Chapter 13

Recent Techniques to Identify the Stator Fault Diagnosis in Three Phase Induction Motor

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ABSTRACT

Induction motors have gained its popularity as most suitable industrial workhorse, due to its ruggedness and reliability. With the passage of time, these workhorses are susceptible to faults, some are incipient and some are major. Such fault can be catastrophic, if unattended and may develop serious problem that may lead to shut down the machine causing production and financial losses. To avoid such breakdown, an early stage prognosis can help in preparing the maintenance schedule, which will lead to improve its life span. Scientist and engineers worked with different scheme to diagnose the machine faults. In this paper, the authors diagnose the turn-to-turn faults condition of the stator through symmetrical component analysis. The results of the analysis also verified through Power Decomposition Technique (PDT) in Matlab /SIMULINK. The results are compatible with the published results for known faults.

1. INTRODUCTION

The Induction Motor, due to its ruggedness and simplicity in design is the most common electromechanical energy conversion device used as industrial drives. But these machines are prone to faults. The faults may be major like turn–to-turn fault or incipient which may ultimately lead to a major fault. To avoid the ultimate catastrophe of breakdown, the condition of the motor should be identified at an early stage. Since 80’s engineers and scientists worked together to identify the condition of the motor at an early stage by sensing the magnetic flux, stator current, rotor current, shaft leakage flux, ground fault current, vibration, temperature and speed. It has been found that electrical and magnetic parameters used in analyzing the machine condition are much more accurate and reliable than mechanical parameters.

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The electrical and magnetic sensor is inexpensive, reliable and can be installed easily. G.B.Kliman, W.J.Premerlani, R.A.Koegl and D.Hoeweler (1996) reported a method to determine the sequence component from the current phasor and explained the theory of the coupled circuit model to identify the turn to turn fault. M.Arkan and P.J.Unsworth (1999) reported a Power Decomposition technique that has been used to derive positive and negative sequence components of arbitrary three phase signals in the time domain, in order to detect the stator fault. Gojko M.Joksimovic and Jim Penman (2000) proposed an induction motor model to detect the stator inter turn short circuit and the dynamic model of motor by using winding function method. Zhongming ye, Binwu and Navid Zargari (2000) proposed an induction motor model to identify the mechanical faults and the dynamic model of motor by using winding function method. Stefano P.C. and Stank Vic (2003) proposed an induction motor model to analyze the sudden loss of balance in the supply voltage and the dynamic model of motor by using dynamic phasor. Burak Ozpineci, Leon M.tolbert (2003) proposed an induction motor model to analyze the open loop V/f and indirect vector control operation and the dynamic model of motor by using Krause model. Marius Marcu, Ilie Utu, Leon Pana, Maria Orban (2004) proposed an induction motor model to identify the electrical and mechanical parameters and the dynamic model of motor can be developed by using stator reference frame theory . Arafat Siddique, G.S.Yadava and Bhim Singh (2005) presented a comprehensive survey on the subject of condition monitoring of stator faults of induction motors. Ali M.Eltamaly, A.L.Alola and R.M.Hamouda (2006) proposed an induction motor model to identify the performance parameter and the induction motor model by reducing its equivalent circuit to be an R-L load. Ramtin Hadidi Iman Mazhari Ahad Kazemi (2007) used an induction motor model to analyze and simulate an induction motor with normal, star /delta and soft starter and in this paper, the diagnosis of the motor turn-to-turn fault is carried out using sequence component analysis of the stator current. The hardware circuits are developed as shown in figures 3, 4 and 5 to obtain the sequence component of the stator current. These sequence components are which validates the simulation model results. A new dynamic model of the induction machine is developed, considering stator and rotor turns (Ns, Nr). This model is used for simulation in Matalb/simulink to obtain the performance parameters i.e., current, speed and torque of the motor. Direct and Quadrature axis voltage and current parameters obtained from this simulation model is used to develop another dynamic model to identify the sequence component by applying power decomposition technique (PDT). The paper is organized as follows. Hardware implementation is dealt in Section 2. Simulink implementation and results are discussed in Section 3. Finally the paper concludes with Section 4.

2. HARDWARE IMPLEMENTATION

It is well known that stator internal faults create an unbalanced operating condition. The analysis of any unbalanced system is complicated and cumbersome. Fortescue proves that an unbalanced phasor can be resolved into a balanced phasors called symmetrical components of the original phasor. Several authors had applied this technique to analyze the system operation under unbalanced conditions. The principal merit of symmetrical component analysis is that a relatively complicated problem can be solved by developing no more than three balanced network for three phase unbalance system. Due to the faults in
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