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Evaluation of discrete modeling efficiency of asynchronous electric machines

Abstract. In the paper the problem of effective mathematical macromodels in the form of state variables intended for asynchronous motor transient analysis is considered. Their comparing with traditional mathematical models of asynchronous motors including models built into MATLAB/Simulink software was carried out and analysis of their efficiency was conducted.

Keywords: asynchronous motor, transient process, discrete macromodel

Creation of effective mathematical models intended for asynchronous motors transients analysis is an important and actual scientific problem [1].

Traditionally asynchronous motor can be considered as a system with are magnetically coupled windings which parameters expressed as active resistances and inductances. Therefore, the process typical for asynchronous motor are analyzed using equations of its electric and mechanical state [2].

In the paper the following approach for asynchronous motors analysis is proposed. In order to create the asynchronous motor model just external variables (available for measurements) which describe the analyzed object behavior will be used and internal processes will not be considered, so the modeled object is represented using the "black box" approach. For this purpose the discrete equations which can be used for computer analysis were written down in the following form using state variables:

$$(1)\qquad \begin{cases} \vec{x}^{(k+1)} = \mathbf{F}\cdot\vec{x}^{(k)} + \mathbf{G}\cdot\vec{v}^{(k)} + \Phi(\vec{x}^{(k)}, \vec{v}^{(k)}) \\ \vec{y}^{(k+1)} = \mathbf{C}\cdot\vec{x}^{(k+1)} + \mathbf{D}\cdot\vec{v}^{(k+1)} \end{cases}$$

where **F, G, C, D** are matrices of corresponding dimensions; $\vec{\Phi}$ is some vector-function of several variables, $\vec{x}^{(k)}, \vec{v}^{(k)}, \vec{y}^{(k)}$ are vectors of discrete internal, input and output variables respectively, *k* is time discrete number.

In order to create mathematical macromodel let us use root mean square values of currents and voltages, mechanical moment of rotor and angle speed of the motor to be analyzed. Three phase asynchronous motor with short circuited rotor is symmetrical relatively to its phases, so as input variables we will use root mean square value of the stator winding voltage **U** just for the phase A and mechanical moment **M** applied to the rotor of the asynchronous motor. Root mean square values of the current **I** in this phase of the stator and rotation speed of the rotor ω are used as output variables.

So, vectors of input and output variables of the asynchronous motor macromodel consist of discrete values of the following vectors:

$$(2)\qquad \vec{\mathbf{v}}^{(k)} = \begin{pmatrix} \mathbf{U}^{(k)} \\ \mathbf{M}^{(k)} \end{pmatrix}, \vec{\mathbf{y}}^{(k)} = \begin{pmatrix} \mathbf{I}^{(k)} \\ \boldsymbol{\omega}^{(k)} \end{pmatrix}.$$

Using described approach macromodels of asynchronous motors with short-circuited rotor of 4A80B2У3; A051-4A type (in Ukraine) were developed using methods of the dynamic systems theory [1] in the form (1). They can represent transient characteristics of analyzed machines as it is shown in the Fig. 1.

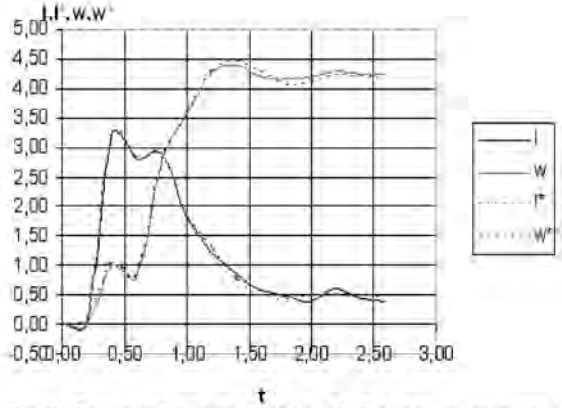

Fig.1. Transient characteristic of the asynchronous motor starting expressed in p.u. system.

In order to evaluate efficiency of created macromodels the transient characteristics obtained with their help were compared with simulation results of typical asynchronous motor models built into SimPower System Blockset of MATLAB/Simulink environment. As results of the analysis have shown, the discrete macromodel is more efficient because its tolerance is lower than 3% while the tolerance of MATLAB/Simulink model is 5,5%. Comparing was carried out using root mean square deviation relatively to the data set obtained during natural experiment and used for the macromodels creation.

Let us note that proposed mathematical macromodels of asynchronous motors are oriented toward calculation of transient processes in electromechanical systems with asynchronous motors in their structure and is described using minimal quantity of variables. Besides it, they can be used for forecasting of electromechanical system macroparameters.

REFERENCES

1. *Yu.Kozak B.Melnyk, I.Nadych* Macromodelling components of electromechanical systems // Przegląd elektrotechniczny . – 2010 – №1, – Pg.112–114.
2. *Мазуренко Л.І., Попович О.М., Гребеніков В.В., Бібік О.В., Головань І.В., Джура О.В., Шуруб Ю.В., Вербовий А.В., Романенко В.І.* Електричні машини змінного струму та машинно-вентильні комплекси на їх основі // Праці ІЕД НАНУ – 2010. – Вип. 26. – С.63–

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