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Vibration analysis of worm and worm wheel gear box

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Abstract: *Gears are important element in a variety of industrial appliccations such as machine tool and gear boxes . An unexpected failure of gear may cause significant economic losses. For that reason fault diagonosis in gears has been the subject of intensive research vibration signal analysis has been widely used in the fault detction of rotaion machineary. The vibration signal of gear box carries the signature of the fault in gears and early fault detction of gear box is possible by analyzing the vibration signals using different signal processing techniques. Review is made of some current vibration analysis techniques used for condition monitoring in gear fault. Each unit of mechanical equipment has a different signature in the frequency spectrum. The vibration spectrum shows the areas of stress and undue energy. Vibration measurements trend changes at different locations along the units to predict the problems. The key benefits include:- Monitoring equipment life, increasing equipment uptime, managing and scheduling maintainace work. Vibration analysis can determine missallignment unbalanced, mechanical losses, eccentric shafts, gear wear, broken teeth & bearing wear.*

Keyword: *gear boxes,gearing*

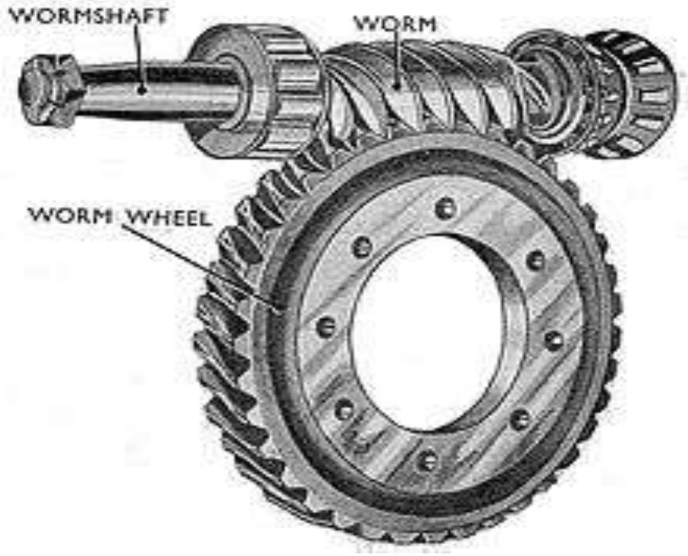
I. INTRODUCTION

The monitoring of a gearbox condition is a vital activity because of its importance in power transmission in any industry. Therefore, to improve upon the monitoring techniques and analysis tools for finding the gear ratios, gear faults, shaft misalignments in the gearbox and the current passing through the motor running the gearbox, there has been a constant improvement in these monitoring techniques. Techniques such as wear and debris analysis, vibration monitoring and acoustic emissions require accessibility to the gearbox either to collect samples or to mount the transducers on or near the gearbox.

But dusty environment, background noise, structural vibration etc. may hamper the quality and efficiency of these techniques. Hence, there is a need to monitor the gearbox away from its actual location, which can be achieved through Motor current signature analysis (MCSA) which has already been successfully applied to condition monitoring of induction motor. Gearbox is an important machinery component in any industry.

II. PROBLEM STATEMENT

All machines with moving parts give rise to sound and vibration. Each machine has a specific vibration signature related to the construction and the state of the machine. If the state of the machine changes the vibration signature will also change. A change in the vibration signature can be used to detect incipient defects before they become critical. Nowadays the demands for condition monitoring and vibration analysis are no more limited trying to minimize the consequences of machine failures, but to utilize existing resources more effectively.



Worm & worm wheel

III. OBJECTIVE

1. To Understand the worm Gear Design and its Manufacturing process
2. To diagnosis the vibration and fault detection in the worm gear box using FFT analyzer.
3. To Evaluate the performance of worm gear box.

IV. LITERATURE REVIEW

Neelam Mehala, Ratna Dahiya "Motor Current Signature Analysis and its Applications in Induction Motor Fault Diagnosis" [1] Motor Current Signature Analysis is an electric machinery monitoring technology. It provides a highly sensitive, selective, and cost-effective means for online monitoring of a wide variety of heavy industrial machinery. It has been used as a test method to improve the motor bearing wear assessment for inaccessible motors during plant operation. This technique can be fairly simple, or complicated, depending on the system available for data collection and evaluation. MCSA technology can be used in conjunction with other technologies, such as motor circuit analysis, in order to provide a complete overview of the motor circuit. The result of using MCSA as part of motor diagnostics program is a complete view of motor system health.

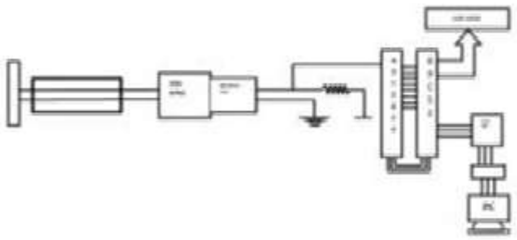
Enayet B. Halim, Sirish L. Shah, Ming J. Zuo and M. A. A. Shoukat Choudhury "Fault Detection of Gearbox from Vibration Signals using Time-Frequency Domain Averaging" [2] A new technique has been proposed that combines wavelet and time domain averaging to analyze a time series and performs averaging in the time-frequency domain. The strength of the technique lies in the way it preserves the frequency domain information while performing the average, and captures the deterministic part of the periodic signal for one period removing the stochastic part efficiently. Gearbox vibration signals are usually periodic and noisy. Time-frequency domain average technique successfully removes the noise from the signal **and captures the dynamics of one period of the signal. The presence of fault in any gear of the gearbox gives rise to a peak in the plot of the time-frequency domain average. Missing tooth produces** large peak and chipped tooth produces peaks with parallel side peaks at the meshing frequency. Simultaneous multiple faults in the gearbox can be identified by looking at the peaks of the plot of time frequency domain average.methods could offer good diagnostic information though successful diagnosis is very dependent on the diagnostic path taken by the investigator

Adam Do'cekal, Marcel Kreidl, RadislavSm d "Rotating Machine Vibration Analysis using Group of Adaptive Models Evolution" [4] This paper is concerned with the application of the Group of Adaptive Models Evolution method to machine vibration analysis. The advantage of the proposed work is the automated selection of the frequencies which allow characterization of properties hence leading to process monitoring. The main aim was to detect vibrations produced by the analyzed part and distinguish them from other vibration sources. Arrangement of an experiment and subsequent application of group of adaptive models evolution enable to discover important frequencies directly from measured data. More precisely, usage of Group of Adaptive Models Evolution selects frequencies that match vibration of parts being impressed with the selected parameter which is supposed to mainly involve the analyzed component of the engine, therefore other knowledge about the solved problem is useful to utilize. The knowledge can be posed by theoretical estimation of frequencies characteristic for the analyzed part, e.g. tooth frequency for gear transmission or characteristic defect frequencies for bearings.

Group of Adaptive Models Evolution enables to obtain an overview of important frequencies or bands distribution in whole vibration spectrum compared with usage of Feature Selection methods, e.g. Branch-and-bound, Sequential forward selection etc. It poses an indispensable advantage of using Inductive Modeling methods for this purpose.

V. EXPERIMENTAL SETUP

In order to diagnosis the fault of gear box, motor current analysis method use. Block diagram of these the experimental setup as shown in figure. Experimental setup consists of single phase DC motor, single stage spur gear box, Resistance, data acquisition card, Pentium-4 computer with software Lab VIEW 2010. Lab VIEW 2010 software is used to analyze the signals. It is easy to take any measurement with NI Lab VIEW. 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. NI M Series high-speed multifunction data acquisition (DAQ) device can measure the signal with superior accuracy at fast sampling rates. This device has NI-MCal calibration technology for improved measurement accuracy and six DMA channels for high-speed data throughput. It has an onboard NI-PGIA2 amplifier designed for fast settling times at high scanning rates, ensuring 16-bit accuracy even when measuring all channels at maximum speeds. This device has a minimum of 16 analog inputs, 24 digital I/O lines, seven programmable input ranges, analog and digital triggering and two counter/timers. The PCI-6251 data of acquisition card which is used in experiment.



Experimental setup

Worm & worm wheel gear

VI MOTOR CURRENT SIGNATURE ANALYSIS

A Common approach for monitoring mechanical failures is vibration monitoring. Due to the nature of mechanical faults, their effect is most straightforward on the vibrations of the affected component. Since vibrations lead to acoustic noise, noise monitoring is also a possible approach. However, these methods are expensive since they require costly additional transducers. Their use only makes sense in case of large machines or highly critical applications. A cost effective alternative is stator current based monitoring since a current measurement is easy to implement. Moreover, current measurements are already available in many drives for control or protection purposes. However, the effects of mechanical failures on the motor stator current are complex to analyze. Therefore, stator current based monitoring is undoubtedly more difficult than vibration monitoring. Another advantage of current based monitoring over vibration analysis is the limited number of necessary sensors. An electrical drive can be a complex and extended mechanical systems. For complete monitoring, a large number of vibration transducers must be placed on the different system components that are likely to fail e.g. bearings, gearboxes, stator frame, and load. However, a severe mechanical problem in any component influences necessarily the electric machine through load torque and shaft speed. This signifies that the motor can be considered as a type of intermediate transducer where various fault effects converge together. A literature survey showed a lack of analytical models that account for the mechanical fault effect on the stator current. Most authors simply give expressions of additional frequencies but no precise stator current signal model. In various works, numerical machine models accounting for the fault are used. However, they do not provide analytical stator current expressions which are important for the choice of suitable signal analysis and detection strategies. These methods require stationary signals i.e. they are inappropriate when frequencies vary with respect to time such as during speed transients. Advanced methods for non-stationary signal analysis are required.

VI. RESEARCHE GAP

Main advantage of worm and worm wheel gear box is Reduction ratio and for that application this gear box is used. But for application of vibration analysis mostly spur and helical gear box is used hence there is research gap for worm and worm wheel gear box to vibration analysis techniques.

VII. Conclusion

The aim of this research is to advance the field of condition monitoring and fault diagnosis in gear box operating under different load conditions. The common type of faults in gear box are studied in this project.

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