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CONTROL OVER THE TECHNICAL CONDITION OF MECHANICAL COMPONENTS OF INDUSTRIAL EQUIPMENT BASED ON ENERGY PARAMETER OF ITS DETERIORATION

The intensity of deterioration of equipment at mining and metallurgical enterprises is determined by the ware rate and the ensemble of damage of the components of functional assemblies and working face of the equipment.

At various stages of defects (nucleation, development, catastrophic impact) there is a common parameter: they do not change the dynamic equilibrium of mechanisms' components but according to D'Alamber's principle they shift the energy level of these components' interaction because of the coercive force occurrence via corresponding defects:

$$[m-\frac{f_4(y^{**})}{y^{**}(t)}]y^{**}(t)+[r-\frac{f_3(y^{*})}{y^{*}(t)}]y^{*}(t)+{}+[c-\frac{f_2(y)}{y(t)}]y(t)=f_0+f_1(t)\,, \quad (1)$$

where, $f(y, y^{*}, y^{**}, t)$ the coercive force, caused by the defects, which accelerate deterioration of the equipment.

Study of the coercive force nature, particularly its energetic aspect, may contribute to the conditions of deterioration of the equipment.

The calculation and explanation of the coercive force occurrence $f_1(t)$ caused by the constructive technological defects and damages of mechanical engineering assemblies may be based on fluctuating activity analysis of excitation band. As far as dynamic reactions of the systems of production equipment mechanisms, which are controlled to identify the process of deterioration of the equipment components, are based on oscillatory characteristics of its *i* point, there is a good reason to consider the oscillation equation.

The oscillation equation is set up based on common and oscillation systems methods. The vibrations from the effect of mechanisms' defects, as a rule are described by differential equations or by the equations that can be derived to a linear one (for indefinite vibrations). These equations are described based on the laws of Newton and D'Alamber. According to these laws geometric sum of the forces of constraint reaction and inertial force at any point of the oscillation system are always zero provided translational vibrations. The vibrations of any system can be described by equations of Lagrange:

$$\frac{d\partial W_k}{dt\partial q_i}-\frac{\partial W_k}{\partial q_i}=Q_i \quad i=1,2,...,s \quad , \quad (2)$$

where W_k – kinetic energy of a system;

q_i – joint coordinates definitely identifying coordinate of the system;

Q – summarized force that acts in the line of *i* coordinate;

s – degree of freedom.

Under the conditions of the minor fluctuations of defects and damages kinetic energy of a system that contains lumped mass (k – 1, 2,..., n) is quadratic function of their speeds.

$$Wk=\frac{1}{2}\sum_{k=1}^{n}m_r v_k^2=\frac{1}{2}\sum_{k=1}^{n}m_k \quad x_k^2+y_k^2+z_k^2 \quad , \quad (3)$$

where v_k – motion speed k- mass;

x_k, y_k, z_k – projection of the velocity vector v_k - rectangular coordinates.

Radius is vector of k- point of oscillatory system with scleronomous constraints, which has n degree of freedom and is joint coordinates function of q_i system. The coordinates x_k, y_k, z_k can be represented by the functions $x_k = x_k\ q_1,...,q_s$, $y_k = y_k\ q_1,...,q_s$, $z_k = z_k\ q_1,...,q_s$.

Taking into account that

$$X_k = \partial x_k/\partial q_1\ q_i + ... + \partial x_k/\partial q_s\ q_s \quad , \tag{4}$$

where (for y_k and z_k analogous), the equations of kinetic energy (in joint coordinates) is:

$$W_k = 1/2\ \ a_{1,1}q_1^2 + ... + a_{ss}q_s^2 + 2a_{1,2}q_1q_2 + ...2a_{s-1}sq_s \quad , \tag{5}$$

where $a_{ij} = a_{ji} = \partial^2 W_k/\partial q_i \partial q_j -$ inertia lag coefficient, it is defined by the mass (moments of inertia lag) of the elements or something that is their functions. Consequently, kinetic energy at small-amplitude oscillation, is a quadratic function of system extend speed. Similarly the potential energy of the system is a quadratic function of very joint coordinates

$$W_n = 1/2\ \ c_{1,1}q_1^2 + ... + c_{ss}q_s^2 + 2c_{1,2}q_1q_2 + ...2c_{s-1}sq_{s-1},q_s \quad , \tag{6}$$

where $c_{ij} = c_{ji} = \partial^2 W_n/\partial q_i \partial q_j -$ harshness coefficient of the system. For the systems with decadent oscillations caused by resistance force Q_{Vi} proportional speeds V_i of the system, a scattering function can be represented, which is a quadratic function of very joint coordinates too.

$$\Phi = 1/2\ \ b_{1,1}q_1^2 + ... + b_{ss}q_s^2 + 2b_{1,2}q_1q_2 + ...2b_{s-1}sq_{s-1},q_s \quad , \tag{7}$$

where b_{ij}=b_{ji} – loss coefficient.

The performed analysis has shown that the level of energy load of production equipment components is quadratic function of oscillative motion speed resulting from parameters of technological process and deterioration rate of the mechanism. During exploitation, energetic load decrease without correction of parameters of technological process gained through minimizing of movable equilibrium of the mechanism, since kinetic energy of equipment's component is defined as geometric sum of products of unbalanced mass by velocity squared of oscillatory motion speed. Consequently, unbalanced mass reduction, bringing axis of inertia to axis of rotation and placement of mechanism mass in reverse direction are obvious reserve of reduction of energy load on the components, which reveals itself whilst control of dynamic reactions of equipment mechanisms and can being carried out with condition monitored maintenance.

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