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Early fault diagnosis of bearing and stator faults of the single-phase induction motor using acoustic signals

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Abstract:

An article describes an early fault diagnostic technique based on acoustic signals. The presented technique was used for a single-phase induction motor. The authors measured and analysed following states of the motor: healthy single-phase induction motor, single-phase induction motor with faulty bearing, single-phase induction motor with faulty bearing and shorted coils of auxiliary winding. A feature extraction method called MSAF-20-MULTIEXPANDED (Method of Selection of Amplitudes of Frequency - Multiexpanded) was discussed. The MSAF-20-MULTIEXPANDED was used to create feature vectors. The obtained vectors were classified by NN (Nearest Neighbour classifier), NM (Nearest Mean classifier) and GMM (Gaussian Mixture Models). The proposed technique can be used for diagnosis of the single-phase induction motors. It can be also used for other types of rotating electric motors.

Keywords: Fault diagnosis, acoustic signal, bearing, motor, classification

1. Introduction

Rotating electric motors are often used in industry, for example in oil refinery, pump oil, steel mill, mine, compressor [1]. Induction motors are widely used electric motors in industry. It is a motivation to analyse such machines. The single-phase induction motor (Fig. 1) is one of the types of induction motor. Diagnostics of rotating electric motors is a normal process of maintenance. A degradation of electric rotating motors depends on environment (heat, moisture) and operation time. Accidents, financial loss, unscheduled downtimes can be predicted based on an early diagnostics of motors. A fault state is a state, which causes adverse effects from the point of view of the correctness of its operation. The early fault state is the state, in which there are symptoms of characteristic phenomena of the fault state (scratches, short circuits, broken coils, broken bars).

In recent years monitoring of machines was developed by engineers [2-3] and companies (Siemens, Dreisilker etc.). Online monitoring of machines also allows for intelligent maintenance with the optimized use of maintenance resources. In the literature the following types of faults of motors were mentioned: stator faults (stator open phase faults, short circuits of windings (Fig. 2), increased resistance of connections), rotor faults (rotor open phase, short circuits of windings, broken bars, faulty ring of squirrel-cage, increased resistance of connections, shaft misalignment, faulty bearings - Fig. 3, 4, 5, rotor eccentricity, bent shaft).

Descriptions of diagnostic techniques of machines can be found in the recent literature [4-9]. Diagnostic techniques of bearings are also described [10-14]. The diagnostic techniques are based on various

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