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Computer model of a synchronized asynchronous motor

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Abstract

A computer model of a synchronized asynchronous motor has been designed and divided into blocks. The computer model consists of units calculating magnetizing currents, stator and rotor current, the main electromagnetic flux and EMF of windings, electromagnetic torque of the rotor, the angular velocity, and the angle of the motor shaft rotation. The paper presents the results of the synchronization process transients as well as the dependences of the motor torque on the synchronization phase.

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*Keywords:*Synchronized asynchronous motor; computer model

1. Introduction

1.1. Objectives

Computer model of a three-phase asynchronous motor with wound rotor (here is ADFNEW) is used as a universal, complete tool to research and study the following electric drive systems:

- «asynchronous motor with wound rotor with the resistor in the rotor winding»;
- «synchronized asynchronous motor» (rotor phase is energized by DC voltage);
- «double fed motor» (rotor is energized by three-phase AC voltage);
- «wound-rotor slip recovery system» (rotor winding is connected to diode rectifier).

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1.2. Allowances

1. The windings of the stator and rotor are distributed on the grooves perfectly and they consist of several coil groups and create a spatial sinusoidal magnetizing force [1]. The sum of currents of the windings is zero while Y-connected. The phase resistance of the stator windings are equal. The rotor winding allows to connect any external resistors and voltages.
2. Slot ripples of magnetic flux during rotation of the rotor are not taken into account. It is considered that this problem is constructively solved through the bevel grooves on one tooth division and mutual selection of the number of grooves of the stator and rotor.
3. The inductance of the leakage flux of stator and rotor windings are assumed to be constant and independent on the saturation of main magnetic circuit.

2. What is new

- the model has combined form, the calculations of the variables are in 3-phase coordinate system stator and rotor windings [2] and in two-phase rotating system;
- the main equation for creating the model is based on the vector sum of the currents that are the components of the T-shaped equivalent circuit

$$\vec{I}_1 = \vec{I}_m + \vec{I}_2 + \vec{I}_C \ . \tag{1}$$

To use equation (1), it is necessary to know the projection of all vectors on a rotating coordinate system.

3. Block scheme

Block scheme of the computer model ADFNEW (Fig. 1) is developed in MATLAB program and is divided on blocks. Each block of the program in accordance with the purpose of the model carries out the certain computational operations, has input and output variables. These variables at the level of the scheme links blocks of the program in one computer model, and if the blocks related by variables of the same type (vector variable), the relationship between the blocks is shown in bold line. Thin lines shows single (scalar) variables. Each unit can perform logic, non-linear operations, the solution of the differential equations system, etc for input variables.

3.1 Stator and rotor currents calculation

The magnitude of the phase current of the stator I1i depends on the magnitude of the stator voltage U1i, the magnitude of the back EMF E1i induced in the winding and the stator winding parameters. It is considered that the three parameters of the stator windings are the same and phase current in the operator form in three-phase fixed coordinate system ABC can be calculated by the formulas

$$\left.\begin{aligned} &I_{1i}(p) = (U_{1i}(p) - E_{1i}(p) - U_{10})\frac{1/R_1}{1+T_1 p}, \\ &I_{1A}(p) + I_{1B}(p) + I_{1C}(p) = 0. \end{aligned}\right\} \tag{2}$$

where: I – the index of phases of the stator, takes the values A,B,C; T1=L1/R1 – electromagnetic time constant of the stator winding, sec; L1 – the inductance of the flux, H, U_{10} – offset voltage winding neutral to the network neutral, V.