

## Analysis of Knock Detection in Single Cylinder DI- Diesel Engine

*Department of Mechanical Engineering, vaishali ahlawat ,*  
MVSr ENGINEERING COLLEGE, Hyderabad, Telangana, ahlawat.v@yahoo.com

### *Abstract*

The motivation behind this paper is to distinguish the "thump" in Diesel motors which decay the motor execution antagonistically. The strategy presented in the present work recommends a recently created approach towards dissecting the vibration examination of diesel motors. The strategy depends on crucial relationship between the motor vibration design and the relative attributes of the ignition procedure in each or distinctive chambers. Thump in diesel motor is recognized by measuring the vibration created by the motor utilizing The DC-11 FFT analyzer with accelerometer. Thump in diesel motor is for the most part because of the motor miss .A diesel motor miss comes about because of at least one barrels when the fuel is not smoldering appropriately. Disgraceful fuel smoldering is brought on by Infusion framework issues which incorporate, Faulty injectors, stopped up fuel channels, wrong Injection timing, Low motor pressure, infusion framework spills, Air releases, defective infusion pump and so on. Motor miss causes quick burning with high weights producing a thunder or dull rattling solid. Unusually boisterous sound with vicious vibration is called "thumping or explosion". Motor barrel vibration in FFT frame is observed at each stack the chamber excitation frequencies are contrasted and the gauge frequencies utilizing diesel oil. Time wave frames on the barrel head are likewise recorded to break down the ignition. Since the very ignition in the barrel is the essential exciter, the vibration investigation of the motor chamber through the deliberate FFT and time waveforms are the delegates of ignition affinity. Vibration accelerometer is mounted on the barrel head, ideally on the jolt interfacing the head and the chamber to record the motor vibrations utilizing DC-11 information lumberjack which straightforwardly gives the otherworldly information as FFT, the general vibration levels. This FFT information recorded is gathered by On-Time window based programming outlined by e-anticipate Inc., Argentina. The Time waveforms are acquired on the chamber head by DC-11 in the OFF-ROUT mode and are displayed in realistic frame by Vast DOS-based programming, composed by VAST, Inc., Russia.

**Keywords:** *Knock, Vibration, burning, Fast Fourier Transformation (FFT).*

### **INTRODUCTION**

Thumping or explosion in diesel motor dependably prompts to the extreme increment in weight beats inside the burning chamber coming about a metallic commotion which causes irreversible harm to the motor parts and structure. In chamber weight estimation is one of the method to identify the thump and its force. Leppard (1982) distinguished thumping by separating the signs produced by the accelerometer or by utilizing the weight sensors. G.Brecq (2005) contemplated

thumping in S.I.Engines got from a Diesel motor fuelled with normal gas with a bowl cylinder head. It was adjusted to start by diminishing the pressure proportion and settling a start connect to the injector area. Draper (1935) proposed a scientific depiction of the weight motions on the premise of acoustic wave hypothesis. Thumping in SI motors fuelled with double fuel mode worked with hydrogen what's more, methane was examined by Z.Liu and G.A.Karim (1965) through displaying in detail the substance response

movement of the pre start and consequent burning procedures.

The varieties of weight and temperature amid the operation of a regular double fuel motor are imperative markers that show regardless of whether thump is experienced for any fuel framework under a predetermined arrangement of working conditions. The onset of thump in the computed model is connected with the creation of high barrel weight and temperature values as a aftereffect of the fast ignition of the vaporous fuel. The anticipated qualities for the onset of thump were by and large steady with the relating exploratory qualities. ZiangAihua (2008) recognized the failing deficiency of inward burning motor by utilizing the vibration signals measured on the motor chamber head utilizing accelerometer while running the motor at different velocities. He gathered the information for single chamber fizzling, twofold chambers constantly fizzling and twofold barrels then again failing. Subsequent to breaking down the vibration signals with db3 wavelet, whether the motor was fizzling or not and what sort of failing were judged by the contrasting of decaying results. Low-recurrence vibration of motor chamber head is in respect to the revolution of chief shaft, and the high-recurrence vibration is in respect to the ignition of chamber. Jenkins S. H.(1975) Noise from a diesel motor is brought about by vibration of the surfaces of the structure, the adornments appended to the structure and covers, for example, valve covers and oil skillet. Two fundamental strengths make the framework vibrate. Burning is a noteworthy constrain which creates weight in the acoustically vital recurrence scope of 500-5000 Hz. The motor system additionally creates strengths which can be essential in the same basic recurrence go. These strengths join and cause the structure to vibrate in its favored modes. Each symphonious of chamber terminating

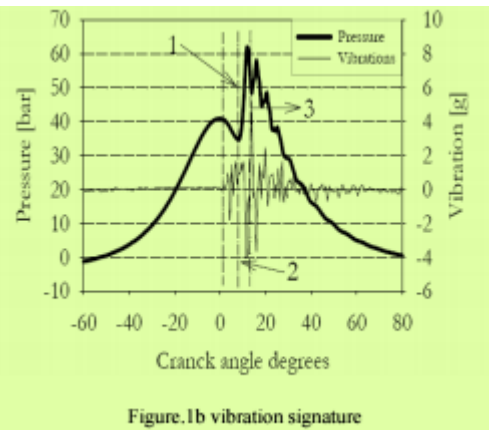
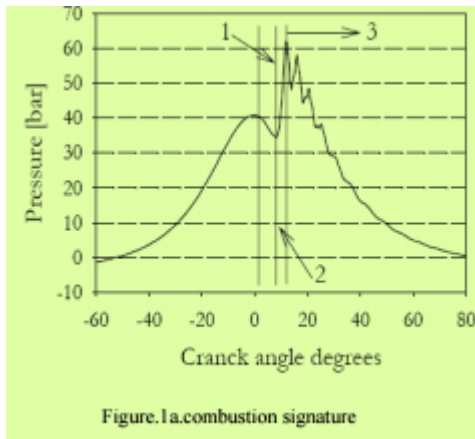
recurrence is created and, since the principal is for the most part beneath 25 Hz for a four cycle diesel motor at evaluated speed, the constraining might be viewed as persistent over the whole acoustical recurrence extend. All methods of motor vibration are along these lines consistently energized. M I Nwafor (2002) considered the

ignition thump attributes of diesel motors running on common gas utilizing pilot infusion as method for starting ignition. The diesel motors thump under typical working conditions yet the thump alluded to in this paper is a questionable one. In the double fuel burning procedure we have the start arrange took after by the ignition arrange. There are three sorts of thump: diesel thump, start thump and thump because of optional start deferral of the essential fuel (unpredictable thump). A few variables have been noted to include in characterizing thump qualities of double fuel motors that incorporate start delay, pilot amount, motor load and speed, turbulence furthermore, gas stream rate. Recurrence examination is the most usually utilized technique for investigating a vibration flag.

The most fundamental sort of recurrence investigation is a FFT, or Fast Fourier Transform, which changes over a flag from the time area into the recurrence space. This is entirely valuable for investigating stationary signs whose recurrence parts don't change after some time. This is entirely helpful for investigating stationary signs whose recurrence segments don't change after some time. Cepstrum Analysis is particularly helpful for recognizing sounds. Sounds are occasional segments in a recurrence range and are basic in machine vibration spectra. Longbao (etal, 2003) concentrated on the wavelets of vibration spectra. Wavelet investigation is suitable for portraying machine vibration

marks with restricted band-width frequencies going on for a brief span period. Wavelets have restricted data transmission in the recurrence space and conservative transfer speed in the time area. In this way, wavelets have a decent fixation and determination exchange off between the time and recurrence space. The vibration flag is then go through example coordinating calculations which contrast the flag with the known library of wavelets speaking to various wonders, for example, thumps. Gideon Goldwine (2004) has surveyed the quality of burning in pressure start motor through vibration signature investigation. Motor discharges

are moreover dependant on the commitment of each chamber to the motor's aggregate yield. All these methodologies can generally be partitioned into the accompanying real gatherings: Analyzing the motor speed/torque varieties, fumes gas weight, auxiliary strains in the motor, and vibration mark of the motor piece, acoustic mark of the motor and temperature of the fumes gas. An association between the vibration signature and the burning procedure is empowered by three stages i.e. defer period, fast burning, blended controlled ignition period as appeared in the figure 1a.



### TRIAL SET UP

Explore comprises of a solitary chamber DI-diesel single barrel 3.68kW Kirloskar motor with pressure proportion of 16.5. The motor is fitted with vortex current dynamometer to apply distinctive burdens. The vibration created by the motor is measured utilizing vibration analyzer hardware

### Vibration analyzer gear

The DC-11 FFT analyzer [figure2] made by DPL gather Canada is a computerized range analyzer and information gatherer particularly intended for machine condition checking, propelled bearing shortcoming recognition and estimation diagnostics. The accompanying are the

estimations that can be made by the instrument.DC- 11.vibration analyzer.



figure2. DC-11 Vibration analyzer with Acceleration pickup

### Highlights

- Time wave frame (oscilloscope) in OFF-ROUTE mode.
- FFT auto spectra
- Envelop spectra chose by numerous band pass channels
- Rotation speed
- Amplitude and stage on turn speed and its sounds

Table: 1. Specifications of the Vibration (FFT) Analyzer

Frequency Range	1-2000Hz
Input Signal Range	100mV
Frequency Span	1-2000 Hz in 1 Hz resolution
Signal to Noise Ratio	Greater than 70 dB
Amplitude Measurement Units	Acceleration, velocity and displacement

## EXPERIMENTATION PROCEDURE

Trial is done on single chamber DI-diesel single barrel 3.68kW kirloskar motor with pressure proportion of 16.5. Experimentation is done at different motor burdens connected through whirlpool current dynamometer and a spring parity. The investigation is conveyed with slick diesel furthermore biodiesel. Water is infused in fumigation shape into the delta complex by electronically controlled optional infusion pump put outside the motor. The heap on the motor can be changed with the dynamometer control board. Full load on the motor is equivalent to 40 kg on the spring equalization. This dynamometer is famous for its steady and predictable readings even on account of minor variety in motor speed and motor vibration. Motor chamber vibration in FFT frame is checked at every heap and for every ester at the same time to think about the barrel excitation frequencies with the benchmark frequencies utilizing diesel oil. Time wave shapes on the barrel head are moreover recorded to examine the

ignition. Since the very burning in the barrel is the essential exciter, the vibration investigation of the motor barrel through the deliberate FFT and time waveforms are the agents of burning penchant. Vibration accelerometer is mounted on the barrel head, ideally on the jolt associating the head and the chamber to record the motor vibrations utilizing DC-11 information lumberjack which straightforwardly gives the ghostly information as FFT, the general vibration levels. This FFT information recorded is gathered by On-Time window based programming outlined by e-foresee Inc., Argentina. The Time waveforms are gotten on the barrel head by DC-11 in the OFF-ROUT mode and are displayed in realistic frame by Vast-a doss based programming, outlined by VAST, Inc., Russia. Four vital focuses on the motor chamber body and the establishment are evaluated the motor vibration. These four focuses are i) Vertical on top of the barrel head, ii) outspread on the barrel and parallel to the pivot of the wrench shaft, iii) outspread on the chamber and opposite to the hub of the wrench shaft, iv) On Engine establishment the vibration information recorded at these four focuses incorporates the motor vibration in the vertical course, the two flat bearings and the vibration transmitted to the establishment separately. The vibration information is recorded with the assistance of an accelerometer.

## RESULTS AND DISCUSSION

The vibration contemplates show that there is tradeoff between the vibrations recorded in various headings on the chamber head. There is likewise a tradeoff between the barrel head vibration and the motor establishment vibration. It can be watched that in table 2. There is an expansion of vibration from Cylinder make a beeline for the establishment. FFT range at 3/4th Full load is appeared in figure 4a. One can watch extra frequencies in the range and an advantageous count can be made with

FFT range for flawless diesel at a similar load. Since the range recorded on the chamber head is the agent of the burning inside the barrel it can be evaluated that new mode of ignition has occurred with various excitation frequencies. There is part recurrence ignition in the go characterized i.e. 10,000 Hz. 3-D diagrams have been drawn for various scopes of frequencies and the moment amplitudes have been concentrated on. It has been watched, the vibration values have diminished as can be watched from the 3-D charts from figures 4b to 4d. Figure 4c portrays vibration in cylinder slap course in pivotal recurrence scope of 900 Hz to 1300 Hz; the adequacy rise is irregular to the tune of 0.45 g at full load keep running of the motor.

**Table 2.** Vibration record On Different locations of The Engine.

S. No	Fuel Injection	Cylinder Head(g)	Engine foundation (g)
1	PME with water Injection	2.137	1.435
2		2.83	1.364
3		2.243	1.155
4		2.163	1.149
5		2.257	1.016
6		2.207	1.14
7		1.848	1.105
8	PME	2.222	1.116

This can be acclaimed to better torque transformation at this rate. The normal range esteem at this rate of water arrangement is 5.71g. This is likewise another sign of better torque change. Be that as it may, the vibration levels in a significant number of the 3-D charts stay high. Higher vibration levels on the establishment of the motor rely on upon the modular vibration of the structure for a specific sort of excitation amid burning which changes with the Kind of fuel utilized. The vibration toward cylinder slap and the vibration transmitted to the establishment of the motor are generally integral. Higher torque transformation typically makes more vibration segregation at the establishment. The time waves portrayed in figures 4e to 4i show longer time length of burning amid terminating stroke. Figure 4h depicts a split recurrence amid the ignition at 1/4 full load when contrasted with Full load which obviously demonstrates thumping of the motor amid water infusion. But with diesel with or without water infusion thump propensity was not saw at higher burdens this is because of the better torque transformation and smoother burning.

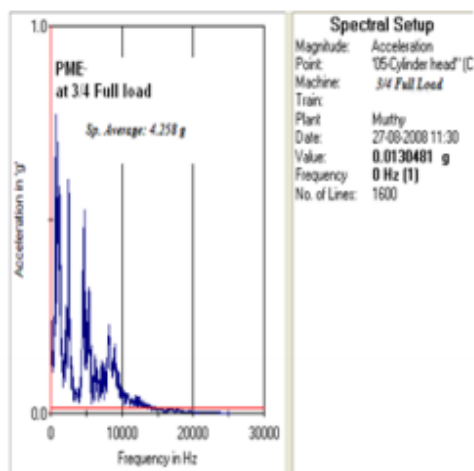


figure. 4a. FFT spectrum for PME at 3/4<sup>th</sup> Full load

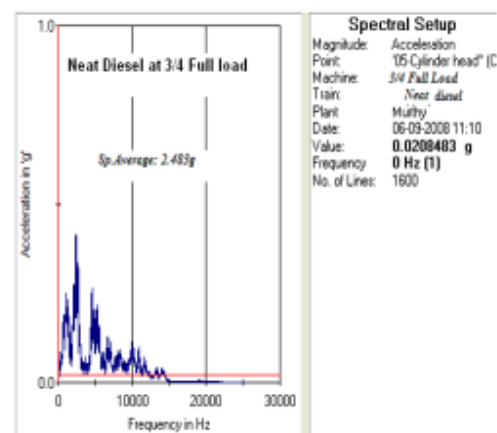


figure.4b. FFT spectrum for neat diesel at 3/4<sup>th</sup> Full load.



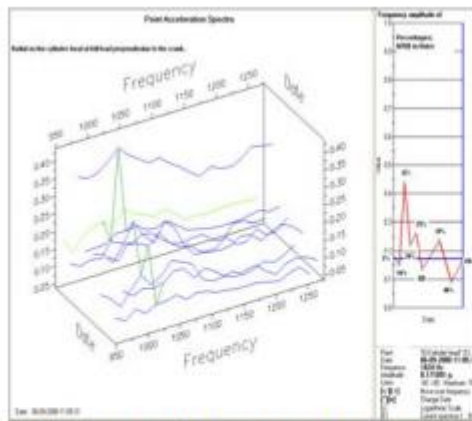


Figure.4c. 3-D spectrum for radial reading on the cylinder head perpendicular to the crank at Full Load

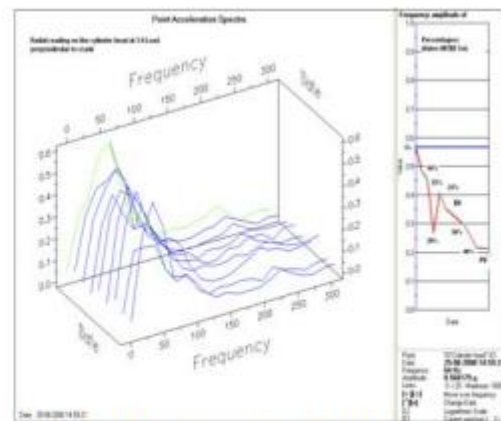


figure.4d.3-D spectrum for radial reading on the cylinder head perpendicular to the crank at 1/4th Full Load

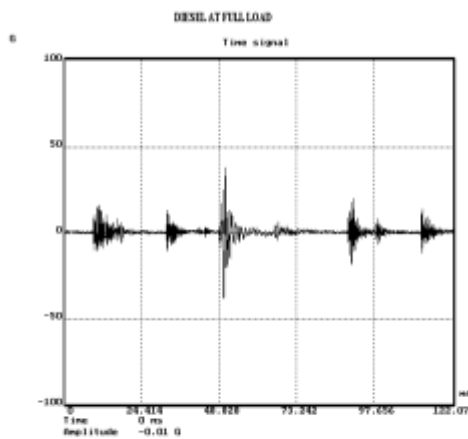


figure4e. Time wave form at full load recorded vertical on the cylinder head with neat diesel run

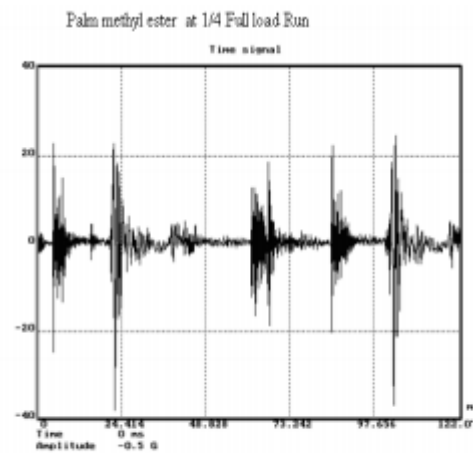


figure.4f. Time wave form at 1/4 full load recorded vertical on the cylinder head with neat PME

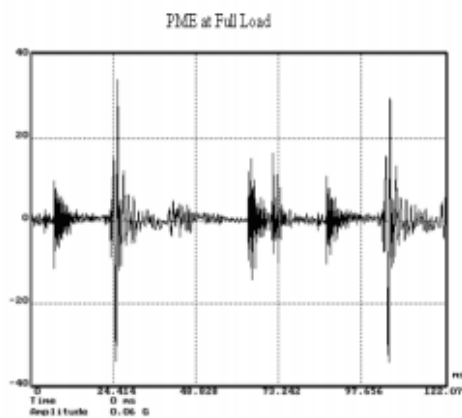


Figure.4g. Time wave form at full load recorded vertical on the cylinder head with PME

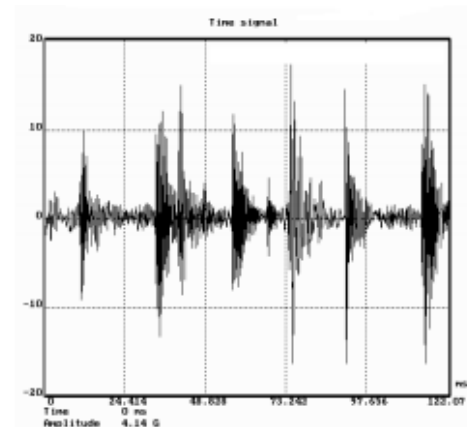


figure.4h. Time wave form at 1/4 full load recorded vertical on the cylinder head with PME and Water Injection

## CONCLUSIONS

a) The vibration considers demonstrate that there is tradeoff between the vibrations Recorded in various bearings on

the barrel head. There is additionally a tradeoff between the chamber head vibration and the motor establishment vibration.

- b) Since the range recorded on the barrel head is the agent of the ignition inside the chamber, it can be evaluated that new method of ignition has occurred with various excitation frequencies.
- c) In the pivotal recurrence scope of 900Hz to 1300 Hz, the sufficiency rise is irregular to the tune of 0.45 g at full load keep running of the motor. This can be acclaimed to better torque transformation at this rate.
- d) The time waves show longer time span of burning amid terminating stroke on account of infusion of water
- e) Knock is identified with water infusion at 1/4 Full Load.
- f) Knock inclination diminishes with increment of load with water infusion.
- g) With Palm Methyl ester operation the motor has not built up any Knock inclination this might be expected to the higher Cetane number of Palm Methyl ester.
- h) At Part stacks the motor may create thump inclination yet at higher burdens the propensity of thump is diminished this is because of the better torque transformation and smoother burning.

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