The American Journal of Engineering and Technology
(ISSN – 2689-0984
Published: April 30, 2021 | **Pages:** 134-139
Doi: https://doi.org/10.37547/tajet/Volume03Issue04-21

IMPACT FACTOR
2021: 5. 705
OCLC - 1121105677

Dynamic Models Of An Electromechanical Electric Drive System Of An Asynchronous Motor

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ABSTRACT

Asynchronous motors require its study not only in stationary modes, but also in dynamic ones. At the same time, this makes it possible to formulate the corresponding requirements for automatic control devices of a regulated IM, the implementation of which will ensure the optimal course of transient processes in the electric drive system; it requires its study not only in stationary modes, but also in dynamic ones. This simultaneously makes it possible to formulate the corresponding requirements for automatic control devices of variable IM, the implementation of which will ensure the optimal course of transient processes in the electric drive system.

The study of electromechanical transient modes requires a joint consideration and solution of the equations of equilibrium of electrical quantities in the windings of the machine and the equations of motion of an electric drive.

KEYWORDS

Asynchronous motor, electric drive, dynamic mode, transient, equation

INTRODUCTION

In the general case, the speed-controlled AM is a rather complex electromechanical system, which includes various elements with different laws of change of parameters. The satisfaction of certain requirements of an electric drive is associated with a change in the parameters (usually electrical and mechanical) of these elements as a function of time, speed and other control parameters of the system [1].

Therefore, the reasonable use of AM requires its study not only in stationary modes, but also in dynamic ones. This simultaneously makes it possible to formulate the corresponding requirements for automatic control devices of the regulated IM, the implementation of which will ensure the optimal flow of transient processes in the electric drive system. It is known that, depending on the purposes and means of accounting for certain factors affecting the operation of an electric drive, transient processes can be divided into three groups: mechanical, determined only by mechanical inertia of the flywheel masses of the drive; electromagnetic, due to the electromagnetic inertia of electrical and magnetic circuits and electro-mechanical, arising from the joint actions of the first two. Naturally, the full picture takes place when considering the electromechanical transient process. In comparison with mechanical ones, one can limit ourselves to considering only mechanical transient processes. Therefore, depending on the specificity of the task, the nature of the load and the regulating parameters of the system, certain types of transient processes can be considered.

MATERIALS AND METHODS

The study of electromechanical transient modes requires a joint consideration and solution of the equations of equilibrium of electrical quantities in the windings of the machine and the equations of motion of an electric drive.

Taking into account the foregoing, in this chapter we will consider the basic relations necessary for mathematical modeling of an electric drive on an ES, as well as analyzes of calculated graphs and experimental studies of transient processes of an electric drive of a "beam" sizing machine.

The start-up process is an integral part of the operating cycle of any electric drive. To take into account the influence of the start-up processes on the operating mode of the production mechanism, it is necessary to know their duration and the nature of the flow. Equation of motion of the electric drive.

$$M_q - M_C = \mathcal{J}\frac{q\omega}{dt}$$

Where M_C is a static moment

$\mathcal{J}$ - moment energy of the system

To determine the duration of the transient process, it is necessary to solve the equation of motion with respect to time and integrate it

$$dt = \mathcal{J}_{np}\frac{d\omega}{M_q - M_c}$$

$$t = \int_{\omega_1}^{\omega_1} \mathcal{J}_{np}\frac{d\omega}{M_q - M_c}$$

The starting characteristics of the electric drive are closely related to their performance characteristics. [2]

The variety of models used is explained by the fact that the processes are investigated with various assumptions and simplifications, depending on the required degree of detail, on the conditions of the problem being solved. Usually, when studying transient processes of an asynchronous electric drive, the simulation should be sufficiently complete with the obligatory consideration of free processes in the circuits of a machine, the concept of a magnetic circuit, etc. /. On the contrary, when considering machine systems, significant simplifications become acceptable.

The latter circumstances lead to the use of various forms of writing the equations of an asynchronous electric drive. However, in this case, electromagnetic transient processes are considered only in the direct current circuit, when, as a change in stator currents and voltages, they remain outside the field of view [3].

In addition, it is difficult to reveal the influence of the capacitance of the capacitor "C" and the mutual induction of the rotor winding of the IR, therefore the electromagnetic transient processes of the electric drive of the sizing machine are considered according to the calculation methods. The symmetric system of voltages constitutes the space vector of the stator current rotating in the direction with the angular velocity ω .Vector differential equations in relative units have the form [4-7].

$$U_s = r_s j_s + X_s \frac{d}{dt} t_s + X_0 \frac{d}{dt} j_s$$

$$O = r_s j_s + X_0 \frac{d}{dt} j_s + X_s \frac{d}{dt} t_s - j(X_0 j_s + X_2 j_2) P\gamma$$

$$M_э = R_e[jX_0(j_2 j_s)]$$

$$r = \frac{d\gamma}{dt} = \mathrm{P}M_э - M_c S_{in}\gamma$$

Where U_s- are the resulting spatial stress vectors;

$j_s j_r$ respectively the resulting spatial vectors of the currents of the stator and rotor circuits;

Mэ electromagnetic moment;

P - is the number of pairs of poles of the machine.

We introduce the following notation

$$\Psi_{s\propto} = X_s j_{s\propto} + X_o j_{r\propto}$$

$$\Psi_{s\beta} = X_s j_{s\beta} + X_o j_{r\beta}$$

$$\Psi_{s\propto} = X_s j_{s\propto} + X_o j_{r\propto}$$

$$\Psi_{s\beta} = X_s j_{s\beta} + X_o j_{r\beta}$$

Taking into account the denominations of the equations, we rewrite the equations in the form.

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$$d = \frac{\Psi_{s\propto}}{dt} = U_{s\propto} - \frac{r_s}{\sigma\, X_s}\Psi_{s\propto}\frac{X_O r_s}{\sigma\, X_s X_s}\Psi_{s\propto}$$

$$\frac{\Psi_{s\beta}}{dt} = U_{s\beta} - \frac{r_s}{\sigma\, X_s}\Psi_{s\beta}\frac{X_O r_s}{\sigma\, X_s X_s}\Psi_{s\beta}$$

$$\frac{\Psi_{s\propto}}{dt} = \frac{X_o r_r}{\sigma\, X_s X_s}\Psi_{s\propto} - \frac{r_r}{\sigma\, X_s}\Psi_{s\propto} - P\gamma\, \Psi_{r\beta}$$

$$\frac{\Psi_{s\beta}}{dt} = \frac{X_o r_r}{\sigma\, X_s X_s}\Psi_{s\beta} - \frac{r_r}{\sigma\, X_s}\Psi_{s\beta} - P\gamma\, \Psi_{r\beta}$$

$$M_э = \frac{3}{2}\frac{X_o}{\sigma\, X_s X_s}\left(\Psi_{r\beta}\Psi_{r\propto} - \Psi_{r\beta}\Psi_{s\propto} + \Psi_{r\beta}\Psi_{s\propto} - \Psi_{r\beta}\Psi_{s\propto}\right)$$

$r = \frac{d\gamma}{dt}$ = $PM_э - M_c S_{in}$

$\Psi_{s\propto}$, $\Psi_{s\beta}$, $\Psi_{r\propto}$, $\Psi_{r\beta}$ components of the vector of flux linkage of the stator and rotor along the axes $\propto$, β

$r_{\propto}$, $r_{2\beta}$- active resistances of the rotor circuit, defined as follows

$r_{2\beta} = r_2^1 + r_{up\,p}\sqrt{S}$= r_2^1 (1+ $\wr\sqrt{S}$

$X_{s\propto}$; $X_{s\beta}$; $X_{r\propto}$; X_{rp}- inductive reactance in the circuit

stator and rotor

$$X_{s\propto};\quad X_{s\beta} = X_1 + X_{upc}^I$$

$$X_{upc}^I = 0{,}68\, r_{upc}^I$$

$$X_{r\propto};\quad X_{r\beta} = X_2^I + X_{up\,p}^I\sqrt{s}$$

$$X_{up\,p} = 0{,}68\, r_{upc}^I$$

X_o - inductive reactance corresponding to the air gap flow

$$\boldsymbol{\sigma = 1 - \frac{X_0}{X_s X_2}}$$

M_c the moment of the static load of vector quantities is determined

$$U_{s1} = U_{sI\alpha} + U_{sI\beta}$$

$$U_{s2} = U_{s2\alpha} + JU_{s2\beta}$$

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The modeling uses relative units.

The values [8-12] are taken as the basic ones.

$$U_{баз} = U_{sm} I_{баз} = I_{sm} Z_{баз} = \frac{U_{баз}}{I_{баз}}$$

$$P_{баз} = 3\ U_{баз} I_{баз} t_{баз} = \frac{1}{\omega}$$

$$M_{баз} = \frac{\mathrm{P}_{баз}}{\omega_{баз}} = P_{баз} t_{баз}; \quad \psi_{баз} = \frac{U_{баз}}{\omega_{баз}}$$

Moment of inertia in relative units

$$\mathcal{J} = \frac{0{,}862\ G\ D^2\ n}{S_{баз}}$$

Where GD^2 the flywheel moment, kg.mnm, reduced to the shaft;

n- rotation frequency rpm

$S_{баз}$- rated apparent power VA.

CONCLUSION

Calculation of transient processes in the electric drive of a textile machine with IR and C in the rotor, the object of the study was the asynchronous motor AK 61/6.

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