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TRANSIENT ANALYSIS OF INDUCTION MOTOR USING DIFFERENT SIMULATION MODELS

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Introduction

Squirrel cage induction motors have wide range of applications in many industrial drive systems due to their simple construction, robust design and low operational costs. Their application becomes even wider as a result of implementation of voltage inverters providing very good speed-torque control characteristics. In this paper a dynamic behaviour of a squirrel cage induction motor type 2AZ 155-4, produced by Rade Koncar, is analysed. The motor has the following rated data: voltage (Δ/Y) 220/380 V, number of poles 2p=4, rated current 8,7/5 A, power factor cosφ=0,81, rated speed n_n=1410 rpm, frequency 50 Hz. The first simulation motor model, supplied from a symmetrical power supply, is developed in MATLAB/Simulink [1]. The following dynamic motor characteristics, such as: speed characteristic, electromagnetic torque characteristic and current were obtained from this model. Than the analysis is extended with a simulation model of the motor fed by a voltage inverter. In this case the motor transient speed, current and electromagnetic torque characteristics are obtained, for rated frequency as well as for frequencies lower and higher than the rated one. The results obtained from the simulation in MATLAB/Simulink are compared and verified with the results from the second simulation model developed in the software program PSIM. Distribution of magnetic flux density inside the motor cross section is gained by application of the Finite Elements Method (FEM) for all motor operation regimes.

Simulation models

Simulation of motor transient characteristics in SIMULINK is performed by building a simulation model based on d,q transformation. In Fig. 1 a block diagram of the simulation model is presented. This model is consisted of four main parts: power supply, transformation of three phase voltages into d,q system which rotates synchronously, motor model from which the motor speed and electromagnetic torque as output variables are obtained and finally transformation from d,q system into three phase system in order currents to be obtained.

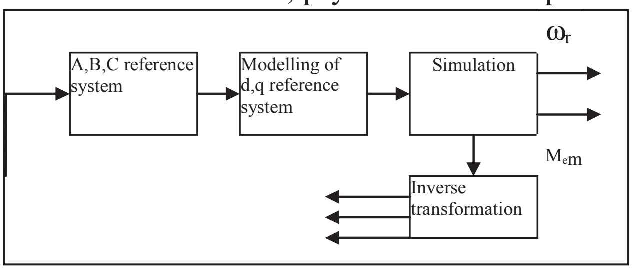


Fig.1 Block chart of Simulink motor model .

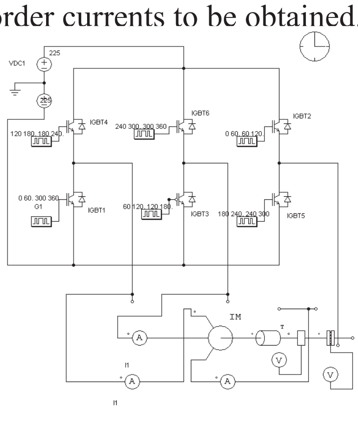
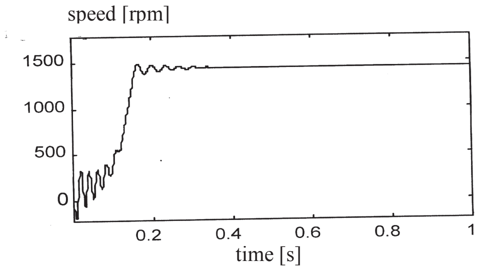
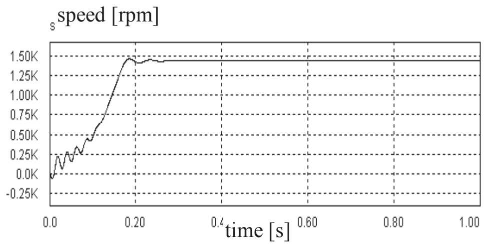


Fig.2 Simulation model in PSIM.

The simulation model of the motor with the voltage inverter in PSIM is presented in Fig. 2. As a first step in the analysis, the simulation models were developed for constant network supply. From the performed dynamic analysis in SIMULINK and PSIM, different transient motor characteristics were obtained for different operating regimes: no-load as well as rated load. In Fig. 3 the transient speed characteristics at rated load, in both simulation software programmes are presented.



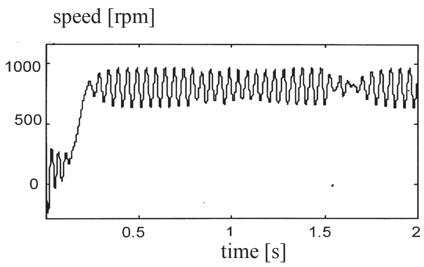
(a) Simulik model.



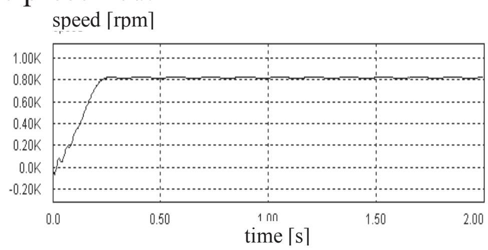
(b) PSIM model.

Fig. 3 Transient characteristics when the motor is supplied from a network, at f=50 HZ and rated load.

For speed regulation analysis a motor model supplied by a voltage inverter is used. In this analysis the motor is loaded by a constant load M_s=14 Nm, and the voltage/frequency ratio is kept constant. In Fig. 4 the transient characteristics of speed at rated load condition and when motor is fed by an inverter with frequency of 30 Hz are presented.



(a) Simulik model.

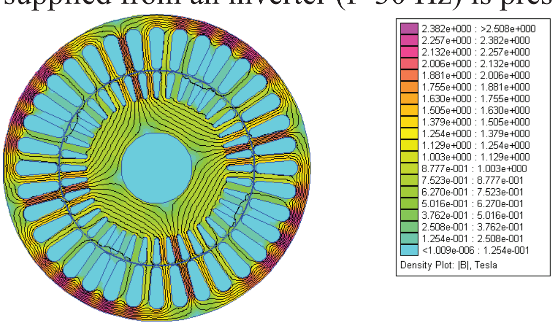


(b) PSIM model.

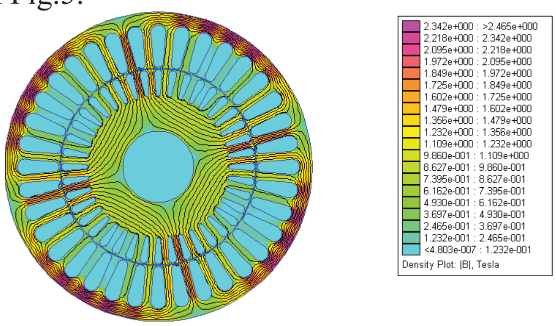
Fig. 4 Transient characteristics when the motor is supplied by voltage inverter, at f=30 HZ and rated load.

FEM models

FEM is widely used for electromagnetic field calculations in electrical machines, in general. Corresponding to the compound configuration of the motor, both in electrical and magnetic sense, and taking into consideration the particular meaning of the slip *s*, a motor model suitable for FEM application is developed. The magnetic flux distribution in the motor cross section for rated load when supplied from a power network (f=50 Hz), as well as when supplied from an inverter (f=30 Hz) is presented in Fig.5.



(a) f=50 Hz.



(b) f=30 Hz.

Fig.5 Magnetic flux distribution in the motor cross section at rated load.

References

[1] V.Sarac, G. Stefanov, "Numrical and Simulation Methods for Calculation of Dynamic Transient Characteristics of Squirrel Cage Induction Motor", International Virtual Journal of Science Technics and Innovations for Industry, ISSN 1313-0226, p.p.5-9, 6-2010, May 2010.