VIBRATION CONTROL IN GEAR BOX

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Abstract: After the design & manufacturing of gear box, company has to check for vibration occurring in the gear box. It should be minimum as vibration causes noise and severe vibration can result in machine breakdown. So as to ensure that vibration does not exceed allowable limit vibration analysis has to be carried out with use of proper experimental setup. Technique to reduce vibration, in case it exceeds allowable limit has to be suggested along with experimental proof**.**

Index Terms **– Gear box, vibration, FFT.**

1. INTRODUCTION

Vibration in motorized equipment is merely the back and forth movement or oscillation of machines and components, such as drive motors, driven devices (pumps, compressors and so on) and the bearings, shafts, gears, belts and other elements that make up mechanical systems. Vibration in industrial equipment can be both a sign and a source of trouble. The generally accepted methods for vibration control of industrial equipment include; Force Reduction, Mass Addition, Tuning, Isolation, and Damping. a paper [1] briefly introduced each method, and described practical methods for their application. Several scenarios and case studies were presented, with emphasis on pragmatic solutions to industrial vibration problems. In gearboxes, load fluctuations on the gearbox and gear defects are two major sources of vibration. Further, at times, measurement of vibration in the gearbox is not easy because of the inaccessibility in mounting the vibration transducers. For detecting different type of gear tooth faults an experimental data is taken from single stage gearbox set up with help of FFT analyzer. Vibration analysis techniques are used for detection of fault in gear system, fluctuation in gear load. A method for detecting the evolution of gear faults based on time- frequency analysis through MATLAB. The various types of defects can be created on gear tooth such as one corner defect, two corner defect, three corner defects, Missing tooth, inadequate lubrication, wear formation etc. By comparing Signals of defective condition with healthy (ok) condition through FFT analyzer in which, analysis is carried out with the signal to trace the sidebands of the high frequencies of vibration. The validation is done successfully by taking input signal from FFT analyzer to MATLAB program. It is for calculating effective statistical parameters in defective condition for time & frequency domain analysis. The actual position in angle of rotation for one tooth missing in gearbox is also investigated by using MATLAB program. It is also helpful tool for health monitoring of gears in different conditions [2]. All machines with moving part give rise to sound and vibration. Each machine has specific vibration signature related to construction of machine. In research paper [3] author has produced some brief review of current vibration techniques used for condition monitoring in gear transmission system. Vibration signature changes according to changes in state of machine. The vibration techniques were developed with two main purposes. The first purpose is to separate the gearbox related signal from other components and to minimize the noise that may mask the gearbox signal, especially in the early stages of the fault. The second purpose is to identify the status of the gearbox, to distinguish the good and the faulty gear and to indicate the defective components. Examples of widely used techniques for gearbox are such as Waveform analysis, Time-Frequency analysis, Faster Fourier Transform (FFT), Spectral analysis, Order analysis, Time Synchronous Average, and probability density moments. These vibration based diagnosis techniques has been the most popular monitoring technique because of ease of measurement. The principle causes of gearbox failure are Error in Design, Application Error and Manufacturing Error Several researchers worked on the subject of gearbox defect detection and diagnosis through vibration analysis. Time domain, frequency domain, time frequency domain based on short time Fourier transform (STFT) and wavelet transform and advanced signal processing techniques have been implemented and tested.

In this research paper the vibration analysis of worm wheel gear box is done and find out solution for gear box vibration reduction.

2. EXPERIMENTAL SETUP

In order to carry out vibration analysis of gear box, FFT analyzer is used. Block diagrams of these two experimental setups are as shown in figure. Experimental setup consists of single phase DC motor, single stage worm and worm wheel gear box, data acquisition system (PC,dewsoftX). DwesoftX software is used to analyze the signals. It is easy to take any measurement with DweSoftX. The measurements can be automated from several devices and data can be analyzed spontaneously with this software. Data acquisition card are used to acquire the current samples from the motor under load. After the manufacturing of gear box, fabrication is done to do assembly of experimental setup which consist of Oldham couplings, pulley shaft, key, hooks, motor, rope, bearing with pillow block cast mounting and weighing machine. Now to assemble these components together frame is prepared on when these components are assembled. Input of gearbox is coupled with motor through shaft and output is coupled with shaft and bearing with pillow block cast mounting is used to give support to output shaft.

Fig 1. Experimental setup

Motor specifications are Power-370W / 0.5HP, Speed-1425RPM, Voltage-220/230V, Phase- 1Ph, Frequency-50Hz, Current-4.2A. Gear box specifications are No of teeth on Worm Wheel= 21 No of Threads on Worm= 6, Module= 3 mm, PCD of Worm wheel= 63 mm. shaft and pulley dimensions are Shaft Diameter= 20mm Shaft Material= Mild steel (M.S), Pulley O.D= 137mm, Pulley Nominal Dia. = 90mm, Overall Width= 35mm, Centre of Groove to rear face= 17.5mm.

3. OBSERVATIONS

Vibration analysis is done at six load conditions along three mutually perpendicular directions. Each analysis is done for approximately 5 seconds. And the results are saved in Dewesoft software. The maximum magnitude of acceleration during analysis for each loading condition and direction are given in following section.

1. Load: 0kg Direction: Axial

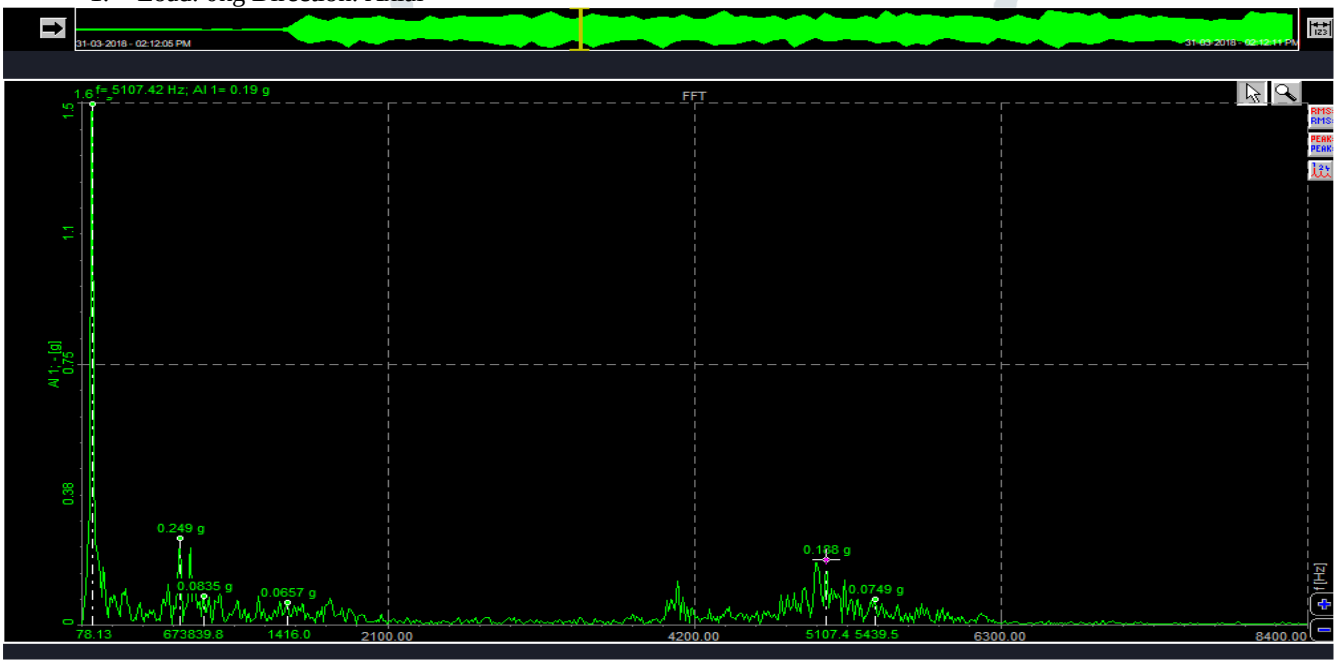

Fig.2 FFT graph for 0 kg load & in axial direction

Maximum deviation is in range of 00-2100Hz and maximum value of deviation is at 78.13Hz with value of 1.6g.

For Load: 0kg & Direction horizontal Maximum deviation is in range of 00-2100Hz and maximum value of deviation is at 78.53Hz with value of 1.55g.

Table 1Acceleration for various loads

Load	Direction	Acceleration value
0	Axial	1.6g
0	Horizontal	1.55g
0	Vertical	0.81g
0.48	Axial	2.04g
0.48	Horizontal	2.3g
0.48	Vertical	1.08g
1.55	Axial	1.08g
1.55	Horizontal	2.0g
1.55	Vertical	0.86g
2.565	Axial	1.58g
2.565	Horizontal	2.02g
2.565	Vertical	1.15g
3.315	Axial	1.67g
3.315	Horizontal	1.93g
3.315	Vertical	0.741g
5.6	Axial	1.4g
5.6	Horizontal	2.04g
5.6	Vertical	0.763g

4. VIBRATION REDUCTION

Mass Addition to gearbox reduces vibration drastically. As per Newton's 2nd Law which implies that if, the mass of a system is increased while the force input remains constant, acceleration (vibration response) will decrease. This approach to vibration control is especially useful for equipment that has inherent high vibrations or transient (impacting) forces, such as in present case of worm and worm wheel gearbox. Typically, the mass of the system is increased at the equipment foundation. Therefore, to successfully apply this method for vibration control, machines must be firmly connected to the foundation or increasing mass of casing. As in this case altering mass of casing is not economical. So, masses are applied externally to reduce vibration. As seen from observations vibration along horizontal direction are maximum when subjected to load of 0.48kg. So, masses are applied along horizontal direction at the same load condition. So, from above results it can be seen that maximum acceleration occurs at 0.48kg load condition along horizontal direction. So as to reduce vibration masses are applied along horizontal direction at the 0.48kg load condition. Masses used are 50g, 100g, 150g and the maximum acceleration results are as given below

Table 2Vibration reduction after applying mass

Sr.no	Mass Attached (Grams)	Maximum acceleration (g= 9.81ms^-2)	% reduction
1	50	1.81g	21.30%
2	100	1.55g	32.6%
3	150	1.5g	34.78%

5. CONCLUSION

The test setup for warm wheel gear box is manufactured and test for vibrations. Maximum acceleration occurs at 0.48kg load condition along horizontal direction. When masses are attached to gearbox to reduce vibration, a maximum acceleration value reduces significantly.

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