

Determination of Unbalance in Rotating Machine Using Vibration Signature Analysis

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ABSTRACT: Vibrations are found almost everywhere in rotating machines. Rotating machinery vibrates due to unbalances, misalignments and imperfect bearings. Vibrational analysis of rotating machinery is able to identify a large number of system ills. Shaft bow, shaft unbalance and coupling misalignments make up the major portion of the observed vibrational frequency spectra of rotating machinery. These vibrational spectra can be used to determine the type of rotating system abnormality. Unbalance is the most cause of machine vibration, an unbalanced rotor always cause more vibration and generates excessive force in the bearing area and reduces the life of the machine. In this paper, experimental studies were performed on a rotor to predict the unbalance in rotor. The vibration velocities were measured at five different speeds using FFT (Fast Fourier Transform) at initial condition. Based on vibration readings spectrum analysis and phase analysis was carried out to determine the cause of high vibrations. By observing the spectrum unbalance was identified. Then Rotor was balanced and found that vibrations were reduced. The experimental frequency spectra were obtained for both balanced and unbalanced condition under different unbalanced forces at different speed conditions. This paper aims at the implementation of condition based maintenance on rotating machine, by adopting Vibration spectrum analysis which is a predictive maintenance technology. It eliminates unnecessary opening of equipment with considerable savings in personnel resources.

Keyword: Vibration Signature Analysis, Vibration Spectrum Analysis, Unbalance, FFT

Nomenclature:

MINDE: Motor Non Drive End;

MDE: Motor Drive End;

PBE: Pillow Block End;

H: Horizontal;

V: Vertical

A: Axial

v: Velocity

I. INTRODUCTION

Rotor unbalance is the most common reason in machine vibrations. Most of the rotating machinery problem can be solved by using the rotor balancing and misalignment. A very small amount of unbalance may cause severe problem in high speed rotating machines. Overhung rotors are used in many engineering applications like pump, fans, propellers and turbo machinery. The vibration signature of the overhung rotor is totally different from the center hung rotors. The vibration caused by unbalance may destroy critical parts of the machine, such as bearings, seals, gears and couplings. In practice, rotors can never be perfectly balanced because of manufacturing errors such as porosity in casting, non-uniform density of material, manufacturing tolerances and gain or loss of material during operation [1] As a result of mass unbalance, a centrifugal force is generated and must be reacted against by bearing and support structures. A number of analytical methods have been applied to unbalance response such as the transfer method [2]. Further, the unbalance part of the rotor rotates at the same speed as the rotor and therefore the force caused by the unbalance is synchronous [3]. However all the above investigations resulted in fu numerical solutions of the unbalance responses of coupled two-shaft rotor-bearing system. On the other hand, Rao [4] suggested analytical closed-form expressions for the major and minor axis radii of the unbalance response orbit for one-shaft rotor-bearing system. Rao *et al.* [5] and Shiao *et al.* [6]. Vibration signatures are widely used as a useful tool for studying progressive machine mechanical malfunctions, and also form the baseline signature for further comparative monitoring to detect mechanical faults [7]. In this paper a general method is presented for obtaining the unbalance response orbit based on the experimental, where the shafts rotate at different speeds. Unbalance system of an overhung rotors are considered for unbalance study. Experiments were conducted for a single mass, at five different speeds and corresponding results are plotted. The rotor unbalance can be detected by spectral and phase analysis.

Description of the Experimental Setup: The Experimental apparatus is shown in photograph of Figure 2 and Figure 3. It consists of a 0.5 hp A.C. Induction motor 1440 rpm speed, a fixed type flange coupling and a single disk rotor. The rotor shaft is supported by single identical ball bearing (pillow block) and has a length of 1000 mm with a bearing span of 750 mm. The diameter of the rotor shaft is 16 mm. A disk of 220 mm in diameter and 6 mm in thickness is mounted on the rotor shaft at bearing end. The rotor shaft is driven by 0.5 hp A.C. motor. The speed of the motor is controlled by using VFD (Variable Frequency Drive) which is mainly used for A.C motors, to increase or decrease the speeds of the motor in the range of 500 to1440 rpm. The instrument used in experiment includes FFT which measures the vibration in terms of velocity at MINDE, MDE & PBE housing and gives the corresponding values.

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Principles of Vibration Analysis with Applications in Automotive Engineering Ronald L Huston, C Q Liu, 2011-01-10 This book written for practicing engineers designers researchers and students summarizes basic vibration theory and established methods for analyzing vibrations Principles of Vibration Analysis goes beyond most other texts on this subject as it integrates the advances of modern modal analysis experimental testing and numerical analysis with fundamental theory No other book brings all of these topics together under one cover The authors have compiled these topics compared them and provided experience with practical application This must have book is a comprehensive resource that the practitioner will reference time and again Vibration Analysis Rao V. Dukkipati, 2004 Discusses in a concise but thorough manner fundamental statement of the theory principles and methods of mechanical vibrations *Vibration Engineering and Technology of Machinery, Volume I* Rajiv Tiwari, Y. S. Ram Mohan, Ashish K. Darpe, V. Arun Kumar, Mayank Tiwari, 2023-12-12 This book presents the proceedings of the XVI International Conference on Vibration Engineering and Technology of Machinery VETOMAC 2021 It gathers the latest advances innovations and applications in the field of vibration and technology of machinery Topics include concepts and methods in dynamics dynamics of mechanical and structural systems dynamics and control condition monitoring machinery and structural dynamics rotor dynamics experimental techniques finite element model updating industrial case studies vibration control and energy harvesting and MEMS The contributions which were selected through a rigorous international peer review process share exciting ideas that will spur novel research directions and foster new multidisciplinary collaborations The book is useful for the researchers engineers and professionals working in the area of vibration engineering and technology of machinery *Vibration Analysis, Instruments, and Signal Processing* Jyoti Kumar Sinha, 2014-12-17 Provides Typical Abstract Representations of Different Steps for Analyzing Any Dynamic System Vibration and dynamics are common in everyday life and the use of vibration measurements tests and analyses is becoming standard for various applications Vibration Analysis Instruments and Signal Processing focuses on the basic understanding of vibrat *MSA-mechanical Signature Analysis* Simon G. Braun, 1983 **Mechanical Engineering for Sustainable Development** Amit Pal, 2025-03-25 The book covers four research areas 1 Thermal and Energy Engineering 2 Industrial Engineering and Management 3 Computational Design and Simulations and 4 Materials and Manufacturing Topics covered include robotics micro electro mechanical systems cryogenics composites and cellular and molecular biomechanics Keywords Green Hydrogen Economy Renewable Energy Systems Additive Manufacturing Lithium Ion Batteries Air Pollution Control Photothermal Material Electric Vehicle Cloud Computing Wastegate Turbocharger Machine Intelligence Shear Deformation Friction Stir Welding Biogas Production Green Combustion Condensed Catalogues of Mechanical Equipment, 1926 **Mechanics of Machinery** Clarence Walter Ham, Edward Jameson Crane, 1927 *Machinery and Production Engineering*, 1918 **Transactions of the American Institute of Electrical Engineers** American Institute of

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