Inverted Induction Motor and Test Stand

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Abstract:

This paper proposes the construction of an inverted induction motor (with the cage winding at the stator) and the test stand associated to readily monitor rotor parameters and reproduce defects with the intention of optimizing and comparing different techniques of simulation and fault detection.

In order to obtain the level of detail needed for these studies in the working parameters of the operation of a squirrel cage induction motor, full capacity for performing measurements in the rotor is advantageous. In addition, the experiences intended to detect incipient failure signs and threshold values for condition monitoring require a reconfigurable but still realistic machine, having an easy access and modifiable characteristics.

In this paper the practical details related to the construction of the inverted machine as well as the results of the preliminary tests carried out on this machine are exposed.

1. Introduction

Exhaustive monitoring on the rotor of a squirrel cage induction motor is desirable as the models that simulate its behaviour become more detailed and require additional data to be validated; these data often demand a substantial precision and cannot be extrapolated. In addition, as new diagnosis methods have been developed, the necessity of confronting them with reality and to compare them with the standard ones arises. For those diagnostic procedures, as described in [1,2], it is especially important to know their capacity of following the evolution of defects from their very first steps and their ability to forecast adequately the behaviour of the equipment, and thus their expected remaining lifetime.

Although tests carried out on commercial motors can provide some answers, previous works [3] have established the complications that this approach faces due to the intrinsic difficulties in replicate an exact state of failure or reproduce a natural evolution of the fault.

The paper will address both problems of evaluating new techniques of early fault recognition in induction motors, such as wavelet analysis, and providing data for detailed operational models by exhaustive measurements. For achieving these goals this paper proposes the design of a prototype of machine which allows an easy access to critical parts of the machine (as, for instance, the cage winding) and also an easy introduction of changes for simulating different kind of faults. The paper also describes the test bed used, the subsequent data storage and analysis system and the results of some tests which demonstrate the suitability of the prototype for the study of simulation and diagnostic approaches.

2. Design of the prototype of the inverted machine

Broken bar breakages are caused by a combination of thermal and mechanical loads in the rotor that damage preferment the joints between the aluminium bars and the rotor rings; therefore, to reproduce the process of degradation in the cage, the stator windings of a standard a 10 kW, 160L-size rotor winding induction motor has been substituted by 36 aluminium bars, those bars have been shorted at both ends by an aluminium ring, onto which they are screwed. This inverted disposition allows full access to the equivalent of the rotor cage winding in a commercial induction motor, which permits easier monitoring of the parameters of interest, including current and temperature [4]. Another advantage is constituted by the detachable configuration of the now static squirrel cage, which enables to perform modifications such as the insertion of damaged bars in order to artificially reproduce faults in various degrees and the recording of data in order to asses the viability of new techniques of analysis. This disposition, in addition, avoids high mechanical stress on the reconfigurable cage, a drawback identified in previous works [5].

3. Description of the Test Bed, Control and Data Acquisition System

The tested machine is a standard four poles wound stator induction motor, rated 10 kW and 400 V (star). The motor is directly coupled to an alternator which acts as a load. The overall control of the induction motor and the alternator is performed by a PLC which allows for testing any working cycle of the induction machine. Data acquisition is achieved by a Yokogawa DL-750 multichannel recorder.

The full paper will include the results of tests for the calculation of the main characteristics of the machine as well as test under faulty condition which demonstrate the capability of the developed machine for the study of techniques of fault diagnosis.

Fig. 1 – Stator of the inverted induction motor.

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