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CONDITION ASSESSMENT OF INDUCTION MOTOR BY PARKS VECTOR TO DETECT INTER TURN FAULT

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Abstarct: Through this seminar issue of on-line detection of short winding fault in three-phase induction motors is presented, and a technique, based on the computer-aided monitoring of the stator current Park's Vector, is proposed. The park's vector model is realized by employing Virtual instrumentation. The Virtual Instrumentation is acquired by programming in Matlab/Simulink software. Laboratory analysis was performed on a 3 hp three phase induction motor. The motor was originally evaluated under optimum circumstances and Park's vector model was sketched. Subsequently, the short winding fault is reproduced in the motor. The motor was scrutinized again under erroneous condition and Park's vector model was sketched. Both plots were then scrutinized. It is ascertained that current park's vector pattern of healthymotor was perfect circle meanwhile current park's vector pattern under faulty condition was elliptical in shape. Experimental conclusion, derived by employing a distinct fault producing test rig, illustrate the efficiency of the suggested modus operandi, for determining the presence of short winding fault in running three-phase induction machines

Keywords: *Induction motor, Stator winding inter-turn fault, Park's vector, Mat lab/Simulink*

I INTRODUCTION

According to the survey, 35-40 % of induction motor failures are related to the stator winding insulation. Moreover, it is generally believed that a large portion of stator winding related failures are initiated by insulation failures in several turns of a stator coil within one phase. This type of fault is referred as a "stator turn fault. The stator turn fault in a symmetrical three-phase AC machine causes a large circulating current to flow and subsequently generates excessive heat in the shorted turns. If the heat which is proportional to the square of the circulating current exceeds the limiting value the complete motor failure may occur Current Park's vector is an important electrical monitoring technique. The basic idea of current Park's vector is that in three-phase induction motors, the connection to stator windings usually does not use a neutral. For a Y-connection induction motor, the stator current has no zero-sequence component. A two-dimensional representation of the three-phase currents, referred to as current Park's vector, can then be regarded as a description of motor conditions

II PAST STUDIES

As the induction motors form the major work horse in most of the industries, fault detection of it is always indispensable, as far as the reliability of the system is concerned. Due to this, many of the researchers were attracted towards it and a lot of efforts were put to predict the performance of induction machines, using various modelling or simulation techniques and tools

With reference to [1] the condition assessment of transformer by Parks vector and symmetrical components to detect inter turn fault has been proposed. The subject of on-line detection of inter-turn short circuits in the stator windings of three-phase induction motors has been addressed by some researchers. Techniques such as those based on the spectral analysis of the motor current [2], frame vibration [4], or the axial leakage flux [3], [4], have been proposed.

MCSA focuses its efforts on the spectral analysis of the stator current and has been successfully applied to detect broken rotor bars, abnormal levels of air-gap eccentricity and shorted turns in stator windings [5] Motor Current Signature Analysis (MCSA) is based on current monitoring of induction motor therefore it is not very expensive. The MCSA uses the current spectrum of the machine for locating the fault frequencies

Reference to [6] stator inter turn fault detection based on monitoring of phase shift between the line currents and phase voltages are presented Phase shift analysis is used as an indicator of stator inter turn fault level A new method for the early detection of inter-turn faults in an induction motor is proposed in this paper[7] Stator current signal were acquired using hall-effect sensor which is further processed using Matlab software to obtain their wavelet coefficients which is further processed using Matlab software to obtain their wavelet coefficients for the detection of inter-turn fault Reference to [7-8] Computer-aided detection of air gap eccentricity in operating Three phase induction motors by Park's vector approach has been done It was observed that with the help of Park's vector approach qqualitative information about the severity of the fault can be easily obtained by observing the splitting of the current Park's Vector pattern

III PROBLEM DEFINITION

Hence aim of this dissertation work is analysis of inter turn failure of induction motor by using current park vector by simulation in Matlab/Simulink.The analysis of the three-phase induction motor can be simplified using the Park transformation. The method is based on the visualization of the motor current Park's vector representation. If this is a perfect circle the machine can be considered as healthy. If an elliptical pattern is observed for this representation, the machine is faulty. From the characteristics of the ellipse, the fault's type can be established. The ellipticity increases with the severity of the fault.

IV SCHEME OF IMPLEMENTATION

One of the difficulties met in the analysis of the behaviour of most rotating electric machines is that the inductances are function of the relative position of the rotor and stator.

In order to simplify the study of the electrical machines R.H. Park developed a transformation that made their analysis more straight forward by transforming the motor equations into a two-phased orthogonal reference frame The transformation of the three-phased system to the two-phased orthogonal one can be performed upon:

$$\begin{bmatrix} f_d \\ f_q \\ f_0 \end{bmatrix} = [P_{dq0}] \cdot \begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix}$$

Where f is the function to be transformed (it can be the current, voltage or magnetic flux)

$$|P_{dq0}| = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos(\theta) & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta - \frac{4\pi}{3}\right) \\ -\sin(\theta) & -\sin\left(\theta - \frac{2\pi}{3}\right) & -\sin\left(\theta - \frac{4\pi}{3}\right) \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} ($$

By using the above transformation the orthogonal components of the Park's current vector can be computed from the symmetrical three-phased current system, having the components: *ia, ib and ic:*

$$\boldsymbol{i_d} = \sqrt{\frac{2}{3}}[\ \boldsymbol{i_a} \cos \boldsymbol{\theta} + \boldsymbol{i_b} \cos(\boldsymbol{\theta} - \tfrac{2\pi}{3}) + \boldsymbol{i_c} \cos(\theta + \tfrac{2\pi}{3})]$$

$$\mathbf{i_q} = -\sqrt{\frac{2}{3}}\ [\ i_a \ \sin\theta \ + i_b \sin(\theta - \frac{2\pi}{3}) \ + i_c \sin(\theta + \frac{2\pi}{3})]$$

The above mathematical equations are programmed using Matlab /Simulink to get the parks vector Shape of parks vector will give idea regarding severity of inter turn fault When there is asymmetry due to stator faults, motor currents are also distorted Steady state stator current vector locus of a balanced healthy motor excited with balanced supply is a circle If the motor currents are distorted then the current vector locus is an ellipse with an eccentricity and inclination angle is based on the location and severity of fault

V LABORATORY SET UP

The experimental setup to analyze inter turn fault in induction motor will be as shown in Fig5.2 The system consists of induction motor, current transformers (3 no's) to sense the stator current signals, data acquisition card, Personnel Computer with Mat lab program

Three-phase squirrel cage induction machine with rated data 3 hp, 415V, can be employed to scrutinize the signals. The stator winding has been modified by addition of a number of tapings connected to the stator coils, for each of the three phases. The other end of these external wires is connected to an enlarged motor terminal box, allowing for the introduction of shorted turns at several locations in the stator winding.

The typical parks vector pattern for a healthy motor will be as shown in figure 5.1 The occurrence of inter turn fault leads to deformation of current parks vector leading to elliptic representation whose ellipticity increases with the severity of the fault When the motor is healthy ,the i_d-$i_q$waveform and the corresponding parks vector are generated Inter turn fault is simulated and the corresponding i_d-i_q waveform and the parks vector are generated The variation of ellipticity and shift in the major axis are being studied to find out severity and location of fault The experiment is repeated by shorting winding in each phase The corresponding current signals from current transformer are converted into digital signals by DAQ NI 6323 These digital signals are read by MATLAB software For each fault created corresponding parks vector,Id-Iq waveform and three phase currents are obtained These waveforms are being compared with the healthy waveform and severity of the fault are analyzed depending on ovality of the parks vector and also by observing the shift in the major axis of the ellipse the interturn fault in which phase it has occurred can be asertained

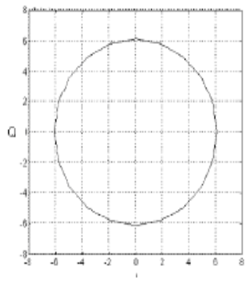

Fig5.1 Current parks vector for ideal condition

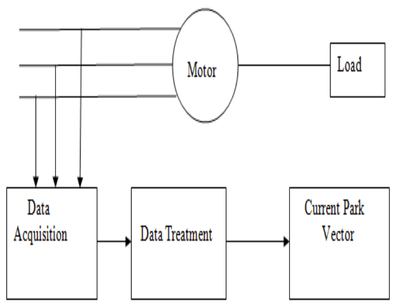

Fig 5.2 Block for Laboratory setup

VI CONCLUSION

This paper introduces a new approach based on computer aided monitoring of the motor current parks vector, for diagnosing the occurrence of inter turn short circuits in the stator windings of operating three phase induction machine

The online diagnosis is based on identifying the appearance of an elliptic pattern, corresponding to the motor current parks vector representation. The ellipticity increases with severity of the fault and whose major axis orientation is associated to the faulty phase Parks vector also simplifies the analysis and implementation on DSP as compared to other condition monitoring techniques available

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