CONTRIBUTION ON THE STUDY OF ROTOR CURRENTS DISTRIBUTION OF ASYNCHRONOUS THREE PHASE MOTOR WITH SYMMETRICAL AND ASYMMETRICAL CAGE

ABSTRACT

The modernization of technological process, the massive implementation of automatization, and a new generation of machines tools with numerical command in industry requires the use of electrical drives fast, accurate and high economic efficiency, in terms of functional behavior as close to the optimum.

In present, adjustable electric drives are made both DC and AC machines. Due to technical and economic advantages, asynchronous machine is currently used on a wide range of power and speed. Besides these advantages, the asynchronous machines have some disadvantages that cause some drawbacks to using asynchronous machines in electrical drives.

Such a disadvantage can be constituted by the presence of the upper harmonics in voltage and/or output current from static converter which fed the asynchronous machine. This harmonics lead to the appearance of a deforming regime, which affecting the proper function of the asynchronous machine.

Even if the asynchronous machines with rotor cage not requires special maintenance, the disadvantage of this machine can be referred on the occurrence of certain defects in mechanical and electrical part. These defects negatively affect the behavior of this machine in electrical drives.

The occurrence of defects in the asynchronous machine due to bars or end rings interruption, even if it has only 10 % of failures could have serious consequences in electrical drives. Prevent these types of defects is quite laborious, because you cannot have direct access to the bars or end rings current during machine operation. Most diagnosis procedures for rotor cage current are based on analysis of the harmonics spectrum of the stator current. Those procedures are noninvasive.

Given the above, the study distribution of currents in symmetrical or non-symmetrical cage by direct measurement of currents is an actual and perspective subject. By direct measurement knowing the exact values of currents that flowing through the cage can improve the design of asynchronous machines, and even may develop a method of diagnosis rotor of asynchronous machines.

In the first chapter is justified and fit the subject of thesis in current research, and is presented the structure and the objectives of the thesis.

The second chapter of thesis presents a synthesis of mathematical models and method used for diagnostic of asynchronous machines fault, with all the advantages and disadvantages of each other's.

In the third chapter is presented the mathematical model in dq reference for rotor cage asynchronous machine, in which highlights the advantages of this model for symmetrical machine case. When accurse a fault in machine this model shows his disadvantages. In the last part of chapter three is realized a simulation scheme in MatLab Simulink, for asynchronous machine in dq reference for two conclusive situations: on nominal load and for short-circuited regime. From this simulation we can observe the distribution of currents on the rotor cage bars. The used code program is presented on annex V.

The fourth chapter of thesis is developed the hybrid mathematical model in phases references for asynchronous machines with rotor cage, in witch was embedded the method of equivalent circuits. Due to this, the resulted mathematical model has the advantages of numerical analysis and advantages of equivalent circuits. The hybrid mathematical model is presented in program code, in annex V.

The five chapters of thesis present the experimental laboratory setup, realized for direct measurement of current form rotor cage bars. Here are given the results that validate the hybrid mathematical model (from chapter 4) for symmetrical and also for nonsymmetrical asynchronous machine with rotor cage.

The final chapter, six, of thesis presents the general conclusions and also the main contribution of the author in development of thesis topic. At the end of this chapter, are drawn the main direction in which the topic could be developed in the future.

Last part of thesis content five annexes, comprising matrix equations used for develop the mathematical models (for chapter 3 and 4), and the code program with some detailed explanations.

Starting from the proposed objective, over three years of the individual research program, they were study over 130 reference titles including books, scientific reports and scientific papers. From this titles, six titles belongs to the author, and another scientific paper with experimental result is accepted, camera ready, on the International Conference on Electrical Machines – Lausanne, 2016.

After the research in proposed topic, in this thesis we can mention original elements and contribution, so:

- Development of a bibliographic synthesis regarding fault diagnosis and methods for evaluating these faults on asynchronous machines.
- Development of a bibliographic study on equivalent circuit's method, this method was used for calculation of currents on rotor bars.
- Proposal and developing a hybrid mathematical model, starting from equivalent circuit's method, but also containing a combination of

magnetic and electric circuits. With help of this model, we can easily study the currents from rotor bars.

- Development and application of computing program for hybrid mathematical model in symmetric and non-symmetric regime for a real machine.
- Design and practical implementation of an experimental setup for asynchronous machine, with the possibility of direct measurement of currents in the cage bars. The experimental setup allows functioning both as symmetrical and asymmetrical in various regimes – bars interruptions. As outlined, in the bibliography was not found significant information regarding direct measurement of rotor bars currents.
- Development of a complete experimental study regarding the distribution of the currents in adjacent bars from a broken bar in rotor cage compared with symmetrical cage. This study can be useful in diagnosis, reliability and maintenance of asynchronous machines.
- Validation results obtained with elaborated hybrid mathematical model with the help of experimental results, obtained through direct measurements on the laboratory experimental setup.