carry out the examine the vibration of different diesel-biodiesel fuel blends in engine. In this case the frequency domain signals were analyzed in engine speed of 1500rpm and five biodiesel fuel blends & diesel fuel on the engine been experimented. The results showed that the use of biodiesel fuel can reduce vibration and noise characteristics. The results of the experiments for noise and vibration has been compared for biodiesel blends and diesel fuel. It was found that B30 have the lowest vibration and noise.

KEYWORDS: *Biodiesel, Diesel, Noise, Vibration*

1. INTRODUCTION:

Vibration is the mechanical oscillations of an object about an equilibrium point. The oscillations may be regular such as the motion of a pendulum. Vibrating object in slow motion, we could see movements in different directions. Any vibration has two measurable quantities. Amplitude or intensity, and frequency of the object moves helps determine its vibrational characteristics. The terms used to describe this movement are frequency, amplitude, and acceleration.

1.1 Vibration Monitoring Techniques:

- **Measuring level of vibration by using FFT Spectrum Analyzer Basics:**

The FFT or Fast Fourier Transform spectrum analyzer is now being used increasingly to improve performance reduce costs in electronics manufacturing test. The FFT spectrum analyzer can be considered to comprise of a number of circuit different blocks:

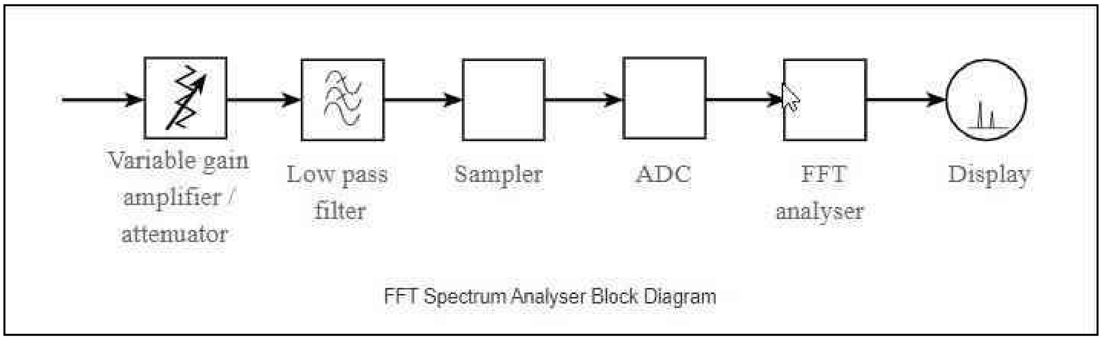


Figure 1: FFT Spectrum Analyzer Block Diagram

The data from the sampler is in the time domain but it is converted into the frequency domain by the FFT analyzer. This is then able to further process the data using digital signal processing techniques to analyze and process the data so that it can then be passed to the display to give the required display

•Analogue front-end attenuators / gain:

If the signal level is too high, then clipping and distortion will occur, too low and the resolution of the ADC and noise become a problem. Matching the signal level to the analogue to digital converter, ADC range ensures the optimum performance and maximizes the resolution of the ADC

- ***Analogue low pass anti-aliasing filter:***

The signal is passed through an anti-aliasing filter. This is required because the rate at which points are taken by the sampling system within the FFT analyzer is particularly important. This results from the where the actual values of the higher rate fall when the samples are taken. To avoid aliasing a low pass filter is placed ahead of the sampler to remove any unwanted high frequency elements.

- **Sampling and analogue to digital conversion:**

To perform the analogue to digital conversion, two elements are required. The first is a sampler. This takes samples at discrete time intervals this is called the sampling rate. The samples are passed to an analogue to digital converter, ADC which produces the digital format for the samples that is required for the FFT analysis.

1.1 Biodiesel:

Biodiesel can be produced from straight vegetable oil, animal oil and waste cooking oil. The process used to convert these oils to Biodiesel is called transesterification. This process is described in more detail below. The largest possible source of suitable oil comes from oil crops such as rapeseed, palm or soybean. Most biodiesel produced at present is produced from waste vegetable oil sourced from restaurants, chip shops. Though oil straight from the agricultural industry represents the greatest potential source it is not being produced commercially simply because the raw oil is too expensive. After the cost of converting it to biodiesel has been added on it is simply too expensive to compete with fossil diesel. Waste vegetable oil can often be sourced for free or sourced already treated for a small price. The result is Biodiesel produced from waste vegetable oil can compete with fossil diesel.

2. RESEARCH GAP:

1. Many of the researchers have found Biodiesel as an alternative fuel and its results in reduction of vibration and noise characteristics as compared to diesel.
2. Many approaches were selected by the researchers to decrease the vibration and noise by using different Biodiesel blends. But very few of them developed the use of Jatropha Biodiesel Blends.
3. Also, there are no explanation for reduction in influence on vibration of engine by using Jatropha Biodiesel blends in comparison with Diesel fuel. The unavailability of such research causes huge loss to the user.
4. So, this research paper presents different Jatropha Biodiesel blends and Diesel fuel so to find effect on vibration of engine & noise characteristics.

3. METHODOLOGY:

3.1 Diesel Engine Specifications:

The engine that used in the experiment has one number of cylinder, 4 no. of strokes. Table 1 shows the features of the engine. The engine used in the experiment delivers maximum power at 1500 revolutions per minute (rpm) for Diesel fuel. The operating revolutions performed on the experiment is at 1500rpm. Below given are specification for engine test setup.

Engine Specification	
No. of cylinders	1
No. of strokes	4
Cylinder diameter	87.5mm
Stroke length	110mm
Connecting rod length	234mm
Orifice diameter	20mm
Dynamometer arm length	185mm

Table 1. Engine Specifications

3.2 Biodiesel Proposition:

For the needs of the experiment, Diesel oil and Jatropha oil blends with different percentages were set up in the Machine Tools. The proportions ranged from 10% jatropha oil to 50%. The pure diesel occupied the rest of the mix. Mixtures will be symbolized by their percentage of jatropha oil with the BXX symbol. Where XX is the percentage of jatropha oil. Thus, the molded blends are B10, B20, B30, B40 & B50. In this study, five fuel blends (FB) were prepared and used. These blends were B10, B20, B30, B40, B50 & Diesel (B00). Biodiesel used in this research was produced in laboratory of Indian Biodiesel Corporation, Baramati. In this center, biodiesel is produced from seeds of Jatropha.

Type	Diesel (%)	Biodiesel(Jatropha Oil) (%)
B00	100	0
B10	90	10
B20	80	20
B30	70	30
B40	60	40
B50	50	50

Table 2: Fuel Ratios

3.3 Fuel Properties:

Below table shows fuel properties for Biodiesel Blends and Diesel.

Sr No.	Fuel	Density gm/cc	Flash Pt Deg Celcius	Calorific Value MJ/Kg	Moisture %	Viscosity mm2/ sec	Fire Pt Deg Celcius	Catane No -	Cloud Pt Deg Celcius
1	Diesel	0.831	64	42.5	0.001	2.7	69	49	-6
2	Jat B10%	0.831	68	42.3	NA	-	-	-	-
3	Jat B20%	0.832	72	42.11	NA	2.8 8	84	49.29	1. 7
4	Jat B30%	0.834	89	41.9	NA	-	-	-	-
5	Jat B40%	0.836	94	41.86	NA	-	-	-	-
6	Jat B50%	0.84	99	41.7	NA	-	-	-	-

Table 3: Fuel Properties

3.4 Experimental Vibration analysis of Diesel and Jatropha oil using RT Pro Photon Software at 0 KG load:

Experimental acceleration values for Diesel(B00) and Jatropha Oil Blends (B10, B20, B30, B40 & B50) for zero kg load at 1500rpm speed are given below

VIBRATION DATA LOAD = 0 KG		
Fuel	Blend	Acceleration m/s^2
DIESEL	**B00**	11.974
JATROPHA	**B10**	5.9793
	B20	6.1659
	B30	6.6533
	B40	6.777
	B50	7.7858

Table 4: Experimental Results for Acceleration of different blends at zero load

Following, Fig 2 to Fig 7 shows Vibration analysis by frequency spectra for different blends B00 (Diesel), B10, B20, B30, B40 & B50 at 0KG load.

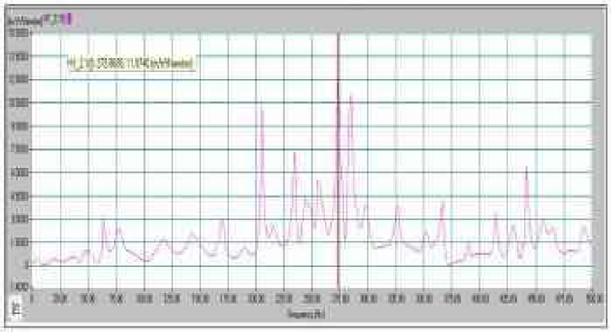


Figure 2: Frequency spectra of the engine vibration for B00 blend at zero kg load

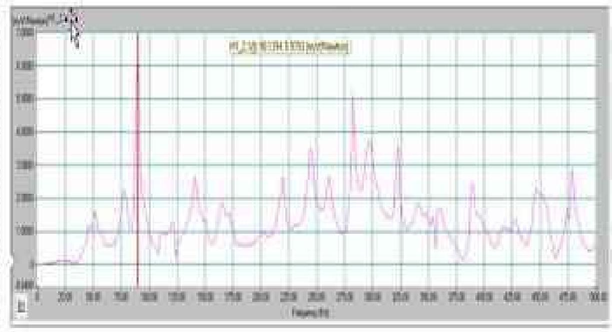


Figure 3: Frequency spectra of the engine vibration for B10 blend at zero kg load

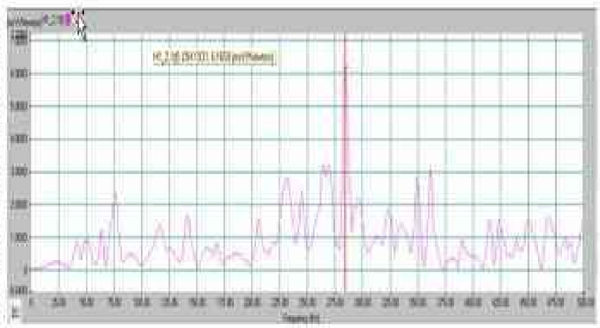


Figure 4: Frequency spectra of the engine vibration for B20 blend at zero kg load

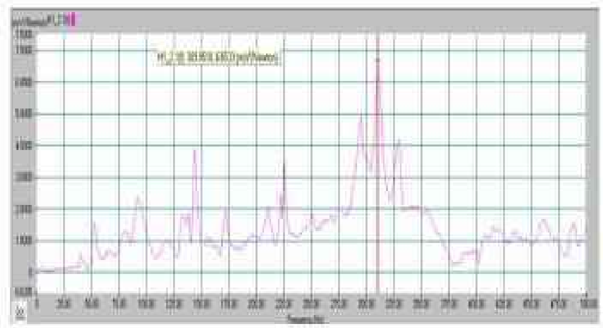


Figure 5: Frequency spectra of the engine vibration for B30 blend at zero kg load

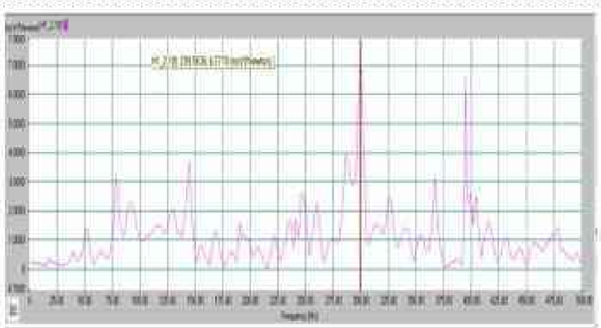


Figure 6: Frequency spectra of the engine vibration for B40 blend at zero kg load

Figure 7: Frequency spectra of the engine vibration for B50 blend at zero kg load

Fig 2-7 is the result of the frequency spectra obtained from engine vibrations for 0KG. The overall result tested shows that the highest acceleration is obtained for Diesel fuel 11.974 m/s^2. Whereas value of acceleration is increasing for B10 to B50 blends from 5.9793 m/s^2 to 7.7858 m/s^2 .This concludes that at 0KG load maximum vibration is obtained for B00 blend whereas B10 shows minimum vibration.

5.3 Experimental Vibration analysis of Diesel and Jatropha oil using RT Pro Photon Software at 5 KG load:

Experimental acceleration values for Diesel(B00) and Jatropha Oil Blends (B10, B20, B30, B40 & B50) for 5kg load at 1500rpm speed are given below:

VIBRATION DATA LOAD = 05 KG		
Fuel	Blend	Acceleration m/s^2
DIESEL	**B00**	9.727
JATROPHA	**B10**	7.2421
	B20	10.8309
	B30	8.0642
	B40	15.0789
	B50	8.1166

Table 5: Experimental Results for Acceleration of different blends at 5kg load

Fig 8 – Fig 13 shows Vibration analysis by frequency spectra for different blends B00 (Diesel), B10, B20, B30, B40 & B50 at 5KG load

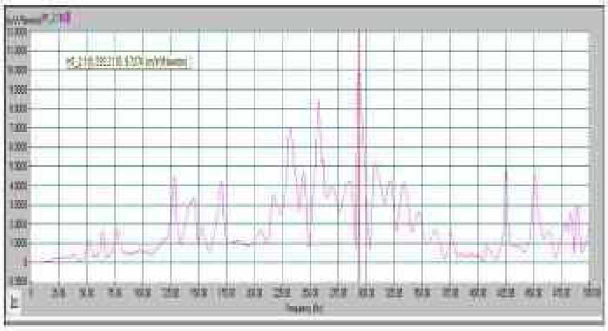


Figure 8: Frequency spectra of the engine vibration for B00 blend at 5 kg load.

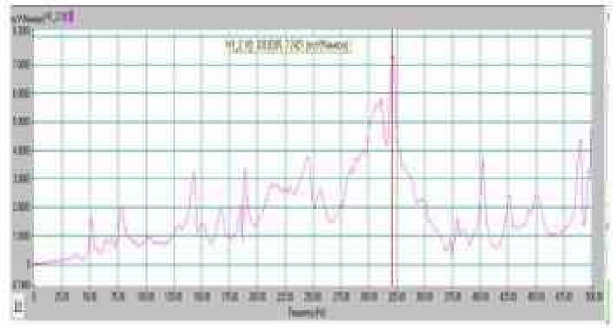


Figure 9: Frequency spectra of the engine vibration for B10 blend at 5 kg load

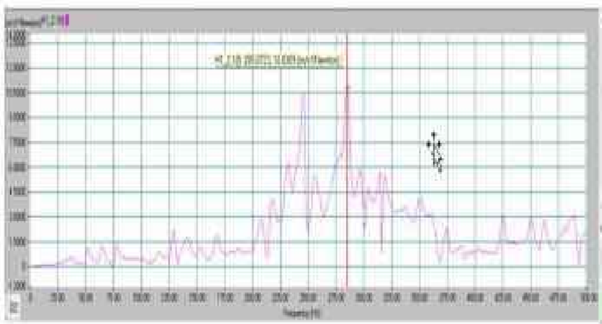


Figure 10: : Frequency spectra of the engine vibration for B20 blend at 5 kg load

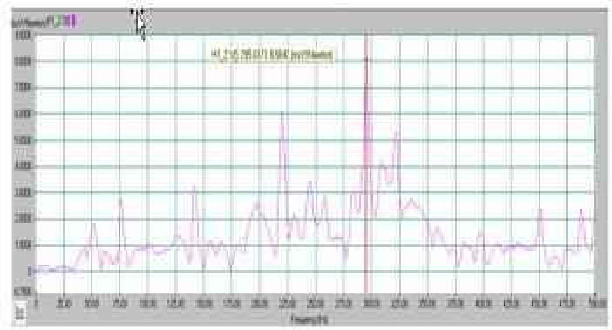


Figure 11: Frequency spectra of the engine vibration for B30 blend at 5 kg load

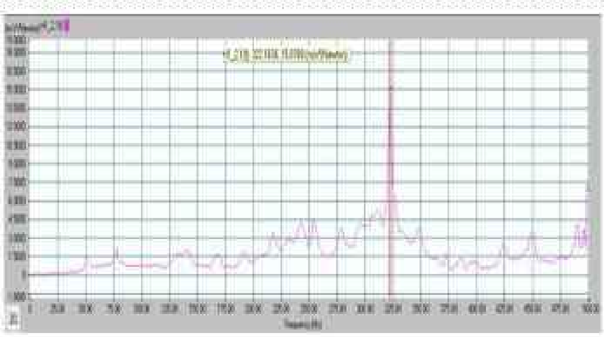


Figure 12: : Frequency spectra of the engine vibration for B40 blend at 5 kg load

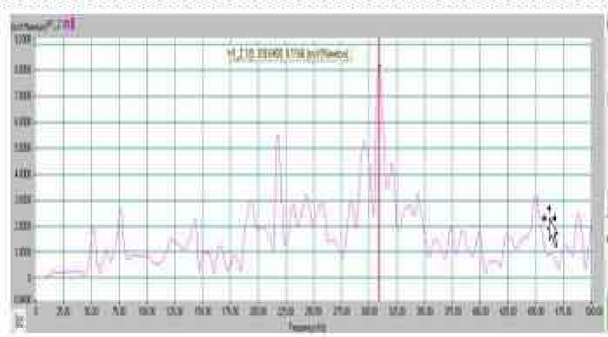


Figure 13: Frequency spectra of the engine vibration for B50 blend at 5 kg load

Fig 8-13 is the result of the frequency spectra obtained from engine vibrations for 5KG load. The overall result tested shows that the highest acceleration is obtained for B40 fuel 15.0789 m/s^2. Whereas variations in value of acceleration is obtained from B10 to B50.

As increasing slightly load implies that acceleration obtained for B00 is high compared to B10, B30 & B50 blends. This concludes slightly increasing load shows maximum vibration for B00 blend whereas B30 shows minimum vibration.

3.4 Experimental Vibration analysis of Diesel and Jatropha oil using RT Pro Photon Software at 10 KG load:

Experimental acceleration values for Diesel(B00) and Jatropha Oil Blends (B10, B20, B30, B40 & B50) for 10kg load at 1500rpm speed are given below.

VIBRATION DATA LOAD = 10 KG		
Fuel	Blend	Acceleration m/s^2
DIESEL	**B00**	9.4352
JATROPHA	**B10**	9.8827
	B20	9.8795
	B30	6.5957
	B40	10.7819
	B50	9.4657

Table 6: Experimental Results for Acceleration of different blends at 10kg load

In this the result of frequency spectra obtained from engine vibrations for 10KG load. The overall result tested shows that the highest acceleration is obtained for B40 fuel 10.7819 m/s^2. Whereas variations in value of acceleration is obtained from B10 to B50. As increasing slightly load implies that acceleration obtained for B00 is high compared to B30 blends. This concludes slightly increasing load shows minimum vibration for B30 compared to B00 blend (Diesel)

3.6 Experimental Noise analysis of Diesel and Jatropha oil using RT Pro Photon Software at different load

Experimental noise values for Diesel(B00) and Jatropha Oil Blends (B10, B20, B30, B40 & B50) for 0kg, 5kg & 10kg load at 1500rpm speed are given below

Sr. No.	Fuel	Blend	NOISE (dB)		
			0 KG	05KG	10KG
1	DIESEL	**B00**	86.3153	89.8584	90.9301
2	JATROPHA	**B10**	86.7926	89.1914	91.2558
		B20	86.0708	89.1217	90.1965
		B30	86.2192	89.7489	91.3628
		B40	85.9852	88.7035	90.9902
		B50	85.5465	89.0338	91.4887

Table 7: Experimental Results for Noise (in Decibels) of different blends at 0kg, 5kg & 15kg load

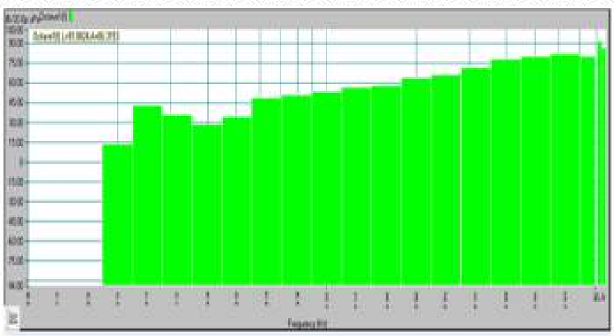


Figure 14 : Average of noise values of the engine vibration for B00 blend at 0kg load.

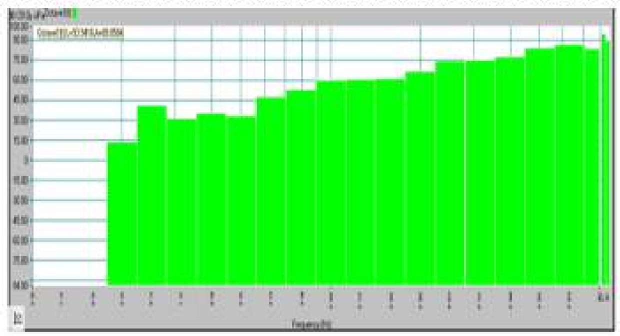


Figure 15: Average of noise values of the engine vibration for B00 blend at 5kg load.

Figure 16: Average of noise values of the engine vibration for B00 blend at 10kg load.

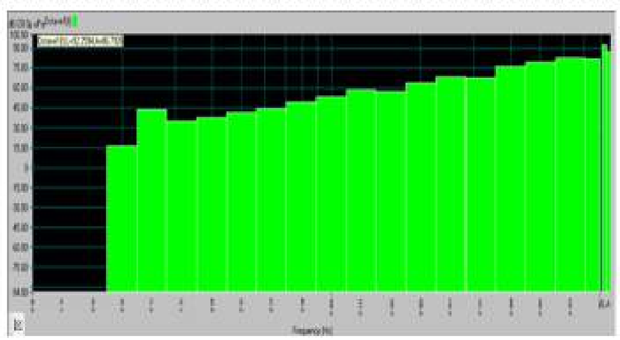


Figure 17: Average of noise values of the engine vibration for B10 blend at 0kg load.

Figure 18: Average of noise values of the engine vibration for B10 blend at 5kg load.

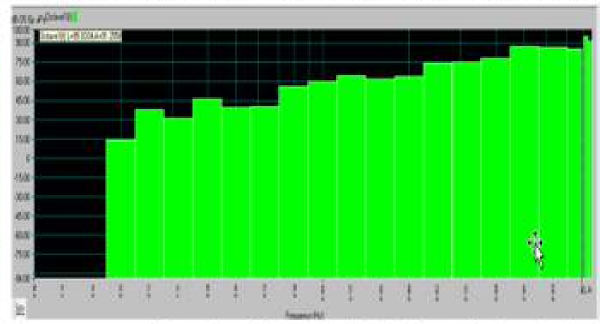


Figure 19: Average of noise values of the engine vibration for B10 blend at 10kg load.

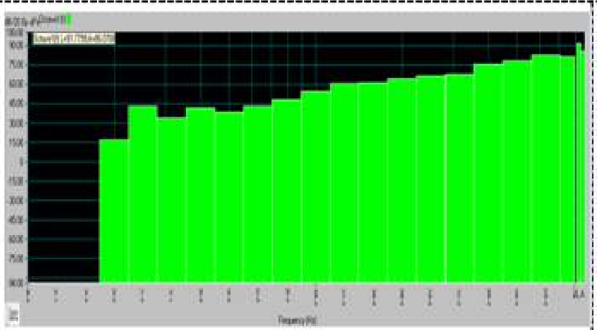


Figure 20: Average of noise values of the engine vibration for B20 blend at 0kg load.

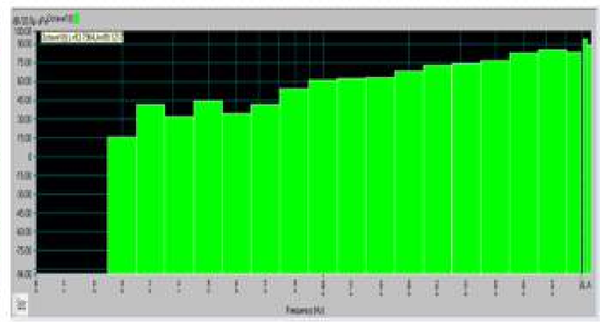


Figure 21: Average of noise values of the engine vibration for B20 blend at 5kg load.

Fig 14 - 21 is the result of the average noise obtained from engine vibrations for 0KG, 5KG & 10KG load. The overall result tested shows that the highest sound is obtained for B00 fuel 90.9301 dB. As load increases the sound is increasing for B00 (Diesel) fuel whereas lowest sound is obtained for B30 blends. As increasing slightly load implies that noise is obtained for B00 is high compared to B30 blends. This concludes slightly increasing load shows minimum vibration for B30 compared to B00 blend (Diesel).

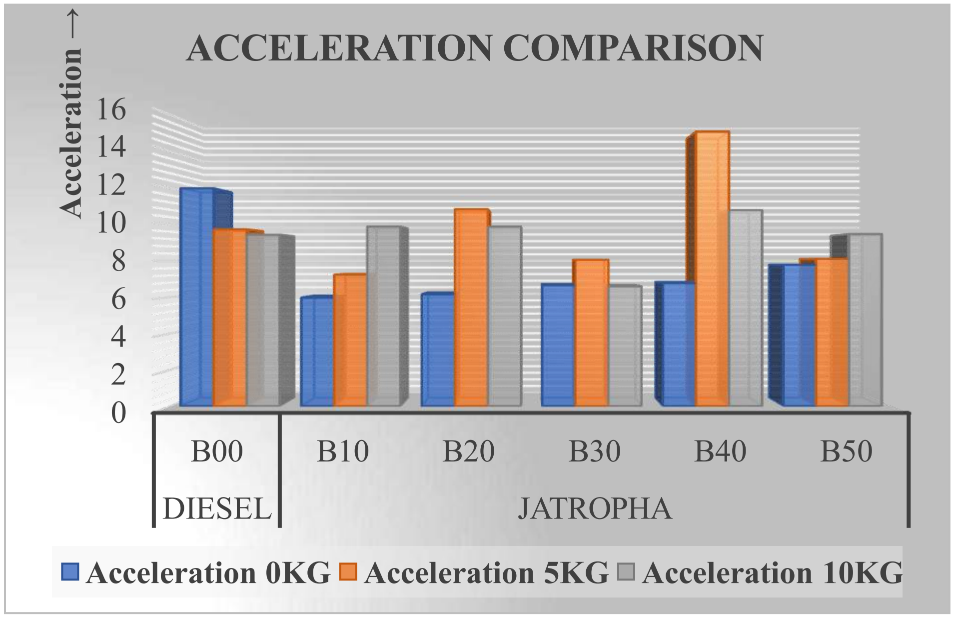
3. RESULTS AND DISCUSSION:

The overall result tested for Diesel (B00) & Jatropha blends (B10 to B50) shows that for slightly increasing load the acceleration varies for all the blends. But comparing Diesel with Jatropha fuel it can be concluded as B30 shows minimal acceleration value in comparison with other values obtained through experimentation.

Sr. No.	Fuel	Blend	Acceleration m/s^2		
			0 KG	**05KG**	**10KG**
1	DIESEL	**B00**	11.974	9.727	9.4352
2	JATROPHA	**B10**	5.9793	7.2421	9.8827
		B20	6.1659	10.8309	9.8795
		B30	6.6533	8.0642	6.5957
		B40	6.777	15.0789	10.7819
		B50	7.7858	8.1166	9.4657

Table 8: Comparison of acceleration value.

- B10 blend Vs B00 shows decrease in acceleration by 50% at 0KG load, decrease in acceleration by 74% at 5KG, & increase in acceleration by 95% at 10KG.
- B20 blends Vs B00 shows decrease in acceleration by 51% at 0KG load, increase in acceleration by 90% at 5KG & increase in acceleration by 96% at 10KG.
- B30 blends Vs B00 shows decrease in acceleration by 56% at 0KG load, decrease in acceleration by 83% at 5KG & decrease in acceleration by 70% at 10KG.
- B40 blends Vs B00 shows decrease in acceleration by 57% at 0KG load, increase in acceleration by 65% at 5KG & increase in acceleration by 88% at 10KG.
- B50 blends Vs B00 shows decrease in acceleration by 65% at 0KG load, decrease in acceleration by 83% at 5KG & same acceleration is obtained at 10KG.



Graph 1: Chart Representing of acceleration comparison.

1. The overall result tested for Diesel (B00) & Jatropha blends (B10 to B50) shows that for slightly increasing load the noise varies for all the blends. But comparing Diesel with Jatropha fuel it can be concluded as B30 shows minimal noise value in comparison with other values obtained through experimentation.

Sr. No.	Fuel	Blend	NOISE (dB)		
			0 KG	**05KG**	**10KG**
1	DIESEL	**B00**	86.3153	89.8584	90.9301
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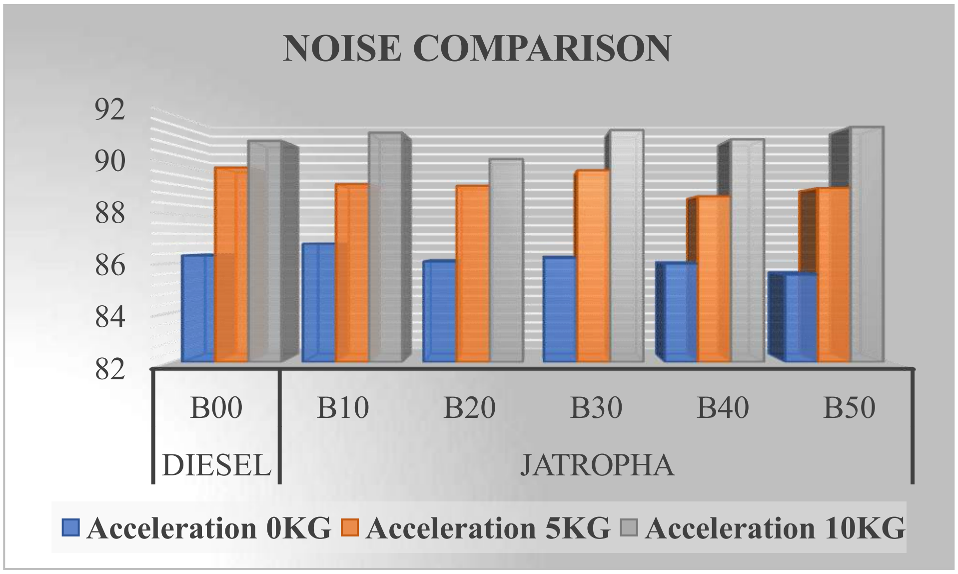
		B40	85.9852	88.7035	90.9902
		B50	85.5465	89.0338	91.4887

Table 9: Comparison of noise value.

- B30 blends Vs B00 shows decrease in noise values at 0KG load, 5KG & 15KG
- For other blends B10, B20, B40 & B50 Vs B00 not many variations are seen that is almost similar values are obtained for them



Graph 2: Chart Representing of Noise value.

5. CONCLUSION:

In the present study, tests on an engine were performed for Diesel and Biodiesel blends were successfully undertaken. For each fuel type, blends of Jatropha compositions (B10, B20, B30, B40 and B50) were prepared and tested. The results including vibrations and noise were compared with those using the standard diesel (B00). According to the measurements, it appears that adding a significant percentage of biodiesel mixture with diesel caused changes in engine behavior regarding vibrations. Specifically, the fuel mixture significantly affected the acceleration. Minimal reduction in acceleration observed using B30 with an increasing load of engine.

- The influence of vibration and noise slightly decreased when using biodiesel fuel as compared to pure diesel.

For zero load, maximum vibrations were observed in Diesel shows 11.974 m/s^2 whereas minimum were observed at B30 6.6533m/s^2

As we are **increasing load by 5 KG** (Slightly load change) Diesel shows 9.727 m/s^2 whereas minimum vibration were observed at B30 8.0642 m/s^2.

- Similarly **increasing load to 10KG** shows vibration for Diesel 9.4352 m/s^2 whereas minimum vibration was observed at B30 6.5957 m/s^2.

- So, as we are increasing the load, the vibrations are increasing but as compare to Diesel fuel the values are lower for B30 fuel comparing for all load values.

In case of Noise, The noise is increasing with slightly changing load for Diesel from zero load to 10 KG load and minimum noise is observed for B30. From this overview it can be concluded that Biodiesel blends can be employed safely comparing with Diesel fuel as minimum vibration & noise are observed by using Biodiesel blends.

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