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A Review Of Diagnosing Techniques And Fault Anlaysis In Induction Machines

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ABSTRACT

Induction motors are widely used in most of the industrial applications. Induction motor can be submitted to external and internal stresses, and degradation can occur in their electrical and mechanical parts.one of the major faults that may occur in induction motors is airgap eccentricity. It constitutes a major portion of the faults related to induction motors. Almost all mechanical faults lead to this condition, such as faulty bearings, shaft and coupling. Machine eccentricity is the condition of unequal airgap that exists between the stator and the rotor and cause other faults in motors. Furthermore, if these faults have not been diagnosed and prevented, the rotor may touch the stator and result in irreparable damage of machines or if the air gap between stator and rotor increases the torque and flux vary unevenly. Defects in such induction motors causes heavy losses and leads to poor productivity and high manufacturing cost. In order to avoid this, condition monitoring of motor is required both in off state online state. In this paper a survey has been made show the types of faults and various fault detection and diagnosis techniques that are proposed in various literatures in previous years.

Key words: induction motor, external and internal stresses, degradation, faults , Defects, heavy losses, condition monitoring

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I. INTRODUCTION

Rotating electrical machines play a very important role in the world's industrial life. Among them, the induction motors are most widely used because of their relative simplicity, robust construction, and low price. However, even if induction machines are known as reliable, they can be submitted to external and internal stresses, and degradation can occur in their electrical and mechanical parts. Because of natural aging processes and other factors in practical applications, induction motors are subject to various faults such as winding faults, unbalanced stator and rotor parameters, broken rotor bars, eccentricity and bearing faults.

Several fault identification method have been developed and been effectively applied to detect machine faults at different stages by using different machine variables, such as current, voltage, speed, efficiency, temperature and vibrations. Thus, for safety and economic considerations, it is essential to monitor the behaviour of motors of different sizes such as large and small.

II. CAUSE AND EFFECT DIAGRAM

The noises in the motor are caused by various factors which include man, machine, method, materials. The sub causes of these factors gives the exact root causes for the problem. it is generated by repeatedly questioning "WHY" on the causes. The possible causes for noises in motor are for bearing noise it may due to improper selection of bearings, improper lubrication in bearings, shaft bent, bearing deformation etc. the possible causes for rubbing noise is due to paper projections, stampings projection ,improper varnish and also due to dust present in it. causes for abnormal noise may be due to rotor struck, more air gap between stator and rotor, improper fitting of covers and other parts. Causes for noises by machines are improper maintenance, machine settings. causes for method are due to dimensional variations of components. Cause and effect are shown in diagram 1.

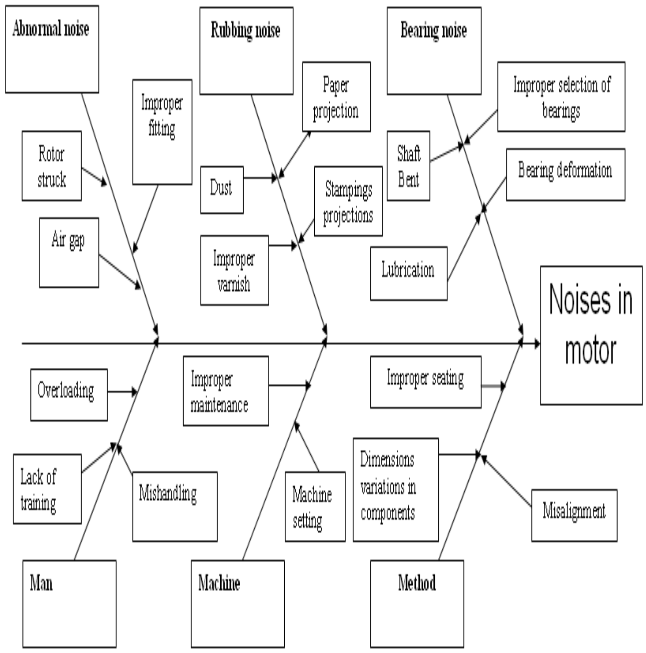

Fig1.Causes and Effect diagram

III. LITERATURE SURVEY

In this paper[1] author has used both vibration and motor current signature analysis are used to detect mechanical faults such as bearing faults and electrical faults occurring in the rotor and stator parts of an induction motor are identified by sensors. wavelet packet transform are used to extract the feature and it has been given to SVM to classify the fault.

A survey of the reliability of the squirrel cage IM on board drilling, production and other platforms offshore and petro-chemical industries, gas terminals and refineries onshore have been discussed[2]. The faults are sorted according to the nature of the supply and motor date, driving conditions, electrical protection, maintenance and so on. And the result of the survey is compared with a survey from the IEEE motor reliability working group. From the compared results it reveals various condition monitoring machinery and for detecting faults.

This paper has attempted to review fundamentals, main results, and practical applications of the MCSA used for induction motors faults detection[3]. The paper is focused on the motor current signature analysis which utilizes the results of spectral analysis of the stator current to detect and localize the abnormalities of electrical and mechanical that indicate or may lead to failure of induction motor. This paper investigates[4] diagnostic techniques for electrical machines classified as: 1) electrical faults; 2) mechanical faults; 3) signal processing for analysis and monitoring; and 4) artificial intelligence and decision-making techniques. In electrical drives, switching power converters are used to reduce the lifetime of the machine. The availability of digital processor and sensors used for the drive control paves the way for an integrated diagnostic procedure that should work at the system level as an intelligent protection and preventive maintenance.

The author revealed that Load variation is one of the major factors directly affecting the dynamic behaviours of eccentricity signatures as observed in the current spectrum of induction motors. Thus, [5]the change in the static and dynamic related fault signature amplitudes provides misleading information where the eccentricity degree and the load level exhibit similar effects in the current spectrum. In this paper, the time-stepping finite element method (TSFEM)-based, load-level-independent method is proposed to determine the static and dynamic eccentricities degrees individually.

In this paper[6], the author classified the major faults which occurring in the electrical motors and also stated about most prevalent fault. The symptoms and causes of the faults in the motor and the various fault detection techniques are have been discussed in this paper.

This paper, the influence of broken bars rotor in the indirect field oriented control of an induction machine is investigated[7]. A comparison of two regulators based on the classical and fuzzy PI is presented. Taking From the compared results, fuzzy logic PI seems to provide to replace conventional pi to improve the performances of this last and thus of vectorial control. Fuzzy logic pi is not sensitive to the variations of the parameters of the system, as with the external disturbances which justifies its robustness.

The contribution of this paper[8] is a novel methodology that is suitable for hardware implementation, which merges information entropy analysis with fuzzy logic inference to identify faults like bearing defects, unbalance, broken rotor bars, and combinations of faults by analyzing one phase of the induction motor steady-state current signal. The proposed methodology shows satisfactory results that prove its suitability for online detection of single and multiple combined faults in an automatic way through its hardware implementation in a field programmable gate array device.

This paper present an analytical model of axial air gap induction motors with solid rotors that includes the 2-d current distribution in the rotor. the model is quasi-three -dimensional and considers the circumference as well as radial and angular dimensions. By considering one can consider the various arrangements of the stator windings i.e., single layer, double layer and gramme for this type of motor. Hence Quasi 3D model is used in the circumference radial as well as angular dimensions considered by various arrangement of stator windings such as..... [9]This method is valid for both constant current and constant voltage sources. The results shows that produced torque with the high accuracy by proposed method.

[10] Induction machines are generally reliable but eventually do wear out. Faults and failures of induction machines can lead to excessive downtimes and generate large losses in terms of maintenance and lost revenues, and this motivates the examination of on-line condition monitoring. On-line condition monitoring involves taking measurements on a machine while it is operating in order to detect faults with the aim of reducing both unexpected failures and maintenance costs. This paper surveys the current trends in on-line fault detection and diagnosis of induction machines and identifies future research areas.

This paper presents[11] a non-parametric approach is used to detect the failure of a broken rotor bar for an inverter-fed induction motors (IM). We lay the mathematical foundation for the concept of a diagnostic model of a rotor bar fault is formed and the diagnostic model captures rotor bar high frequency (HF) characteristics which leads us to a conclusion that the HF equivalent motor resistance can be used as a direct indicator of broken rotor bars. The proposed detection technique is insensitive to other motor parameters and is effective under arbitrary load conditions. The time domain-based signature analysis enables the efficient detection and enhances fault isolation property.

[12]The proposed system diagnoses induction motors having four types of faults such as breakage of rotor bars and end rings, short circuit of stator windings, bearing cracks, and air-gap eccentricity. Although MCSA is one of the most powerful online methods for diagnosing motor faults, They are composed of an optimal-slip-estimation algorithm, a proper-sample-selection algorithm, and a frequency auto search algorithm for achieving MCSA efficiently. The proposed system is able to classify four kinds of motor faults and diagnose the fault status of an induction motor. Experimental results obtained on 3.7-kW and 30-kW three-phase squirrel-cage induction motors and voltage-source inverters with a vector control technique are discussed**.**

The author reported that condition-monitoring equipment, which improves the safety and reliability of the equipment. Early detection of abnormalities in the motors will help to reduce the fault number and associated repair costs. In this paper, [13]Computer aided Online Fault Diagnosis Technique which monitors the online condition of motor, diagnose faults, insulation condition, working temperature, possibilities of occurrence of short circuit faults. Sensing elements are embedded at various deterministic points in the motor, the analog o/p which is digitized, Converted to RS-232 Compatible Levels and interfaced with the PC. A special GUI is designed to enable the user to detect faults occurring inside the motor will helpful in making an analysis of the conditions of motor. Thus, the user can get to know about the motors performance and can take necessary steps to improve the life of the motor. This technique is best suited for motors above 10hp.

Accordingly, this work presents[14] a technique for the diagnosis of broken rotor bar in induction motor. Stator voltages and currents in an induction motor were measured and employed for computation of the input power of one stator phase. Waveforms of the instantaneous power were subsequently analysed using the Bartlett periodogram. The latter is calculated either with a rectangular window or a Hanning’s window. The evaluation of the global modulation index on the instantaneous power spectrum is used for fault detection. Several rotor cage faults of increasing severity were studied with various load effects.

This paper clearly states about the importance, benefits and contribution of Electric motor in the field of production and these motors are exposed to a variety of undesirable conditions and situations such as mal-operations[15]. The method proposed, allows analyzing the operating conditions of induction motors. Motor Current Signature Analysis (MCSA) is used particularly to detect loosening of broken rotor bars and end ring faults.

In addition, [16]this paper presents four case studies of induction motor fault diagnosis by using MCSA . Motor current signature analysis (MCSA) can effectively detect abnormal operating conditions in induction motor applications.

This paper presents a new signature for detection of rotor faults in induction motors and also proposed method is based on the variations of axial flux density in the presence of these faults[17]. A machine modelling based on permeance circuit under eccentricity fault and also by machine modelling based on coupled magnetic circuit theory under broken rotor bars fault produce the low frequency part of the magnetic field spectrum is particularly analyzed and Analytical relations which describe the machine operation under broken bars fault highlight the influence of speed variation to modify the low frequency components of the external magnetic field.

This paper[18] deals with the use of the signature analysis of the complex apparent power modulus as a new technique for the diagnostics of mixed air gap eccentricity condition in operating three-phase squirrel-cage induction motors. The winding function approach is considered for a modelling and simulation study concerning the occurrence of air gap eccentricity in three-phase induction motors is presented. Then, both simulation and experimental results are presented to illustrate the effectiveness of the proposed approach. A suitable fault-severity factor is also proposed as an indicator of the condition of the machine.

This paper[19] involves current signal frequency analysis for air gap eccentricity and bearing damage in induction motors. Magnetic flux density in the air gap is calculated to get effect of faults on current signal. Equation of characteristic frequencies for eccentricity is revised. In addition, a sudden eccentricity is simulated in short intervals to get effect of bearing damages to produce the new frequencies which are used to detected the bearing faults that is related with eccentricity.

In this paper[20], a new automated approach for testing inverter-fed induction machines for air gap eccentricity is proposed. The machine with a pulsating magnetic field is excite using inverter at multiple angular positions to observe the variation of equivalent impedance due to eccentricity, whenever the motor is stopped. Thus the increase in inductance under standstill excitation can be used as an indicator of increasing airgap eccentricity. Standstill testing is used to provide reliable assessment of eccentricity which has been independent of variations in operating conditions, load interferences, or motor type which verifies that eccentricity can be detected with high sensitivity and reliability without additional hardware.

In this paper, the author has proposed new method called SPRT are used for detecting eccentricity, which has not been reported before, is investigated[21]. The variation in the inductive component as a function of rotor position and time under static, dynamic, and mixed eccentricity conditions is analyzed. Thus the airgap eccentricity can be detected in addition to rotor cage problems with the SPRT.

The principles of a new technique using particle swarm algorithms for condition monitoring of the stator and rotor circuits of an induction machine is described in this paper[22]. Using terminal voltage and current data, the stochastic optimization technique is able to indicate the presence of a fault and provide information about the location and nature of the fault. The technique is demonstrated using experimental data from a laboratory machine with both stator and rotor winding faults.

In this work, author propose to use the air-gap torque to detect mechanical faults in particular the eccentricity and also reveals about consequences of the eccentricity[23]. Fault in the motor Fault detection methods current space vector (Park vector) and complex apparent power are compared. This signature is subsequently analysed using the classical fast Fourier transform (FFT).The proposed failure signature shows its effectiveness and its robustness in both electrical and mechanical fault detection. In order to obtain a more robust diagnosis, it is proposed a support vector machine (SVM) suitable to online identification of induction machine faults: broken rotor bar (electrical fault) and eccentricity fault (mechanical fault). The input patterns to train the SVM are obtained using experimental data related to healthy and faulty machines under several load rates. The inputs of the SVM are very important for successful fault detection. In this work, we extract only the air-gap torque spectral components magnitudes relative to the studied faults.

It is widely used to detect mechanical defects such as bearing failures or mechanical imbalance [24]. A piezo-electric transducer providing a voltage signal proportional to acceleration is often used. This acceleration signal can be integrated to give the velocity or position.

IV. RESULT

Induction machine failure[27] surveys have found the most common failure mechanism in induction machines these have been categorized according to the main components of a machine – stator related defects, rotor related defects, bearing related defects and other defects. The industry is facing loses due to its internal rejections. This project focuses on identifying root causes for each defect and their elimination. Data pertaining to all the defects are collected and Pareto analysis has been conducted for prioritizing the defects. Abnormal noise, rubbing noise, bearing noise has been found to be a major defect.

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