Application of the Fourier and the Wavelet Transform for the Fault Detection in Induction Motors at the Startup Electromagnetic Torque

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Abstract — **In this paper, a method for the diagnosis of rotor bar failures for the induction machines has been presented. It based on the analysis of the stator current, using the Fourier transform and discrete wavelet transform (DWT) at the start-up electromagnetic torque. Using the simplified dynamic model of the squirrel cage induction motor taking account the broken rotor bars and the discrete wavelet transform (DWT) in order to extract the different harmonic components of the stator currents. The performance presented by using of the DWT: its ability to provide a local representation of the non stationary current signals for the healthy machine and with fault (two adjacent broken bars). The results are compared with those obtained using the Fourier transform.**

Keywords: **Broken rotor bars, fault diagnosis, startup electromagnetic torque, Spectrum Analysis, discrete wavelet transform (DWT).**

I. INTRODUCTION

INDUTION machines have provided industry with the ability to convert energy from electrical to mechanical form reliably and cost-effectively for over a hundred years. These machines provide the driving force to various equipment such as conveyors, fans and pumps and are necessary for numerous processes in production and manufacturing plants. They play a vital role in industry and subsequently maintain the economic engine of a country. Every effort should be made to preserve them in operating state and to avoid unwanted machine failure, which leads to unnecessary production downtime [1].

In order to preserve a high level of machine integrity, it is necessary to assess the condition of the machine. Many fault detection methods have been proposed, but their established techniques contain many aspects which can be improved.

The most popular methods of induction machine condition monitoring utilize the steady-state spectral components of the stator quantities. These stator spectral components can include voltage, current and power and are used to detect turn faults, broken rotor bars, bearing failures and air gap eccentricities.

Presently, many techniques that are based on steady-state analysis are being applied induction machines [1]-[2].

Diagnostic method to identify the above faults may involve several different types of fields of science and technology.

Several methods are applied to detect the faults in induction motors such as Fourier transform and Wavelet transform analysis.

The Fourier transform is an effective method and widely used in signal processing, the transformed signal may lose some time domain information. The limitation of Fourier transform in analysing non stationary signals lead to the introduction of time-frequency or time scale signal processing tools, assuming the independence of each frequency channel when the original signal is decomposed. This assumption may be considered as the limitation of this approach [3].

Wavelet transform is a method for time varying or non-stationary signal analysis, and a new description of spectral decomposition via the scaling concept. Wavelet theory provides a unified framework for a number of techniques, which have been developed for various signals processing application. One of its feature is multi-resolution signal analysis with a vigorous function of both time and frequency localization. This method is effective for stationary signal processing and non-stationary signal processing. Mallet's pyramidal algorithm based on convolutions with quadratic mirror filter is a fast method similar to FFT for signal decomposition of the original signal in an orthonormal wavelet basis or as a decomposition of the signal a set of independent frequency bands. The independence is due to the orthogonality of the wavelet function [3], [4].

In this context, the main aim of this paper is to present a new method based on stator-current analysis for online fault detection in induction machines, which would overcome the averaging problems of classical FFT. The solution based is analysis by wavelet decompositions. A comparison between the FFT and wavelet decomposition is selected for further implementation.

II. SPECTRUM ANALYSIS OF STATOR CURRENTS

The rotating magnetic field induces rotor voltages and currents at slip frequency and an effective three phase magnetic field is produced by these induced currents at slip frequency with regard to the rotor. Two different cases can be appeared:

- Symmetrical cage winding: only forward rotating field