УДК 621.327.539

INFLUENCE VOLTAGE DEVIATION ON THE TECHNOLOGICAL AND ENERGY CHARACTERISTICS OF MILK SEPARATORS

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A study of the voltage deviation on the technological and energy characteristics of milk separators are carried out. The dependences of productivity and the unit cost of electricity of the milk separator from the voltage are established.

Milk separator, voltage deviation, electric drive, productivity e, unit cost of electricity.

Now the actual deviation Voltage in Ukraine 3 - 4 times higher than the permissible value. Duration defective power supply is (in the most customers) 45% of the time [3].

Milk separators require constant angular velocity of the drum. However, due to bias voltage changes the angular velocity of the engine, which in turn causes the change in technological characteristics separator. Therefore, the study of technological change and energy characteristics of milk separators with bias voltage has theoretical and practical value.

The purpose of research - impact of bias voltage setting for technology and energy characteristics of milk separators.

Materials and methods research. The analysis of the angular velocity of electric separators milk and energy loss in the bias voltage was carried out using the theory of electric related electromechanical properties of induction motors, power transmission characteristics of working machines and mechanisms established modes of electric power, and the use of mathematical modeling.

In experimental studies of stress on the engine separator milk COM-3-1000M changed by autotransformer. It measured the rotational speed of the shaft tachometer and measured performance of static moment resistance separator and specific power consumption.

Studies. At the bias voltage on the mechanical characteristics of the motor work area describe equation [1]:

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

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 of the milk separator Fan has the form [2]:

$$M_c = M_0 + b\omega^2, \tag{2}$$

where M_0 - initial time N·m; b - coefficient $N \cdot m \cdot c^2$.

In steady state operation

$$\beta_{\partial} U_*^2 (\omega_0 - \omega) = M_0 + b\omega^2, \tag{3}$$

whence we obtain

$$U_* = \sqrt{\frac{M_0 + b\omega^2}{\beta_{\partial}(\omega_0 - \omega)}}, \tag{4}$$

In relative terms the expression (4) is:

$$U_* = \sqrt{\frac{M_0 + b\omega_н^2 \omega_*^2}{\beta_{\partial}(\omega_0 - \omega_н \omega_*)}}, \tag{5}$$

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

It follows from (5), the angular velocity separator milk at bias voltage varies from complex algorithms.

In milk separator performance depends on a square angular velocity:

$$Q = d^2 \omega^2 z tg\alpha (R_б^2 - R_м^2)(\rho_п - \rho_{ж})\eta_c /(8{,}6\eta_п), \tag{6}$$

where Q - capacity, kg / s; d - diameter of the ball fat, m; ω - angular velocity, s^{-1}; z - number of spaces in the drum; α - angle to the horizontal plate; R - radius of rotation, m, $\rho_п$ - plasma density, kg/m3; $\rho_{ж}$ - fat density, kg/m^3; η_c - efficiency separator, $\eta_п$ - dynamic viscosity of the plasma.

Hence, the performance separators milk

$$Q_* = \omega_*^2. \tag{7}$$

Then the variation of milk separator performance by changing the voltage can be written as:

$$U_* = \sqrt{\frac{M_0 + b\omega_н^2 Q_*}{\beta_\partial(\omega_0 - \omega_н\sqrt{Q_*})}}. \tag{8}$$

Experimental study of productivity and moment resistance of static separator milk COM 3 1000M by changing the voltage shown that with its growth performance and static moment resistance creamer nepryamoliniyno increase (Fig. 1).

Bias voltage affects the transients in electric separator milk. Experimental curves of transition $n = f(t)$ starting milk separator COM 3 1000M at nominal and reduced to √ 3 times the voltage shown in Fig. 2. As follows from the above relationships, reduce stress causes negligible decrease speed, but greatly increases the start-up, leading to overheating of the engine.

Bias voltage causes a change in energy performance separator milk, one of which is the specific power consumption, kW·h/kg, which is defined as:

$$q = P_1 / Q, \tag{9}$$

where P_1 - power consumption of the motor network, kW.

In relative terms the expression (9) is:

$$q_* = \frac{P_2 + \Delta P_c + \Delta P_v}{P_{2н} + \Delta P_{сн} + \Delta P_{vн}} \cdot \frac{Q_н}{Q} = \frac{P_2 + \Delta P_{vн}(\alpha + \Delta P_v / \Delta P_{vн})}{P_{2н} + \Delta P_{vн}(\alpha + 1)} \cdot \frac{Q_н}{Q}, \tag{10}$$

where $P_{2н}$ and P_2 - by shaft horsepower at rated engine and different from the nominal voltage; $\Delta P_{сн}$ and ΔP_c - permanent loss; $\Delta P_{vн}$ and ΔP_v - variable loss; α - coefficient of losses.

If we neglect the mechanical losses and losses in the steel rotor, the permanent loss of power when the voltage deviation

$$\Delta P_c = \Delta P_{сн} U_*^2. \tag{11}$$

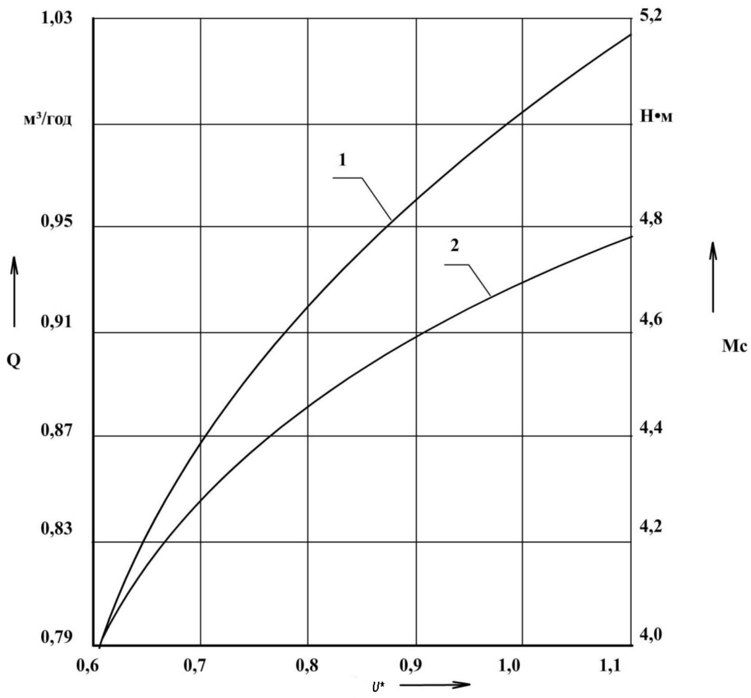

Figure **1. Dependence of performance (1) and static moment resistance (2) milk separator COM 3 1000M from the voltage**

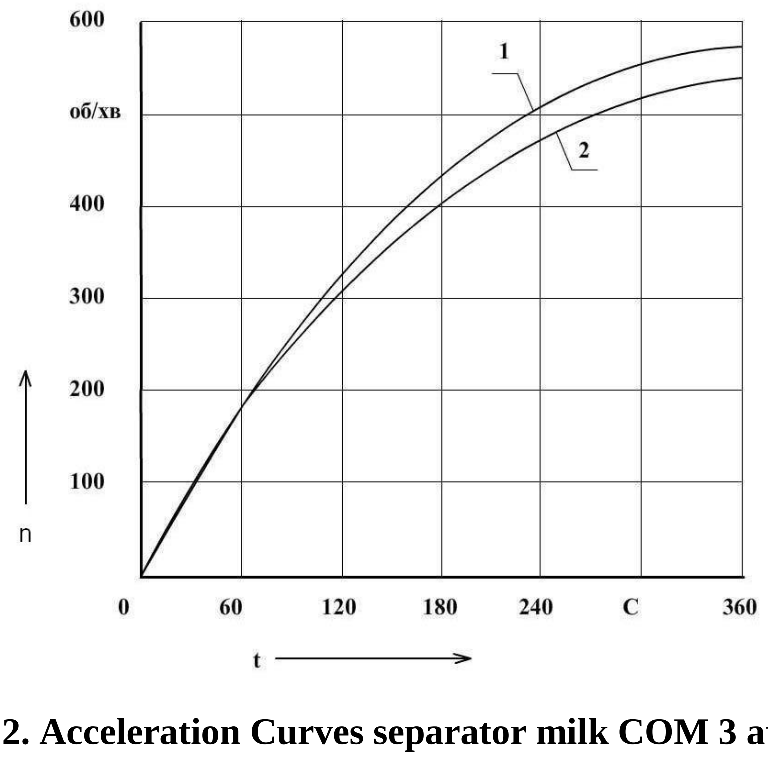

Figure. 2. Acceleration Curves separator milk COM 3 at 1000m par (1) and reduced to √ 3 times the voltage (2)

Variable power losses in the induction motor are determined by the formula [1]

$$\Delta P_v = \Delta P_{v2} + \Delta P_{v1} = \left(1 + \frac{R_1}{R_2^{/}}\right) M_{\partial} \omega_0 s, \tag{12}$$

where ΔP_{v2}, ΔP_{v1} - variable power losses in the rotor and stator circuits, W; R_1 - rotor winding resistance, Ohm; R_2' - rotor winding resistance, reduced to the stator winding, Ohms, M_{∂} - time engine, N·m; ω_0 - synchronous angular speed, s^{-1}; s - slide motor.

If we neglect the initial point separator, according to formula (1):

$$\beta_{\partial} U_*^2 (\omega_0 - \omega) = M_{сн} \omega_*^2 = K_з \beta_{\partial} (\omega_0 - \omega_н) \omega_*^2, \tag{13}$$

where $K_з$ - the load factor of the engine; $\omega_н$ - nominal angular velocity of the motor, s^{-1}.

Then

$$s = \frac{K_з s_н \omega_*^2}{U_*^2}. \tag{14}$$

Variable power loss, using (1) and (14) can be written as:

$$\Delta P_v = \left(1 + \frac{R_1}{R_2^{/}}\right) \beta_{\partial} U_*^2 \omega_0^2 s^2 = \left(1 + \frac{R_1}{R_2^{/}}\right) \frac{\beta_{\partial} \omega_0^2 K_з^2 s_н^2 \omega_*^4}{U_*^4}, \tag{15}$$

or

$$\Delta P_v = \Delta P_{vн} \omega_*^4 / U_*^4, \tag{16}$$

where $\Delta P_{vн}$ - variable power loss at rated voltage.

Dividing numerator and denominator of (10) on $P_{2н}$ and given that

$$P_2 / P_{2н} = M_{сн} \omega_*^2 \omega / M_{сн} \omega_н = \omega_*^3, \tag{17}$$

$$\Delta P_н = P_{2н} \frac{1 - \eta_н}{\eta_н} = \Delta P_{vн} (\alpha + 1), \tag{18}$$

where $\eta_н$ - efficiency at nominal output voltage

obtain

$$q_* = \frac{\omega_*^3 + \frac{1-\eta_н}{\eta_н} \cdot \frac{(\alpha U_*^2 + \omega_*^4 / U^4)}{(\alpha+1)}}{\omega_*\left(1+\frac{1-\eta_н}{\eta_н}\right)} = \eta_н \omega_*^2 + \frac{1-\eta_н}{(\alpha+1)} \cdot \frac{(\alpha U_*^2 + \omega_*^4 / U_*^4)}{\omega_*}. \qquad (19)$$

Thus, the voltage drop causes the increase of the power consumption of milk separators, and its increase - a slight decrease (Fig. 3).

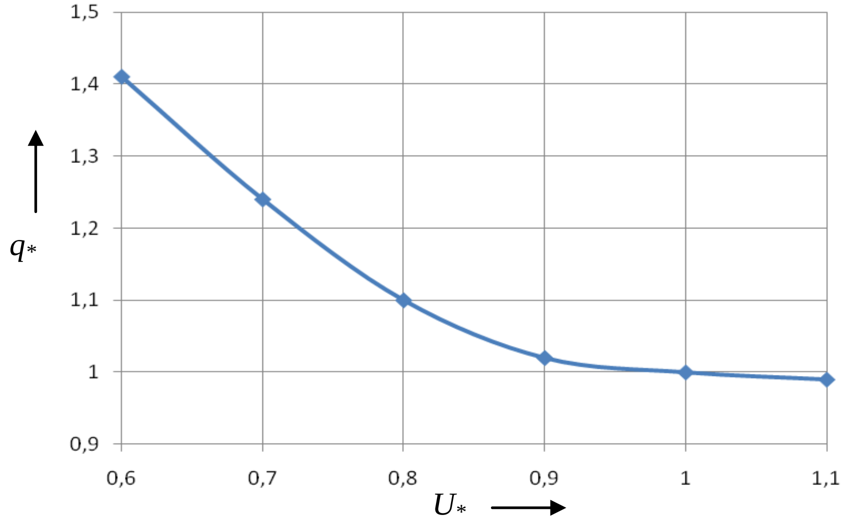

Figure. 3. The dependence of the specific electricity consumption of the voltage separator for milk

Conclusions

Based on the research found that at low voltage by 20% angular velocity of the drum is reduced by 4%, milk separator performance - up to 9%, and the specific consumption of electricity increased by 10%.

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