851. Entropy-based fault detection approach for motor vibration signals under accelerated aging process

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Abstract. The purpose of this study is to analyze motor vibration signals due to the bearing fault, which is artificially generated by aging process. Vibration signal data recorded by the experimental setup has been conditioned by a high-pass filter (Butterworth type) to reach the regarding frequency components of the bearing failure. Spectral analysis has been applied to realize the degradation on the bearing and the power spectral density figures revealed that the magnitudes of frequency components between 1.5-4 kHz bandwidth increased after every aging cycle. Vibration signals were investigated statistically by examining four main statistical parameters: mean value, standard deviation, skewness and kurtosis. Evaluation of these parameters indicated that significant variance occurred on standard deviation. At this point Shannon entropy became an approach to analyze the variance on the standard deviation. The probability of the aging cycles has been defined as a function of standard deviation values for each aging cycle. Entropy definition, which is a function of probability, determines the uncertainty level on the data and it has been examined to identify the effect of the aging progress on the bearing by examining the transferred entropy amount between aging cycles.

Keywords: motor vibration signal, bearing fault, spectral analysis, statistical analysis, aging process, Shannon entropy.

1. Introduction

The usage of induction motors in recent decades increased evidently in various industries. The main reasons depend on the facts of easy structure and running facilities, low cost and maintenance efforts and high reliability. On the other hand, the performance goals in every industry started to force the enterprises to increase the productivity efficiency by minimum failure at these production lines, which means that every motor has to run without fault continuously. Therefore, this approach increased the importance of fault diagnosis tools and applications for induction motors significantly. According to the studies on this subject in [1-5], it is observed that the most significant motor faults are because of the mechanical effects. In particular, bearing faults take an important part (more than 40 % of all induction motor faults). Also many researchers concentrated on the development of fault diagnosis and condition monitoring techniques to detect incipient motor faults signals and overcome the unscheduled machine down-times because of motor faults.

There are many different approaches and techniques developed in recent decades, which are mainly based on three groups as "Signal-based", "Model-based" and "Data-based" condition monitoring and fault diagnosis techniques. Signal-based fault signature analysis is one of the most preferred techniques for condition monitoring and diagnosis and also to investigate the incipient fault signature of the motor. There are different types of signals that can be measured and analyzed from the actual motor which has been subjected in [1-5]. Mainly these are electrical measurements (current, power, flux), mechanical measurements (vibration, noise), temperature measurement, chemical measurements (gas analysis) and partial discharge detection.

Bearing faults generally causes static and dynamic eccentricities on the rolling elements, which lead to many negative effects on the performance of the motor. Primarily, mechanical vibration on the system occurs due to bearing faults and the level of the signal increases during