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EFFECT OF REJECTION VOLTAGE AND FREQUENCY CURRENT ON TECHNOLOGICAL CHARACTERISTICS VACUUM PUMP

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Studies of voltage deviation and current frequency to the angular speed and technological characteristics of vacuum pumps have been conducted. The dependences of performance and capacity vacuum pump from the voltage and frequencies were established.

Vacuum pump, voltage deviation, frequency, electric drive, performance, power.

In dismissing the quality of nominal power losses occur, which have two components: electromagnetic and technology. Electromagnetic component is determined by the loss of active power and change the life of electrical insulation. The technological component damage caused by the influence of energy quality performance processing plants and the cost of products [1].

Deviation of voltage and current frequency causes a change in the angular velocity of the motor, which in turn causes a change in the technological characteristics of working machines.

The purpose of research - to establish the impact of bias voltage and frequency of current technological characteristics of vacuum pumps.

Materials and methods research. The analysis of the angular velocity electric vacuum pumps and energy loss in the bias voltage and frequencies was conducted using the theory of electric related electromechanical properties of induction motors, power transmission characteristics of working machines and mechanisms and the use of mathematical modeling.

In experimental studies of stress on the engine changed using transformers, current frequency - the frequency converter, thus measuring the rotational speed of the shaft tachometer. Using Dependence of transporters of angular velocity, determine the change of technological parameters of conveyor at a deviation of voltage and current frequency from the nominal value.

Studies. In dismissing the mechanical characteristics of the motor voltage on the working area described by the equation [2]

$$M_{\partial} = \beta_{\partial} U_*^2 (\omega_0 - \omega), \tag{1}$$

where M_{∂} - point motor N·m; β_{∂} - mechanical stiffness characteristics of the electric motor, N·m· s; ω_0 - synchronous angular velocity, s^{-1}; ω - angular velocity is given, s^{-1}; $U* = U / U_н$ - voltage in relative units.

Mechanical characteristics vakuum-pump is weakly expressed as Fan [3], so we can assume that $M_c \approx$ const. Then, in steady state

$$\beta_{\partial} U_*^2 (\omega_0 - \omega) = M_c, \tag{2}$$

or

$$\beta_{\partial} U_*^2 (\omega_0 - \omega_н \omega_*) = M_c, \tag{3}$$

where $\omega_* = \omega/\omega$ - angular velocity in relative units.

After transformation we obtain

$$\omega_* = \frac{\omega_0}{\omega_н} - \frac{M_c}{\beta_{\partial} \omega_н U_*^2}. \tag{4}$$

Power vacuum pumps with increasing angular velocity varies linearly:

$$Q = 0{,}98 eDL\omega\varphi_н \eta_м, \tag{5}$$

where e - eccentricity, m; D - diameter of the stator, m; L - length of the stator, m; ω - angular velocity, s^{-1}, $\varphi_н$ - filling ratio, $\eta_м$ - gauge factor:

$$\eta_м = (p_б - h) / p_б, \tag{6}$$

where $p_б$ - pressure, Pa; h - vacuum Pa.

Then

$$Q_* = \omega_*, \tag{7}$$

and the variation of performance vacuum pump by changing the voltage can be written as:

$$Q_* = \frac{\omega_0}{\omega_н} - \frac{M_{сн}}{\beta_д \omega_н U_*^2}. \quad (8)$$

Experimental dependence of the performance and power of vacuum pump voltage shown in Fig. 1. Found that the performance and capacity of the vacuum pump change nonlinearly with voltage changes.

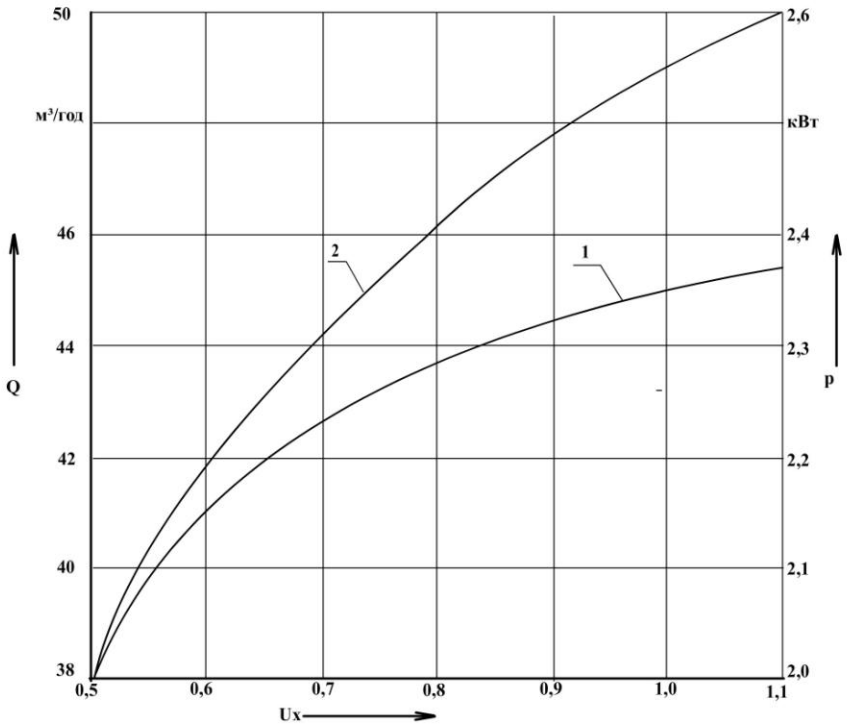

Figure 1. Dependence of (1) and power (2) of vacuum pump installation УВУ60/45 from the voltage at 53.32 kPa vacuum

When changing frequencies mechanical characteristics of asynchronous electric motor on the working area described by the equation:

$$M_д = \beta_д \left(\frac{2\pi f}{p} - \omega\right), \quad (9)$$

where *f* - frequency current, Hz, *p* - number of pole pairs.

In steady state operation

$$\beta_д \left(\frac{2\pi f}{p} - \omega\right) = M_{сн}, \quad (10)$$

or

$$\beta_{\partial}(\frac{2\pi f}{p} - \omega_{н}\omega_{*}) = M_{сн}. \tag{11}$$

Synchronous angular velocity of the motor at rated frequency current holder $f_{н}$ is given by:

$$\omega_{0н} = \frac{2\pi f_{н}}{p}. \tag{12}$$

Then equation (11) can be written as:

$$\beta_{\partial}(\omega_{0н} f_{*} - \omega_{н}\omega_{*}) = M_{сн}, \tag{13}$$

whence we obtain

$$\omega_{*} = \frac{\omega_{0н}}{\omega_{н}} f_{*} - \frac{M_{сн}}{\beta_{\partial}\omega_{н}}. \tag{14}$$

For engines with stiff mechanical characteristics $\omega_{н} \approx \omega_{0н}$, so the second term in expression (14) can be neglected. Then we get:

$$f_{*} \approx \omega_{*}, \tag{15}$$

and the variation of performance vacuum pump thus be written as:

$$Q_{*} = f_{*}. \tag{16}$$

Experimental dependence of the performance and power of vacuum pump frequencies are shown in Fig. 2. As follows from the above relationships, rejecting frequencies performance vacuum pump varies directly proportional to the switching frequencies and power - increases non-linearly with increasing frequencies.

Conclusions

At the voltage deviation changes the angular speed and performance vacuum pump is inversely proportional to the square of the voltage, while rejecting frequencies - is directly proportional to the frequency of the current. Power vacuum pump depends nonlinearly on the voltage and frequency of the current.

Based on the research found that at low voltage 20% performance vacuum pumps is reduced to 3%., but at lower frequencies by 2% - 2%.

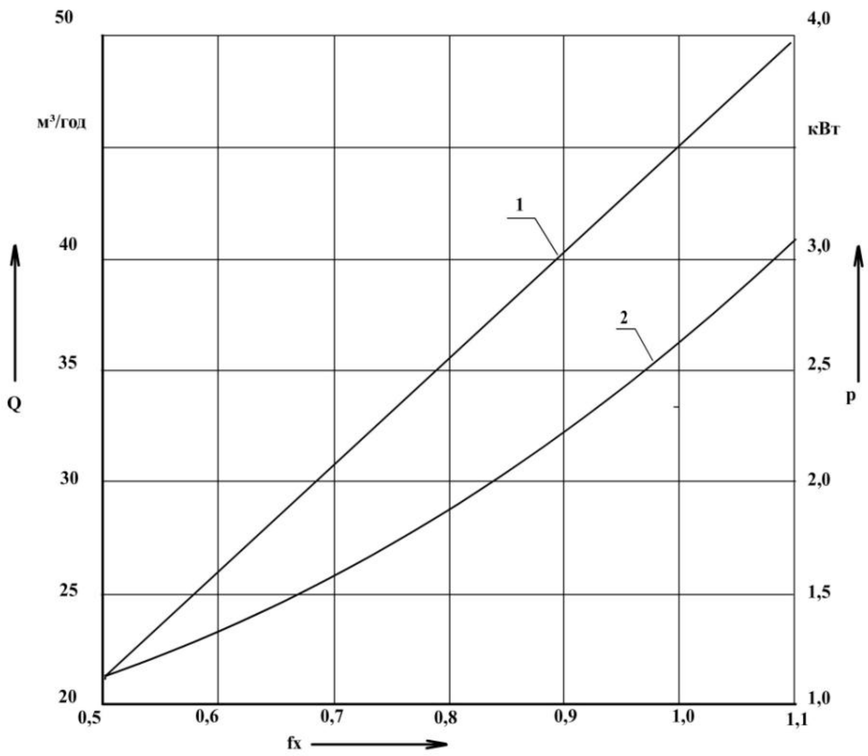

Fig.2. Dependence of performance (1) and power (2) of vacuum pump installation УВУ60/45 from frequencies at 53.32 kPa vacuum

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