Mechanical Systems and Signal Processing 25 (2011) 360–372

Contents lists available at ScienceDirect

Mechanical Systems and Signal Processing

journal homepage: www.elsevier.com/locate/jnlabr/ymssp

Electrical motor current signal analysis using a modified bispectrum for fault diagnosis of downstream mechanical equipment

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ARTICLE INFO

Article history:
Received 7 December 2009
Received in revised form
6 July 2010
Accepted 10 July 2010
Available online 16 July 2010

Keywords:
Reciprocating compressor
Modified bispectrum
Kurtosis
Motor current signature analysis

ABSTRACT

This paper presents the use of the induction motor current to identify and quantify common faults within a two-stage reciprocating compressor based on bispectrum analysis. The theoretical basis is developed to understand the nonlinear characteristics of current signals when the motor undertakes a varying load under different faulty conditions. Although conventional bispectrum representation of current signal allows the inclusion of phase information and the elimination of Gaussian noise, it produces unstable results due to random phase variation of the sideband components in the current signal. A modified bispectrum based on the amplitude modulation feature of the current signal is then adopted to combine both lower sidebands and higher sidebands simultaneously and hence characterise the current signal more accurately. Based on this new bispectrum analysis a more effective diagnostic feature, namely normalised bispectral peak, is developed for fault classification. In association with the kurtosis value of the raw current signal, the bispectrum feature gives rise to reliable fault classification results. In particular, the low feature values can differentiate the belt looseness from the other fault cases and different degrees of discharge valve leakage and inter-cooler leakage can be separated easily using two linear classifiers. This work provides a novel approach to the analysis of stator current for the diagnosis of motor drive faults from downstream driving equipment.

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1. Introduction

Induction machine stator current signals have been used widely to determine the health of the induction machine since the early 1980s [1]. A limited amount of work has been undertaken in using the current signals to investigate the potential of using the induction machine as a means of assessing the condition of downstream driven equipment. In [2], it was shown that the influence of mechanical problems that result in rotor disturbances can be detected through the changes in the induction machine stator current. Further in [3], it was shown that the induction machine stator current can be used to detect the presence of load imbalance as well. In [4], a large-scale test involving the on-line monitoring of 120 induction machines in a coal preparation plant using supply parameters was presented. The outcomes were sufficiently promising to suggest that there are serious opportunities for the techniques to be exploited, especially using the effective negative sequence impedance. Further, it has been shown that the induction machine supply current can contain components

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doi:10.1016/j.ymssp.2010.07.004