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RESEARCH ARTICLE

INVESTIGATION AND ANALYSIS OF ACCELERATION AND FREQUENCY OF VARIOUS ELECTRICAL MOTORS USING LAB VIEW SIGNAL EXPRESS 2012

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ABSTRACT

A variety of analysis is available to highlight the concept of predictive maintenance in industries. Vibration analysis is one of them. It is usually carried out to support the “health” of the machine for the period of persistent process. In this paper, the faulty signals of the Machines were carried out using Lab VIEW Signal Express 2012. The Accelerations and frequencies of two motors were measured. The techniques of vibration analysis, i.e. Acceleration and frequency measurement were investigated to detect both healthy and fault related signals of rotating machineries.

INTRODUCTION

Vibration monitoring of electrical machines is one of the invigorating mission for Researchers in essence of industrialized units. There are copious condition monitoring techniques including Vibration monitoring, thermal monitoring, chemical monitoring and acoustic emission monitoring (Vas, 1993). Vibration monitoring is carried out to hold up in the evaluation of the well-being of the machine all the way through nonstop process. It has been exposed more than a few times over that the vibration signature of a functioning machine be accountable for supplementary information about the inside mechanisms of the machine than any other kind of non-destructive test. A bearing that has a slight rising defect will grounds a telltale change in the machine vibration, as will an imbalance condition, a misalignment, or any of an incalculable of other faults. Vibration analysis, precisely applied, permits the technician to recognize insignificant up-and-coming mechanical flaws comprehensive before they become a risk to the reliability of the machine, and thus delivers the necessary lead-time to datebook maintenance to ensemble the necessities of the plant management.

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In this way, plant management has governed over the machines, comparatively than the other way everywhere. Vibration measurement and analysis is the groundwork of Predictive Maintenance, which stances in penetrating inequality to the antique "run-to-failure" type of maintenance practice. Abundant studies, such as those accompanied by the Electric Power Research Institute (EPRI), have accessible that on customary, the cost to industry for maintenance will be reduced by more than 50% if a predictive maintenance enclose is used as a substitute for of run-to-failure (Khan, 2011). The practice of vibration examination as one of the main tackles for condition monitoring has been developed widely over an era of just about 35 years. With the matching expansions in electronic equipment, transducers, computers and software at present machine supervision is almost completely programmed. From 1960 to the mid-1970s straightforward tangible approaches were used, along with careful protector on the machine‘s performance, repeatedly shatterproof by persistent maintenance. Elementary tools were sporadically used to quota and trace the values on which letdown revealing and clinched maintenance verdicts were based. Despite the fact that just about digital tools were easy to get all through the early 1970s, significant expansions took place for the period of the late 1970s and the early 1980s due to the ease of access of new microprocessors (Hartog, 1985). Circuits could be emaciated, plummeting the proportions and weight of apparatuses and permissible data to be fingered at high speeds.

Onboard microprocessors gave instruments the capability to seizure data, examine it via suitable algorithms, then stock and display the information. A very substantial feature of frequency analysis was effective computation of the FFT (Fast-Fourier-Transformation) of multi-channel measurements within seconds correspondingly minutes and the capability to store data for further conclusions. Long-term data storage became a putative practice. From the mid-1980s forward the expansions have been related with the desktop computer, its interfaced apparatus and software, which permit the entire process and the real machine condition to be examined automatically, giving a comprehensive provision for measurement, analysis and problem diagnosis trailed by action or maintenance approaches. The 1990s are considered by lessening the instrumentation and the data acquisitions and data process units. Sensors systems are joined with electronic data pre-processing and multi-sensor agreement allow not only accentuating on single machine mechanisms, the entire plant with the connections and enslavements of all procedures become translucent. Though vibration analysis was used previous essentially to govern faults and perilous operation circumstances. At the present time the anxieties for condition monitoring and vibration analysis are no more inadequate annoying to curtail the penalties of machine failures, but to exploit current resources more efficiently. To stare at an electrical signal, we use an oscilloscope to realize how the signal varies with time. This is very significant information; yet, it does not provide us the full image. To, fully recognize the performance of a scheme or device; we also want to investigate the signal in the frequency domain. This is a graphical illustration of the signal's amplitude as a function of frequency. The spectrum analyzer is to the frequency domain as the oscilloscope is to the time domain. The amplitude of the frequency at the machines running rpm and its different harmonics is patterned. Any amplitude beyond a threshold value clues toward a particular fault. The diagnosis of fault before a major break takes place is the aim of preventive maintenance. In addition to frequency domain analysis, the spectrum analyzer has the capability to accomplish time domain analysis by the statistical time values and their tendency of settings and, spectrum analysis to enumerate periodical information of spectral data (Neha Gupta and Pahuja, 2012).

Literature review

All electrical machines produce noise and vibration, and the analysis of the generated noise and vibration can be used to give statistics on the condition of machine. Even very minor amplitude of vibration of machine frame can generate high noise. The vibration of electrical machines is consummated through the use of broad-band, narrow-band or signature analysis of the calculated vibration energy of the machine. Monitoring of Vibration based judgement is the best technique for fault diagnoses. A signal analysis technique based on the Hilbert-Huang Transform (HHT) is deliberated in (Yan and Gao, 2006) for machine health monitoring. The analytical circumstantial of the HHT is introduced, based on a synthetic analytic signal, and its efficiency is experimentally assessed using vibration signals measured on a test bearing as shown in figure 1. The consequences validate that HHT is matched for seizing momentary events in dynamic systems such as the transmission of structural faults in a rolling bearing, thus providing a practicable signal processing tool for machine health monitoring.

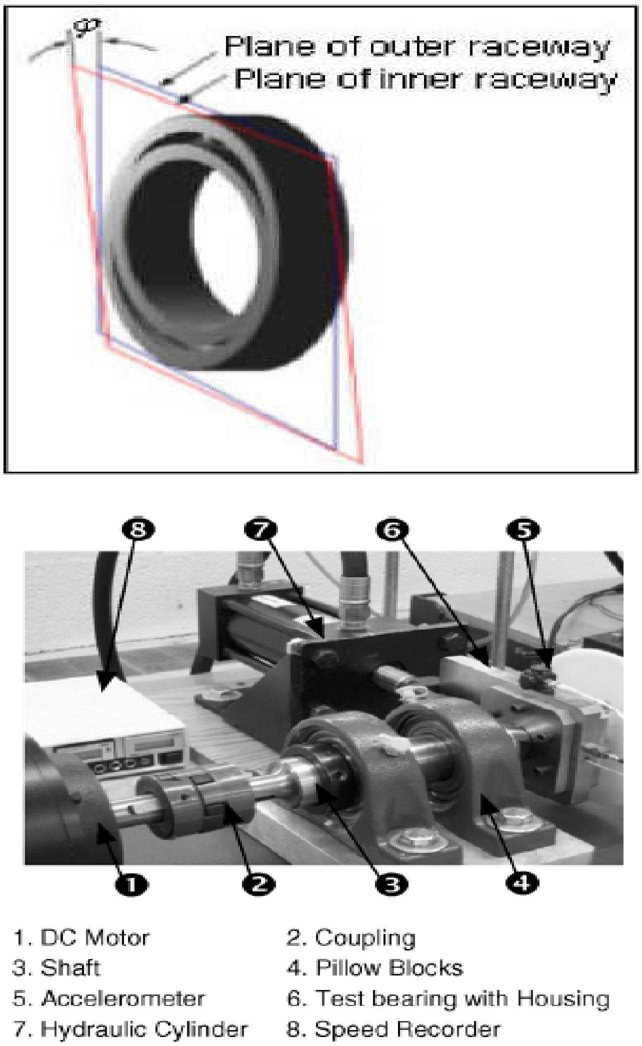

Figure 1. (a) Bearing Misalignment, (b) Expermental test bed of Bearings

Bearing misalignment instigated by the inner and outer raceways tumbling out of the same plane caused in periodic vibrations, which can be recognized from its spectrum as presented in figure 2 (a) & 2 (b).

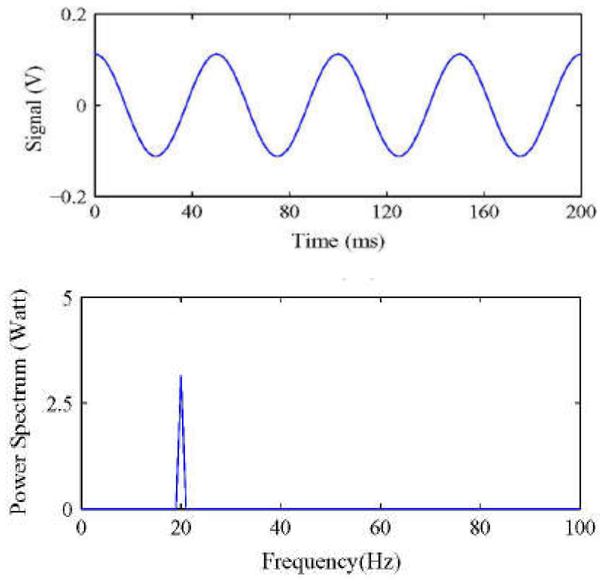

Figure 2. (a) Periodic vibration by Bearing mis alignment, (b) Power spectrum of misalignment

The IMFs of the two data fragments and resultant HHT identified frequency changes at the time instance of 45 ms during the first data segment and at 55 ms during the second data segment is shown in figure 3.

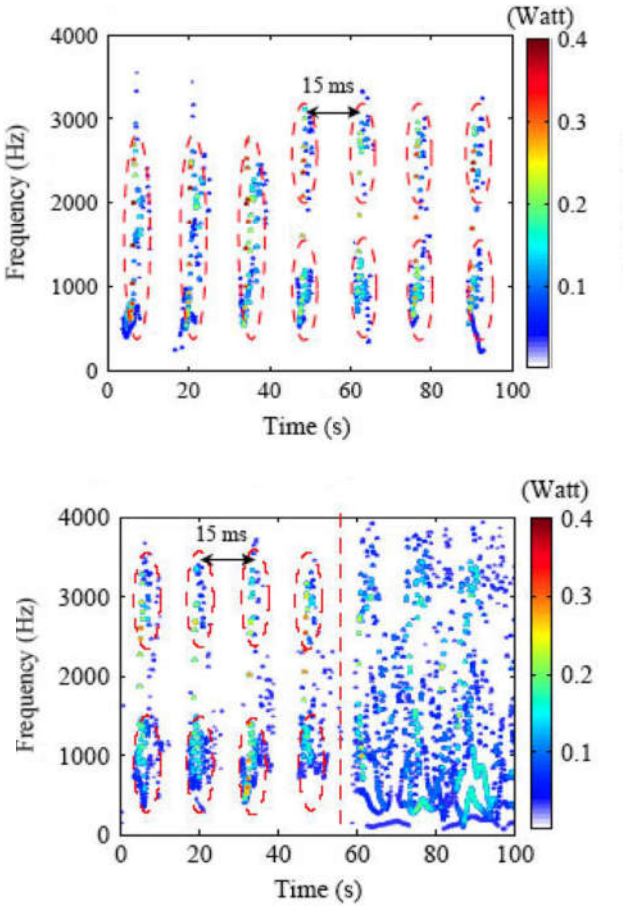

Figure 3. HHT of the two data parts (part left & part right)

Such frequency variations reflect squalor of the bearing health condition as the defect broadcasted through the bearing raceway. Substantially, impacts generated by the rolling ball-defect interfaces excite intrinsic modes of the bearing system, giving rise to a train of transient vibrations at the mode-related resonant frequencies. As the defect size rises, different intrinsic modes would be excited, resulting in the change of frequency components in the transient vibrations. In addition, these transients have shown a monotonous pattern with a 15-ms interval, which relates to a 67-Hz frequency constituent that is associated to a bearing misalignment.Thus, the HHT has shown to provide an operative tool for bearing health diagnosis.

MATERIALS AND METHODS

Data acquisition (DAQ) is the method of measuring an electrical or physical occurrence such as voltage, current, temperature, pressure, or sound with a computer. A DAQ system comprises of sensors, DAQ measurement hardware, and a computer with programmable software. Compared to conventional measurement systems, PC-based DAQ systems develop the processing power, productivity, display, and connectivity capabilities of industry-standard computers providing a supplementary powerful, flexible, and cost-effective measurement solution. The process flow diagram of DAQ system is shown in figure 4.

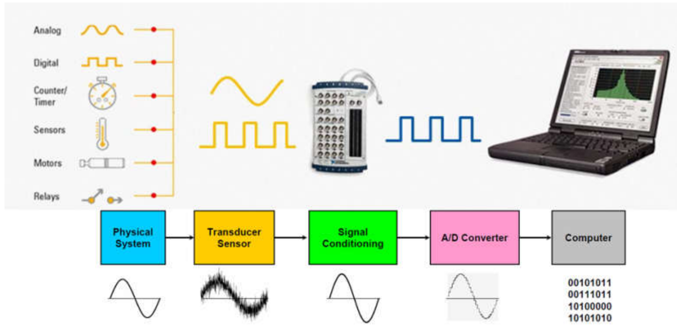

Figure 4. Process flow and Software and Hardware interfacing

An experimental setup was carried out for the purpose of measuring vibrations of electrical motors in an industry. The experimental setup consists of 3-Axis Accelerometer, a Data Acquisition Hardware (DAQ) and Laptop with LABVIEW Signal Express 2012. A comprehensive study to measure Vibrations of Electrical Motors was conducted in an industry. The experimental setup is shown in figure below. The Experiment was repeated for two different motors. The ADXL335 is a diminutive, thin, low power, inclusive 3-axis accelerometer with signal accustomed voltage outputs. The artifact measures acceleration with a bare minimum full-blown range of ±3 g. It can gauge the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration consequential from movement, shock, or vibration. The consumer selects the bandwidth of the accelerometer by means of the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be chosen to ensemble the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is existing in a small, low shape, 4 mm × 4 mm × 1.45 mm, 16-lead, synthetic lead casing chip scale package (LFCSP_LQ).

The USB‑6211 is a multifunction DAQ apparatus. It gives analog I/O, digital input, digital output, and two 32‑bit counters. The device offers an onboard amplifier premeditated for quick settling times at high scanning rates. It too features signal flow technology that provides you DMA-like two-directional high-speed streaming of data across USB. The apparatus is perfect for test, control, and design applications counting portable data logging, field monitoring, embedded OEM, in-vehicle data acquisition, and academic. The USB‑6211 descriptions a lightweight mechanical enclosure and is bus powered for simple portability. The included NI‑DAQmx driver and arrangement usefulness make simpler configuration and measurements. LabVIEW SignalExpress is an interactive measurement program you can employ to speedily attain, analyze, and present data from hundreds of data acquisition devices and instruments, with no programming required. Make use of LabVIEW SignalExpress to generate projects that acquire, analyze, create, generate, and display signals. You can obtain signals from hardware devices installed on your computer, analyze the signals, and then transmit the resultant signals to hardware devices. The steps you employ to generate projects depend on the LabVIEW SignalExpress assistants you have installed. You can employ LabVIEW SignalExpress steps that correspond with NI hardware devices, or you can import LabVIEW VIs to correspond with hardware devices. You also can employ a sweep procedure to frequently measure a signal with different parameter values.

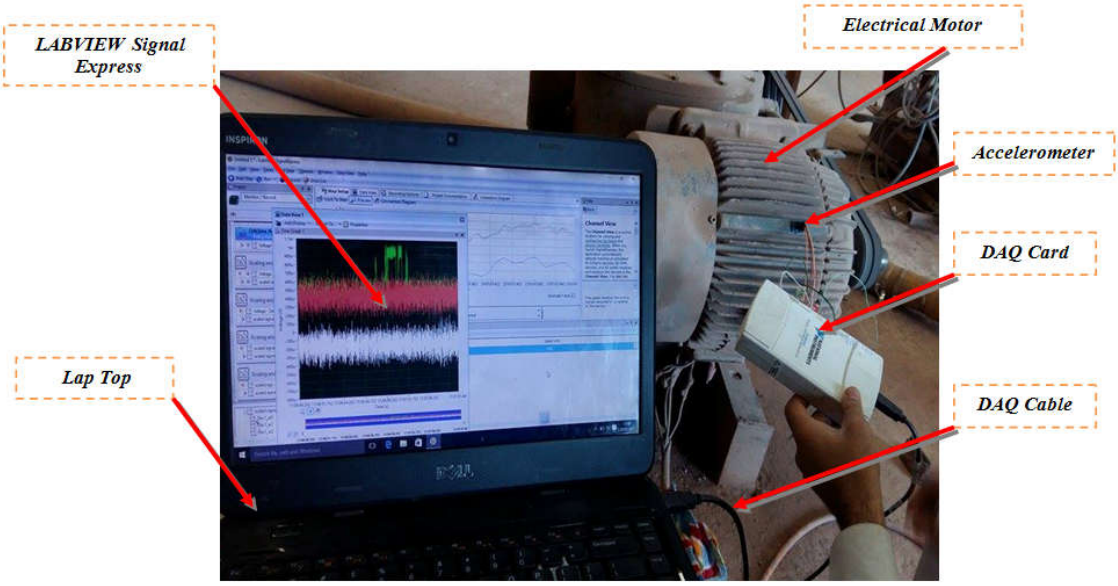

Figure 5. Experimental Setup for Measurement of Faulty Signals

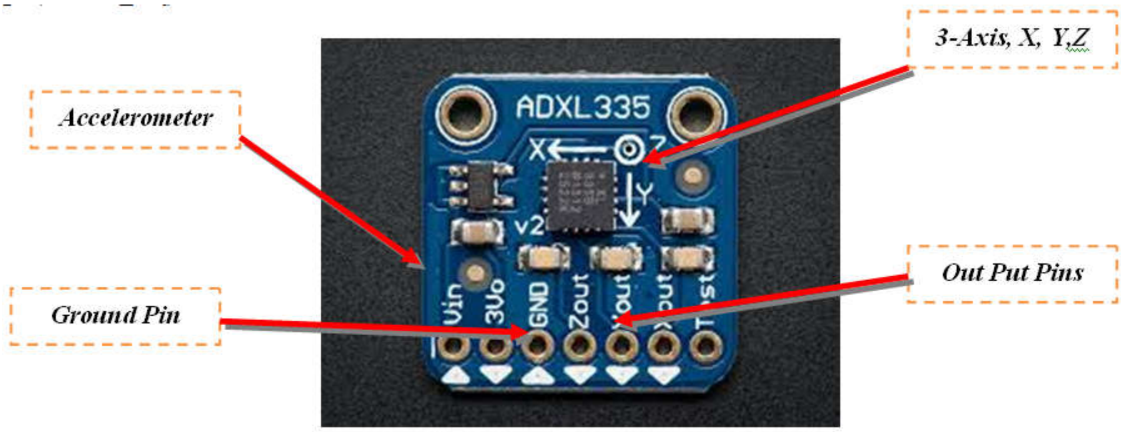

Figure 6. ADXL 345 Analog Accelerometer

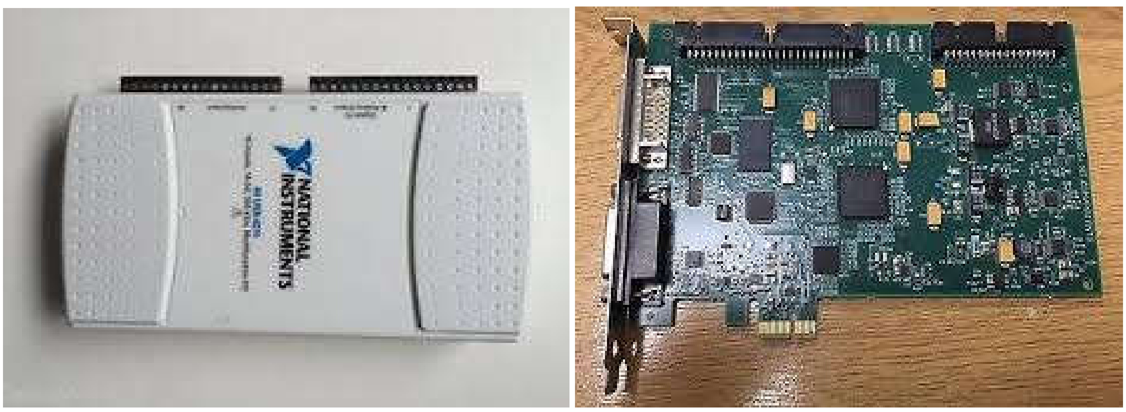

Figure 7. Data Acquisition Hardware (DAQ, NI USB-6211)

RESULTS

Various Electrical Motors were analyzed for vibration Analysis in terms of Accelerations and Frequencies. Plots were sketched by importing Data from LABVIEW Signal Express to Excel sheet. The Plots were then labelled. The detail of each plot is given below. Figure 9 shows the vibrations of electrical motors. These vibrations were measured in terms of Acceleration (g). The maximum and minimum Vibrations were monitored.

The maximum Acceleration of vibrations was recorded as 0.79 g. These vibrations range from 0-0.79 g. The vibration acceleration varied with time. At each interval of time the value changes. Such vibrations are encountered as random vibrations. Figure 10 illustrates a plot between Time and Acceleration. The Accelerations of Motor 2 were recorded using the same procedure as used for Motor 1. The Maximum Acceleration was recorded as 0.4 g.

Figure 8: LabVIEW SignalExpress 2012 Getting started Image

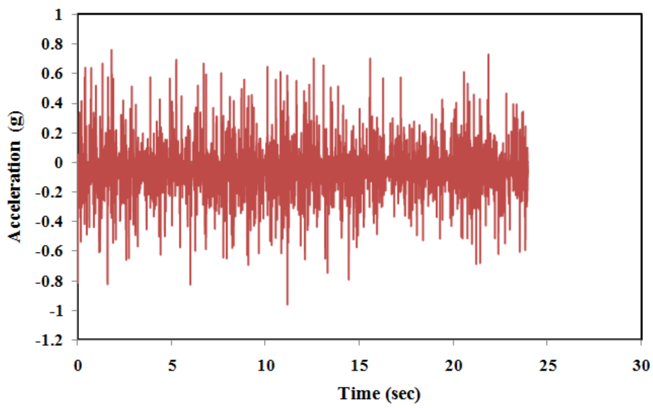

Figure 9. Acceleration Measurement of motor 1

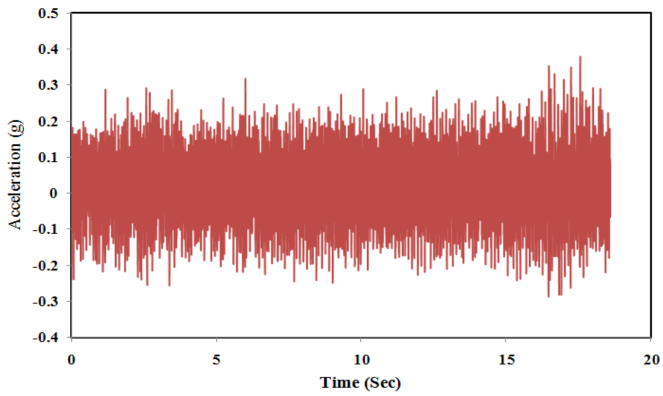

Figure 10: Acceleration Measurement of motor 2

Figure 8 demonstrates a plot between Frequency and power Spectrum for Motor 1. The Graph shows that Power spectrum is a function of frequency of vibrations. At 10 Hz frequency the power spectrum is 49 V^²/Hz rms. But as the frequency increases the power spectrum reduces frequently. This reduction in power spectrum is continues till the frequency reached 22 Hz. By further increasing the frequency from 22 to 30 Hz, the power spectrum increases. At 30 Hz the frequency become constant till the end of the readings. The peak value is 49 Hz for motor 1.

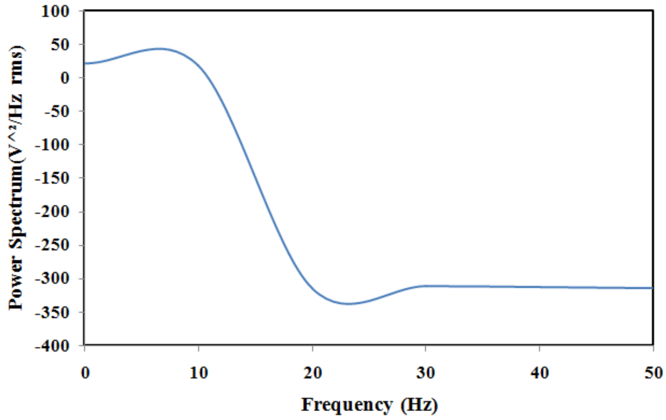

Figure 11. Frequency Measurement of motor 1

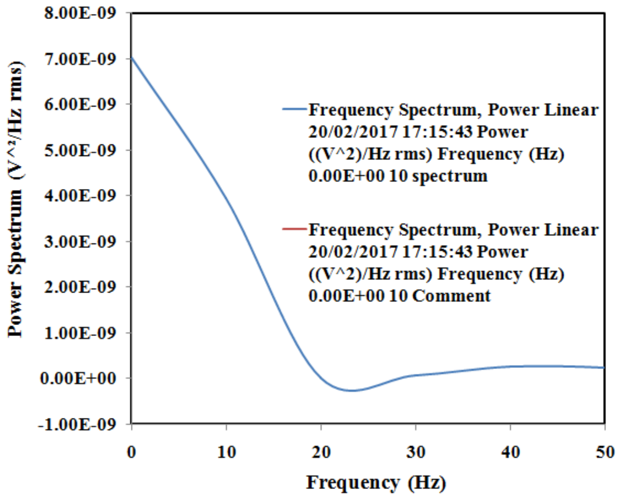

Figure 12: Frequency Measurement of motor 2

Figure 12 demonstrates a plot between Frequency and power Spectrum for Motor 2. The Graph shows that Power spectrum is a function of frequency of vibrations. As the frequency increases the power spectrum reduces frequently. This reduction in power spectrum is continues till the frequency reached 22 Hz. By further increasing the frequency from 22 to 30 Hz, the power spectrum increases. At 30 Hz the frequency become constant till the end of the readings.

Conclusion

A comprehensive study of the vibration monitoring of electrical rotating machines revels the ionic fact that Predictive maintenance is a very useful exercise in a manufacturing plant. The machine vibration signals both in Acceleration and frequency of various rotating systems were investigated. This perseverance was to know how signals are attained by taking the readings and recorded.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

REFRENCES

Amar, M., I. Gondal, and C. Wilson. Fuzzy logic inspired bearing fault-model membership estimation. in 2013 IEEE

Eighth International Conference on Intelligent Sensors, Sensor Networks and Information Processing. 2013.

Biswal, S., J.D. George, and G.R. Sabareesh, Fault Size Estimation Using Vibration Signatures in a Wind Turbine Test-rig. *Procedia Engineering*, 2016. 144: p. 305-311.

Desavale, R.G. and A.R. Mali, Detection of Damage of Rotor-bearing Systems Using Experimental Data Analysis. Procedia Engineering, 2016. 144: p. 195-201.

Dipti Agrawal, M.N.Y., Mr.Suresh Saini, Condition Monitoring of Slip-ring Induction Motor. *International Journal of Innovative Research in Advanced Engineering (IJIRAE),* 2015. 2 (March 2015)(3).

Ebersbach, S. and Z. Peng, Expert system development for vibration analysis in machine condition monitoring. Expert Systems with Applications, 2008. 34(1): p. 291-299.

Goyal, D. and B.S. Pabla, Development of non-contact structural health monitoring system for machine tools. *Journal of Applied Research and Technology,* 2016. 14(4): p. 245-258.

Hartog, J.P.D., Mechanical Vibrations. 1985: doverpublications.

He, Q. and W. Xiangxiang. Time-frequency manifold for demodulation with application to gearbox fault detection. in Proceedings of the IEEE 2012 Prognostics and System Health Management Conference (PHM-2012 Beijing). 2012.

Helwig, N., S. Klein, and A. Schütze, Identification and Quantification of Hydraulic System Faults Based on Multivariate Statistics Using Spectral Vibration Features. Procedia Engineering, 2015. 120: p. 1225-1228.

Huang, H., et al., Study on Dynamic Machining Performance of Machine Tool Based on BP Network. *Procedia Engineering,* 2011. 15: p. 5148-5152.

Khan, S., Simulation and Vibration Analysis of Electrical Machine. 2011.

Krishnakumari, A., et al., Application of Zhao-Atlas-Marks Transforms in Non-stationary Bearing Fault Diagnosis. *Procedia Engineering,* 2016. 144: p. 297-304.

Mjit, M., P.P.J. Beaujean, and D.J. Vendittis. Smart Vibration Monitoring System for an Ocean Turbine. in 2011 IEEE 13th International Symposium on High-Assurance Systems Engineering. 2011.

Mohamed, A.A., et al., Monitoring of Fatigue Crack Stages in a High Carbon Steel Rotating Shaft Using Vibration. *Procedia Engineering,* 2011. 10: p. 130-135.

Myhre, B., S. Petersen, and R. Ugarelli, Using Wireless Vibration Monitoring to Enable Condition-based Maintenance of Rotating Machinery in the Water and Wastewater Industries. *Procedia Engineering,* 2014. 89: p. 1397-1403.

Neha Gupta and S. Pahuja, vibration sensor for health monitoring of electrical machines in power station. *International Journal of Engineering Science and Technology,* 2012. 4(04 April 2012.).

Perrone, G. and A. Vallan, A Low-Cost Optical Sensor for Noncontact Vibration Measurements. IEEE Transactions on Instrumentation and Measurement, 2009. 58(5): p. 1650-1656.

Petersen, S., B. Myhre, and J. Røstum, Wireless Instrumentation for the Water and Wastewater Industry. *Procedia Engineering,* 2014. 70: p. 1314-1323.

Ribeiro, L.C., et al., Equipment for Predictive Maintenance in Hydrogenerators. AASRI Procedia, 2014. 7: p. 75-80.

Siddiqui, K.M., K.S., and V.K.G., A survey of Health Monitoring and Fault Diagnosis in Induction Motor. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering,* 2014. 3 (1, January 2014).

Vas, P., Parameter Estimation, Condition Monitoring, and Diagnosis of Electrical Machines. 1993, Clarendon Press Oxford. p. 378

Yan, R. and R.X. Gao, Hilbert–Huang Transform-Based Vibration Signal Analysis for Machine Health Monitoring. IEEE Transactions on Instrumentation and Measurement, 2006. 55(6): p. 2320-2329.

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