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A Review on Vibration Analysis of Generator Engine Fuelled with Ethanol & Gasoline

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ABSTRACT - Oil, gas, coal, even water has limited availability. Oil and gas have already become expensive, and with each passing day, they are moving towards being extinct. The steady increase in energy consumption coupled with environmental pollution has promoted research activities in alternative and renewable energy. In the current scenario, engines are not much compatible with alternative fuels, because of which research is being carried out at various levels to make engines compatible with alternative fuels. In the current situation most of the research is focused on dynamic IC engines eg. an automobile. This resulted in lesser research for static engines eg. Pump, Generator, etc. Addressing this issue, the generator engine has been tested for compatibility with alternative fuel. The important parameter to be studied was the vibration in the engine run by using alternate fuel. As vibration is one of the important parameters that will affect overall efficiency also the life of the engine. In this project, Ethanol was chosen as an alternative fuel because it is known to improve engine performance and combustion characteristics. This Project study on the effect of the addition of Ethanol in Gasoline on vibration signals from the cylinder head of the Generator engine. Ethanol is added in Gasoline at five different percentages (10% (NB), 15 (B1), 20 (B2), 25 (B3), and 30 (B4)). The experiment is carried out at four different load conditions (zero, half, 3/4th, full) for each fuel and vibration signal were recorded then changes in statistical parameters (Skewness, RMS value, Crest factor, Kurtosis, and Peak amplitude) related to vibration signals are studied and compared to standard petrol means 10% Ethanol (NB).

KEYWORDS - Ethanol, Generator Engine, LabView, Performance Characteristics, Vibration analysis

I. INTRODUCTION

To conserve petroleum fuels for the future and to eliminate the limitation of generator vibration, there is a need for alternative and innovative fuel. Meanwhile, ethanol fuel is mixed with gasoline which can be used as an alternative fuel for any Generator. In the present work blending different quantities of ethanol with petrol and corresponding generator engine performance and vibration, characteristics are analyzed. With this compatibility of Ethanol-blends as an alternative fuel in the internal combustion engine will be checked.

Vibration analysis is an effective tool in detecting and diagnosing the behavior of machines and equipment and more specifically of an engine [1]. Vibration signals measured at the external surface of the engine contain a good amount of information, which if properly interpreted can reveal the running condition of the engine. It may be regarded as one of the languages through which the engine tells its ailments. Thus, it is important to analyze the engine vibrations to know its behavior.

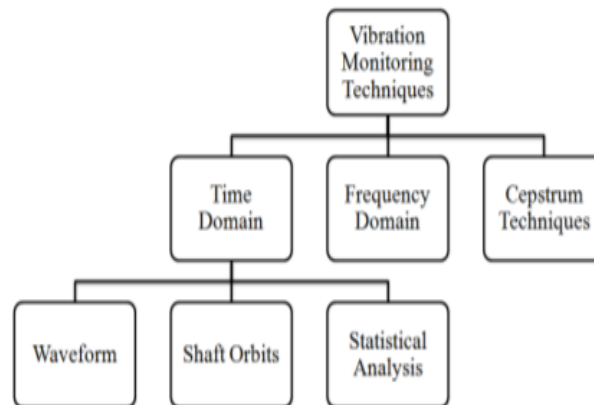


Figure 1. Vibration Monitoring Techniques [7]

II. INTRODUCTION TO ETHANOL

Ethanol is a pure substance while gasoline is composed of Hydrocarbons. The ethanol contains an oxygen atom so that it can be viewed as a partially oxidized hydrocarbon. It helps in complete combustion. Ethanol blending is a procedure of adding ethanol to petrol. Properties of ethanol closely resemble that of petrol. Ethanol blends have been proven to reduce carbon deposits, resulting in a cleaner engine that runs more efficiently. Not only does E30 reduce the need for cancer-causing additives in gasoline like benzene, but it also reduces dependence on foreign oil. Although not approved in non-flex fuel engines, it is safe and has been used in engines for thousands of miles without issue. The vibration signals of the generator engine will be recorded primarily for pure petrol and further for blends of ethanol with petrol. The significant differences between normal conditions and varied conditions will be concluded at the end. Ethanol blends with petrol to prepare three different blends on a volume basis these are E15 (15% ethanol + 85% petrol), E20 (20% ethanol + 80 petrol) & E25 (25% ethanol + 75% petrol). Fuel specifications of the petrol and ethanol-petrol blends are determined as per ASTM standards. The tests are performed at full load, half load, 3/4th load, zero load & full throttle. The test fuels are Standard petrol and petrol ethanol blend E15, E20 & E25, Numbers E indicate % of the volumetric amount of ethanol. The purity ratio of ethanol is 99.5%.

III. LITERATURE REVIEW

Milind S. Yadav, Suresh M. Sawant. “Analysis of Vibration Signals from Cylinder Head of a Diesel Engine Fuelled With Blends of Diesel and Oxy-Hydrogen Gas.” International Journal for Research in Applied Science & Engineering Technology (IJRASET), March 2018. Accessed at <http://www.ijraset.com>. In this paper, the vibrations produced in the IC engine are studied. The focus is on vibration reduction after the use of alternative fuel and hence the data of the blends after used for the experimentation is analyzed to give the best suitable blending percentage for the better performance of the engine [1]. This method of using alternative fuel to study the vibration signals can also be tested for the generator engine.

Arthur Lee, Portable generator vibration measurements. U.S. CONSUMER PRODUCT SAFETY COMMISSION, January 2007. Accessed at <https://www.cpsc.gov>. The experimental setup is explained in detail and the terminologies related to the generator engine and vibration analysis are quite helpful for further work to do. Load variation on the engine can also be considered as a comparison factor for vibration signal analysis[2].

B. Heidary, S. R. Hassan-beygi, B. Ghobadian, and A. Taghizadeh. (2013). “Vibration analysis of a small diesel engine using diesel-biodiesel fuel blends.” AgricEngInt: CIGR Journal, 15(3): 117 – 126. Accessed at <http://www.cigrjournal.org>. This paper consists of the comparative study was to examine the vibration of different diesel-biodiesel fuel blends in power tiller engine[3]. The main goal was to present fuels with minimum vibration. So, the time domain signals were analyzed in five levels of engine speed, three axes, and six fuel blends on the engine [3]. The signal processing and statistical approach were applied for data analysis. Also, give the best suitable blending percentage for the better performance of the engine. This method of using alternative fuel to study the vibration signals can also be tested for the generator engine.

MilindYadav, Suresh Sawant. “Effect of Oxy-Hydrogen Addition in Diesel on Vibration Signals from Engine Crankshaft Bearing” International Journal of Engineering Science Invention (IJESI), vol. 07, no. 02, 2018, pp. 33–41. Accessed at <http://www.ijesi.org>. In this paper, the effect of oxyhydrogen addition in the fuel with different flow rates is discussed. Then it contains the fuel preparation, test setup, and methodology in detail for the different blends used for the analysis. The vibration is considered as the basic criteria for the comparative study. The effect of alternative fuel on engine vibrations is studied from various statistical parameters viz. peak amplitude, RMS value, kurtosis, skewness, and crest factor [4]. These parameters are also explained in detail and using these parameters as a frame of reference to study the vibration signals in the generator engine.

Manieniyan V and Sivaprakasam S. “Vibration Analysis in DI Diesel Engine Using Diesel and Biodiesel.” International Journal of Engineering Trends and Technology, 4(8), 2013, pp. 3586 – 3589. Accessed at <http://www.ijettjournal.org>. In this paper, the engine knock and its effects are discussed in detail. While reading the vibration signals the other effects on the engine such as a decrease in the efficiency, a considerable rise in specific fuel consumption is noted. These effects have to be taken under consideration while performing on test setups to prevent any possible long term damage [5].

Yew HengTeoh, HeoyGeok How, Navaneetha Krishnan Balakrishnan, ThanhDanh Le, and HuuTho Nguyen “Performance, Emissions, Combustion and Vibration Analysis of a CI Engine Fueled with Coconut and Used Palm Cooking Oil Methyl Ester” Accessed at <http://www.mdpi.com>. In this paper they disused about, Blends of the diesel methyl ester with 10%,20%,30%,& 40% of UMPE (used palm cooking oil methyl ester) & CME(Coconut methyl ester) by volume as fuel. The engine vibration was significantly influenced by the fuel blends and methyl ester type. For each of the methyl ester types, it was found that UPME B30 and CME B30 had the lowest vibration, with RMS acceleration values of 30 m/s² and 34.8 m/s², respectively. Furthermore, the results showed that an engine fueled with both of the UPME and CME blended fuels had pressure increase rates that were within the acceptable threshold. The largest reduction of 21.5% in RMS of acceleration was obtained with UPME B30 concerning the baseline diesel.[6]

IV. STATISTICAL PARAMETER RELATED TO VIBRATION ANALYSIS

4.1 Peak Amplitude

Peak amplitude vibration signals are to be recorded in the vibrating body. The amplitude obtained in the frequency spectrum of a system using FFT is nothing but the amplitude of vibration and it is used for analysis [1]. It is an indication of the severity of vibration or shock events. Reduction in this amplitude measurement indicates a reduction in the vibration of that body.

4.2 RMS Value

RMS value is the square root of the average squared value of the vibration signal waveform. RMS value gives the idea about the power or energy of the waveform, the higher the RMS values higher the power or energy in the waveform [4]. It is directly related to the energy content of the vibration profile and thus destructive capacity of vibration. RMS also takes into accounts the time history of a waveform. RMS value is used to study engine body vibrations and with an increase in RMS value engine vibrations increase.

4.3 Crest Factor

The ratio of the peak amplitude of the vibration signal to the RMS value of the vibration signal is called as Crest Factor. The crest factor gives a quick idea about how much impacting is occurring in a waveform. In a perfect sine wave with amplitude equal to one, the RMS value is equal to 0.707 and hence the crest factor is 1.4144. A perfect sine waveform contains no impacting and hence a crest factor above 1.4144 implies that there is some degree of impact [4]. Higher values of the crest factor indicate a strong impacting. Higher values of the crest factor indicate strong impacting suggesting higher vibrations.

4.4 Kurtosis

Mathematically kurtosis is defined as the ratio of the fourth moment to the square of variance. Kurtosis criteria are also used to evaluate the performance of the engine, the inside pressure of the cylinder, and sharp fluctuations of the vibration of the engine body [1]. Higher kurtosis value shows irregular engine performance or rough engine operation and a decrease in its value engine runs smoother. A normal distribution has a kurtosis value equal to 3 and hence

distribution with kurtosis values more than 3 are called leptokurtic and the one with kurtosis value less than 3 are called platykurtic[1].

4.5 Skewness

Mathematically skewness is defined as the ratio of averaged cubed deviation from mean and cube of standard deviation. The skewness of vibration signal Distribution is normally spread or distributed around the mean on positive and negative sides symmetrically. The distribution is said to be skewed when it is not symmetric around the mean [1]. As a general rule of thumb: If skewness is less than -1 or greater than 1, the distribution is highly skewed. If skewness is between -1 and -0.5 or between 0.5 and 1, the distribution is moderately skewed. If skewness is between -0.5 and 0.5, the distribution is approximately symmetric.

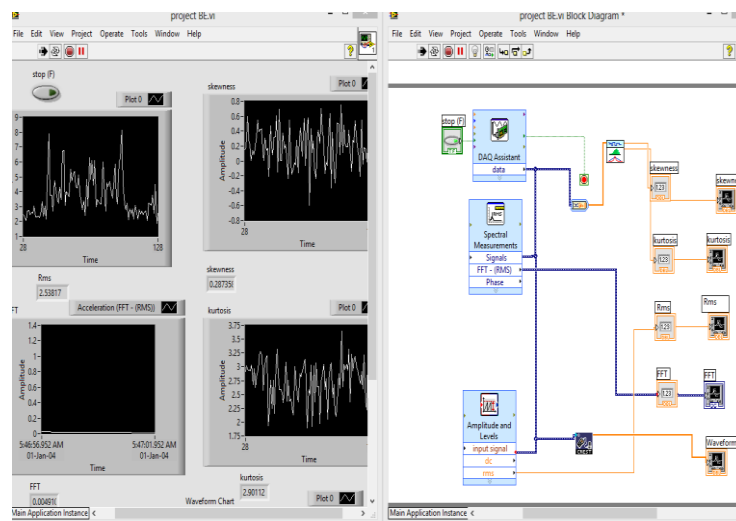


Figure 2. Block diagram for signal extraction and analysis using Lab-View

V. CONCLUSION

- A. If the RMS value of blend which is near to 0.707, that blend gives less vibration.
- B. If a Crest factor of blend above 1.4144 implies that higher Vibration.
- C. If the Kurtosis value of blend greater than 3 implies that higher vibration.
- D. If skewness is between -0.5 and 0.5, so that blend gives less vibration.
- E] IF the value of Peak amplitude increases Vibration also increases.

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