A REVIEW ON FAULT DIAGNOSIS OF INDUCTION MACHINES

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Abstract - Different alternatives to detect and diagnose faults in induction machines have been proposed and implemented in the last years. These new alternatives are characterised by an on-line and non-invasive feature, that is to say, the capacity to detect faults while the machine is working and the capacity to work sensorless. These characteristics, obtained by the new techniques, distinguish them from the traditional ones, which, in most cases, need that the machine which is being analysed is not working to do the diagnosis. The main purpose of this article is to revise the main alternatives in the detection of faults in induction machines and compare their contributions according to the information they require for the diagnosis, the number and relevance of the faults that can be detected, the speed to anticipate a fault and the accuracy in the diagnosis.

Keyword – Induction machines. Fault detection and diagnosis.

I. INTRODUCTION

Induction electric machines with squirrel cage are the most used in modern industry due to the low cost, strength, and economical maintenance. In this kind of machines, there are often electric and mechanic faults (Bonnet et al., 1988, 1992; Benbouzid, 2000). The most important ones can be found in bearings or shafts, winding stators and bar rotors. The first ones can lead, in many cases, to eccentricities in the rotor which have a relatively slow evolution. This, through an anticipated detection, helps to prevent irreversible damage not only in the machine but also in the production process of which they are set. Faults in winding stators consist in: contacts between wires and the motor frame, loops of the same coil, coils of the same phase or of different phases. Faults in winding stators can have a fast evolution so their detection is more difficult. However, through on-line diagnostic routines, it is possible to detect them at the beginning and, in that way, the complete wear and the warning of the winding can be prevented. Finally, faults in shorting bars of the rotors consist generally in breakings or fissures that can extend to neighbouring bars or damage winding stators when there are strains or the fault affects the ferromagnetic plates which form the core. These faults are slow and can be early detected.

In general, it can be confirmed that about 40% of the faults of this kind of machines corresponds to flaws in bearings, 30 or 40% to stator faults, 10% to faults in the rotors, and the remaining ones are a consequence of a great variety of other faults (Motor Reliability Working Group, 1985). These figures were set through the analysis of a group of machines which had a great variety of powers. Besides, in high power machines, rotor faults are the ones that occur most frequently and become the most relevant ones. Taking into account that motors of high power are precisely the ones that need special attention because of their high price, the faults in these rotors are extremely important.

II. TRADITIONAL TECHNIQUES TO DETECT FAULTS IN MACHINES.

Traditionally, techniques such as the measure of the tangent of the delta angle, the measure of the polarization index or the measure of the insulating strength with the use of a megohmmeter to establish dielectric features in the insulators of electric winding machines (Wiedenbrug, 2001). All of them are characterized by the capacity to submit the winding insulator to a voltage above the nominal.

In this way, fault currents can be measured and the dielectric capacity of the insulating material can be settled. The impulse testing has become commonly used recently (Wiedenbrug et al., 2003). It consists in the use of high tension pulses on the windings of a machine and the analysis of a transitory response. As a result, a fault in a winding stator can be found when there are differences among the responses of each coil or phase in the machine.

All these techniques are very effective and are capable of establishing the estate of the insulator and estimate its useful life. However, its use is quite limited because the diagnostic has to be done with the machine out-of-service.

With respect to fissures or cuts in bar rotors, the detection was done through the study of motor vibrations or observing fluctuations of low frequency in stator currents. In both cases, the fault must be found in an advanced estate to be seen ostensibly.

Bearing faults are generally detected by the study of vibrations. If an accelerometer is used, it is possible to control the intensity and frequency of vibrations in the motor. From this, the possible abnormal behaviors can be established (McCully and Landy, 1997).

III. METHODS OF ON-LINE FAULTS DETECTION

A. Obtaining the frequency spectrum of the stator current (MCAS)

The stator current in induction machines has generally got harmonics due to the fact that the disposition of the