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MODELLING PROCESS OF CONTROL OF ENGINE SPEED WITHFLEXIBLECONNECTIONOF THE ENGINE WITH THE MECHANISM

Abstract.Questions of a speed control of the engine in system of the subordinated regulation in the presence of flexible connectionof the engine with the mechanismare considered. Limits of stability are defined. The regulator of the speed is calculatedfor rather small ratios of inertial masses (inertia coefficient less than 5.8). It provides the greatest damping of fluctuations in system. It is shown that in this case the type of transient is defined by only a coefficient of a ratio of inertial masses.

Keywords: systems of the subordinated regulation, a speed control, two-mass system, flexible connection, damping of fluctuations.

It is often supposed at creation of the systems of automatic control (SAC) of speed that kinematic connection between the engine and executive mechanismisn't subject to flexible deformations. In most cases the similar assumption based on representation of rigid connection of the engine and executive mechanism, is admissible. It is connected with that the frequency of own flexible fluctuations of the mechanism often is much higher than a frequency, a control system defining speed of the electric drive.

In some cases the coefficients of rigidity of mechanical links is rather small. Thus elasticity and deformation of links become essential and can have considerable impact on transients in the electric drive. Installations in which the engine connects to inertial masses through obviously expressed flexibleelement can be examples: long shaft, the conveyer belt, long cable in lifting mechanisms. At this SAR of speed it is necessary to consider as two-mass system taking into account influence of flexibilityand gaps in mechanical links on electric drive movement.

We will consider the block diagram of SAR of speed in the presence of flexibleconnection of the engine with the mechanism (figure 1). In figure 1 contour of current is presented in the curtailed look.

For the further analysis we will make the following assumptions:

- · current contour don't have inert ion $W_m^{3}(p) = 1$,

- • speed regulator is the proportional $W_{pc}(p) = K_{pc}$.

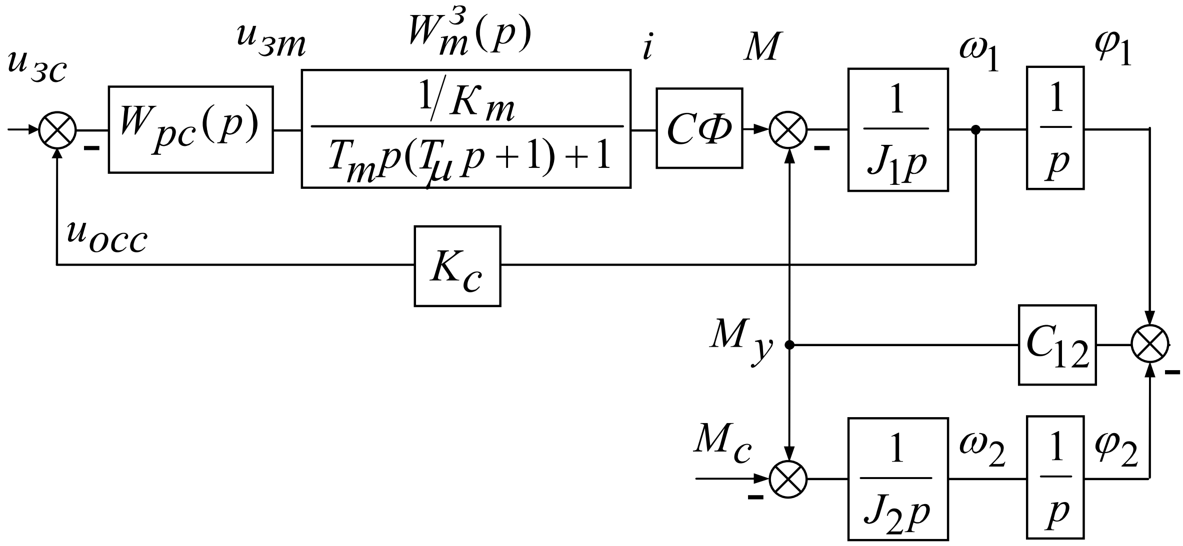

Figure 1 - The block diagram of SAR of speed of two-mass model of the electric drive without gap and viscous friction

We use system of relative units for simplification of the analysis of transients in SAR. After transformations the block diagram will assume the next type:

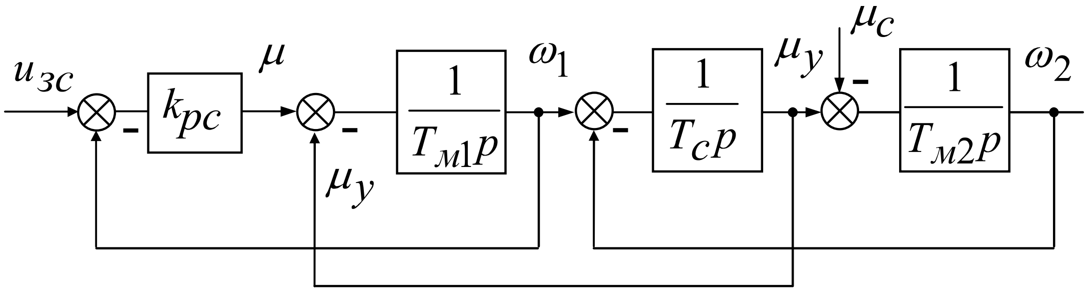

Figure 2 - The block diagram of SAR of speed of two-mass model of the electric drive in relative units

We will transfer internal points of the flexible moment through branching knots to an entrance and an exit of system of regulation. The corresponding block diagram is represented in figure 3.

We will determine transfer function of closed SAR of speed by control and we normalize it across Vyshnegradsky, by replacement $p = s\Omega_o$. Aftertransformationswewillreceive:

$$W_3(s) = \frac{\omega_2(s)}{u_{зс}(s)} = \frac{1}{s^3 + As^2 + Bs + 1}. \qquad (1)$$

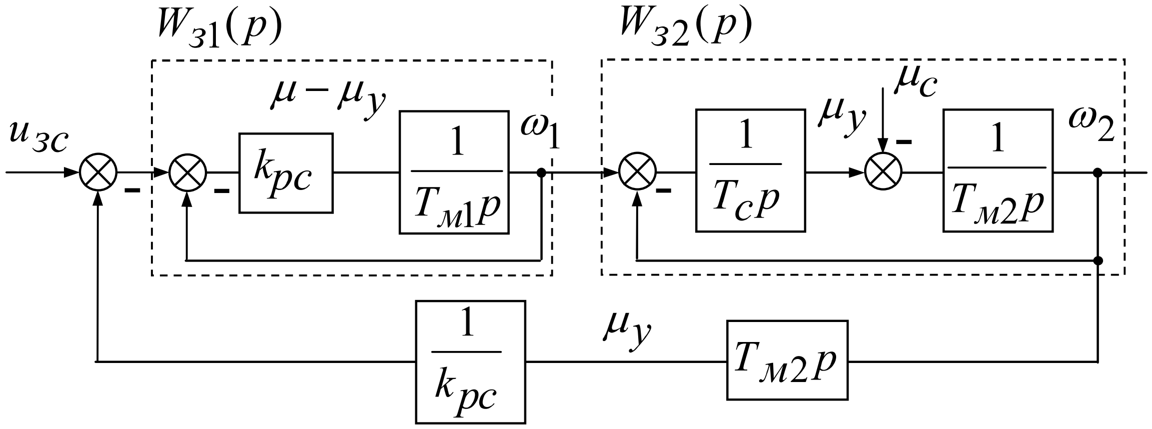

Figure 3 - The transformed block diagram of SAR of speed

Vyshnegradsky's coefficients A and B also will be defined:

$$A = \sqrt[3]{\frac{k_{pc}^2 T_c(\gamma-1)}{T_{м1}}}, \tag{2}$$

$$B = \gamma \sqrt[3]{\frac{T_{м1}}{k_{pc}^2 T_c(\gamma-1)}}, \tag{3}$$

where $T_{м1}$ and $T_{м2}$ - respectively, the electromechanical constants of time caused by inertia of the first and second masses; T_c - constant of time of rigidity of kinematic connection; $\gamma = \frac{T_{м2}+T_{м1}}{T_{м1}}$ - inertia coefficient, k_{pc} - coefficient of strengthening of the regulator of speed.

From formulas (2) and (3) follows:

$$AB = \gamma. \tag{4}$$

The chart Vyshnegradsky let to judge about nature of transientsin regulation system at change of coefficient of strengthening of the regulator of speed (figure 4). Lines of equal value of coefficient of damping $\xi_э$ are put on the chart plane with continuous lines, lines of equal value of coefficient of inertia γ - strokes.

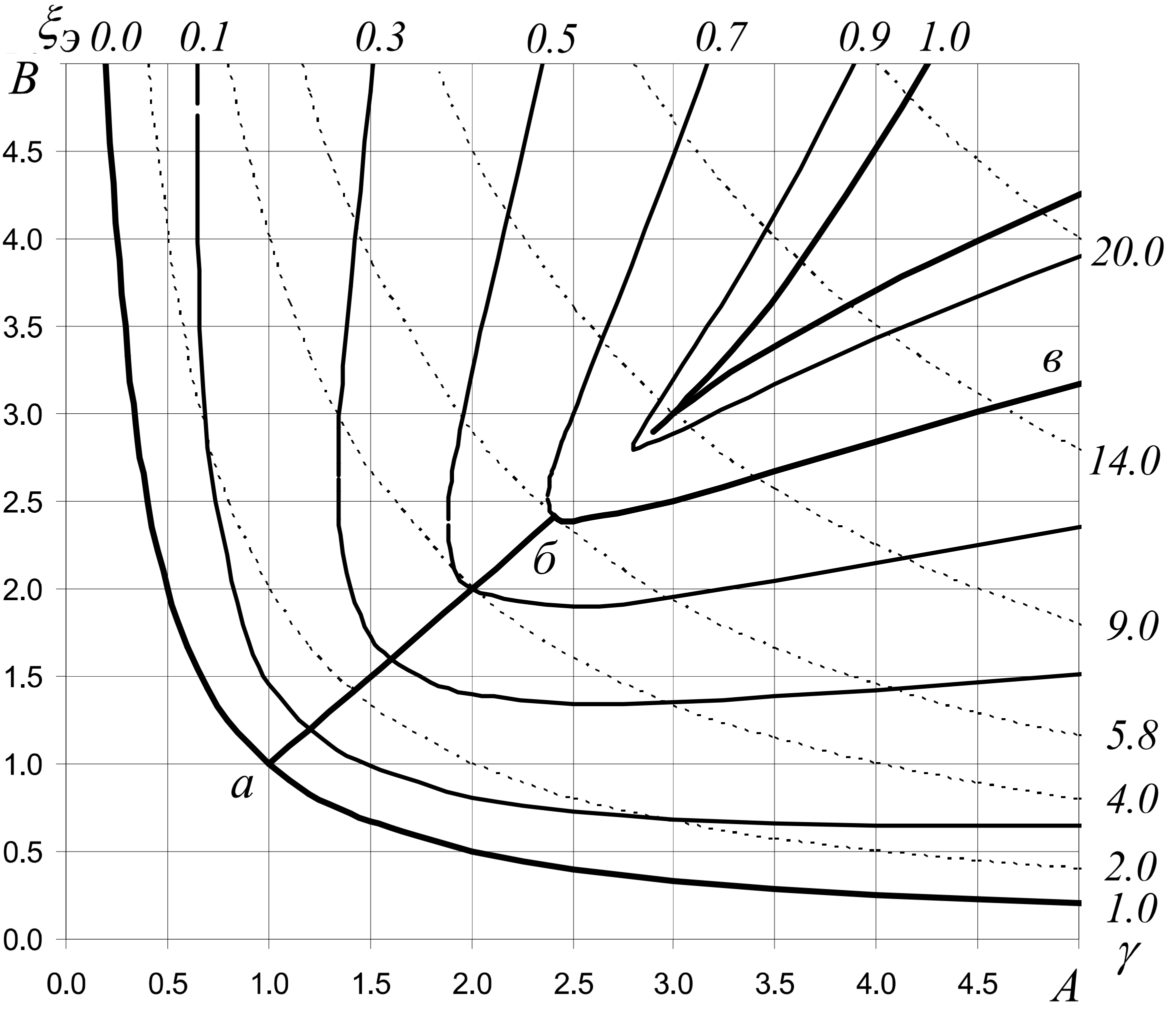

Figure 4 - Vyshnegradsky's chart

At change k_{pc} changed coefficients A and B, the working point on the plane of the chart of Vyshnegradsky moves on a characteristic curve in the form of the equilateral hyperbole. Its situation on the chart is defined only by inertia coefficient γ.

At $\gamma = 1$ a characteristic curve $AB = 1$ coincides with limit of oscillatory stability of system. It specifies that at values $\gamma < 1.2$ damping ability of the electric drive, irrespective of k_{pc}, will be insignificant.

It is obvious as characteristic curves $AB = \gamma$ settle down on all plane of the chart, there is a ratio of parameters of system at which movement of executive mechanism (the second inertial mass) will be smooth (without dissipative forces), despite existence of flexible communication.

At rather small sizes γ it is expedient to chooseso value k_{pc} to provide probably bigger value $\xi_{э}$. For this purpose the working point on the chart has to belong to a straight line $аб$, on which equality $A = B$ is carried out. Value k_{pc} in this case will be defined from expression:

$$k_{pc} = \sqrt{\frac{T_{м1}}{T_c(\gamma - 1)} \gamma \sqrt{\gamma}}\ . \tag{5}$$

Transitional functions of system at such choice k_{pc} are defined only by value γ (figure 5).

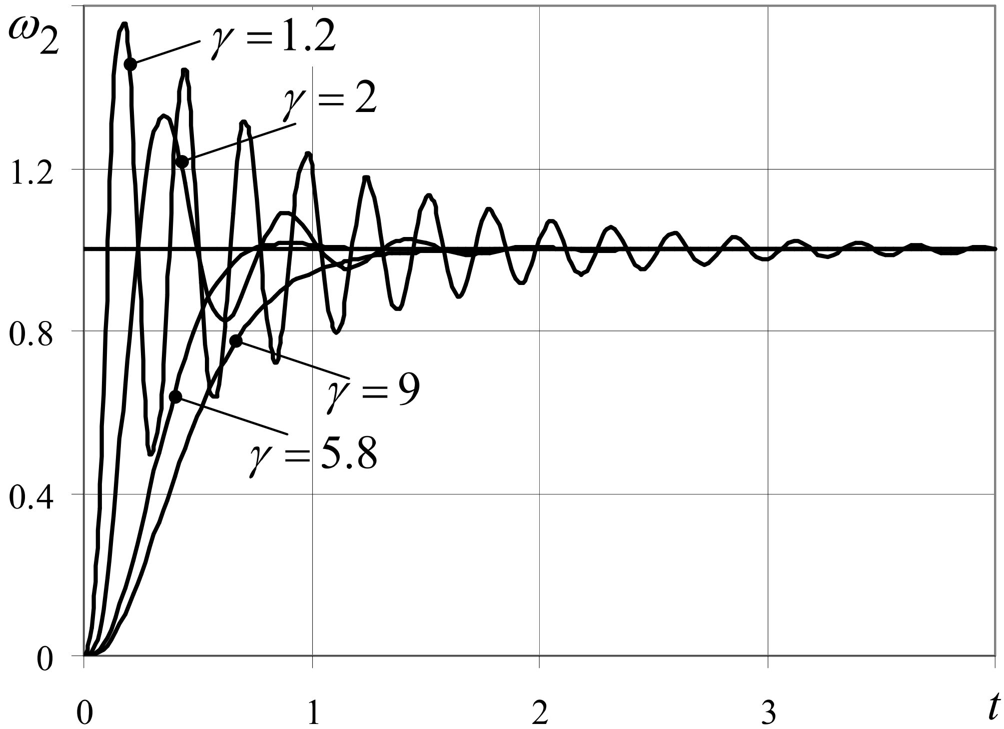

Figure 5 - Change of speed of executive mechanism at a choice k_{pc} on a formula (5)

From figure 5 follows that at $\gamma > 2$ fluctuation of speed of executive mechanism are damped by the electric drive. At $\gamma = 5.8$ coefficient of damping $\xi_э = 0.707$ and reregulation it is close to control for a modular optimum. At $\gamma = 9$ fluctuation in system are absent.

Conclusions

The type of transients in speed SAR in the presence of flexible connection of the engine with the mechanism, and a choice k_{pc} by a formula (5) is determined only by value of coefficient of inertia γ. The quality of regulation processes can be divided into two groups on influence of coefficient of inertia:

- transients at small coefficients of a ratio of inertial masses $\gamma < 5.8$ (the electric drive poorly damps fluctuations in system),
- transients at big coefficients of a ratio of inertial masses $\gamma > 5.8$ (damping ability of the electric drive is considerable).

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