INFLUENCE OUTAGES AT THE ELECTRIC AGRICULTURAL MACHINES

A. Synyavsky, V. Savchenko, Ph.D.

S. Shvorov, doctor of technicai science

Today in Ukraine interruption in the power supply up to 10% of the time processes during the year (against 0.1% in developed countries). Nedovidpusk electricity per year is about 18 million kW × h. Economic losses to Ukraine from power interruptions, and quality electricity approximate estimates reach 1 billion. annually.

Turn off electricity causing frequent starting and braking motor. In a large frequency switching losses in the induction motor transients causing him intense heating. This is especially important for the induction motor with squirrel cage, in which all energy losses fully allocated in the volume of the motor.

The purpose of research - to establish the impact of interruptions in the power supply to the electric performance.

Materials and methods research. Analysis of the impact of outages on the energy losses in induction motors conducted using the theory of the electric relating to electric power, and the use of mathematical modeling.

Results. An indicator that defines the work of induction motor with squirrel cage under conditions of continuous starting and braking is permissible frequency inclusions, where the average temperature in excess after a significant number of cycles is acceptable.

To calculate the allowable frequency of inclusions per hour use the method of average losses as the most accurate in the analysis of thermal processes in the motor. Acceptable considered a number of inclusions per hour electric motor in which the average excess temperature through time $t > 4T_{н}$ from the beginning of is acceptable.

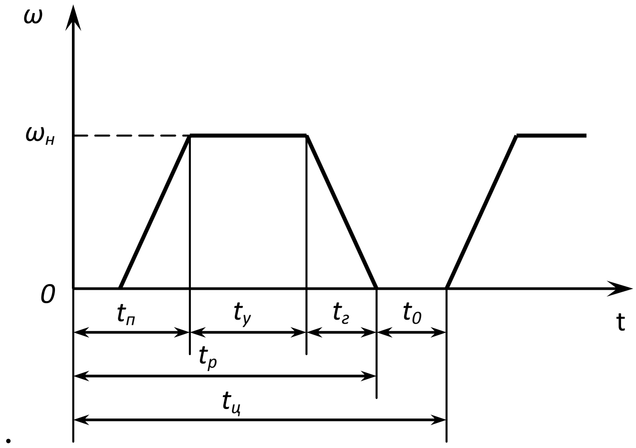
To determine the allowable frequency of inclusions per hour assume (Figure) the duration of the operating cycle consists of a start-up duration $t_п$, operation at steady $t_у$, inhibition of $t_г$ and pause t_0, ie:

$$t_ц = t_п + t_у + t_г + t_0, \qquad (1)$$

or

$$t_ц = \frac{3600}{h}, \qquad (2)$$

where h- actual frequency of inclusions per hour.



Changing the speed of rotation of the motor duty cycle at repeated short-time work

Energy losses in induction motor for starting a cycle consisting of loss at start-up $\Delta A_п$, loss of of braking $\Delta A_г$ and loss in the steady state operation $\Delta A_y = \Delta P_i t_y$. Return power to the environment during the cycle consists of losses when working in the steady state with rated load $\Delta P_{ном} t_y$, during breaks $\beta_0 \Delta P_{ном} t_0$, and during starting and braking $\Delta P_{ном}(t_п + t_г)\left(\frac{1+\beta_0}{2}\right)$, where $\frac{1+\beta_0}{2}$ - the average coefficient of heat transfer deterioration.

Heat balance equation in the steady state of the electric motor with the maximum allowable frequency inclusions per hour would look like this:

Рівняння теплового балансу в усталеному режимі роботи електродвигуна з гранично допустимою частотою вмикань за годину матиме такий вигляд:

$$\Delta A_n + \Delta P_i t_у + \Delta A_г = \Delta P_{ном}(t_n + t_г)\left(\frac{1+\beta_0}{2}\right) + \Delta P_{ном} t_у + \beta_0 \Delta P_{ном} t_0 \cdot \quad (3)$$

Value $\Delta P_{ном}(t_n + t_г)\left(\frac{1+\beta_0}{2}\right)$ can be neglected as it is (2-4)% of ΔA_n and ΔA_n. If the steady state induction motor operates with rated load, then the equation of thermal balance of the engine (3) can be written as:

$$\Delta A_n + \Delta A_г = \Delta P_{ном} \beta_0 t_0. \quad (4)$$

Given (2), we obtain an expression for determining the allowable frequency inclusions at the engine online without blackouts:

$$h_{доп} = 3600 \cdot \frac{\Delta P_{ном} \beta_0 t_0}{(\Delta A_n + \Delta A_г) t_ц}. \quad (5)$$

When disconnecting a growing number of start-up and engine braking, thus increasing its losses in transient conditions, leading to overheating of the engine and its failure.

When the number n duration of $t_в$ per cycle $t_ц$ equation of thermal balance (4) can be written as:

$$n(\Delta A_n + \Delta A_г) = \Delta P_{ном} \beta_0 (t_0 + t_в). \quad (6)$$

Then the expression for the permissible frequency inclusions can be written as:

$$h'_{доп} = 3600 \cdot \frac{\Delta P_{ном} \beta_0 (t_0 + t_в)}{n \cdot (\Delta A_n + \Delta A_г) \cdot t_ц}. \quad (7)$$

Dividing (7) to (5), we obtain:

$$h'_{доп} = h_{доп} \frac{(t_0 + t_в)}{n \cdot t_0}. \quad (8)$$

When the duration of small $t_в < t_0$, then (8) can be written as:

$$h'_{\partial on} = \frac{h_{\partial on}}{n}. \tag{9}$$

Thus, the allowable frequency inclusions motor is reduced in proportion to the number of outages.

These expressions show that the outage promote the growth of energy losses in proportion to the number of transients outages:

$$\Delta A = n(\Delta A_n + \Delta A_г). \tag{10}$$

Conclusions

Frequent interruption in the power supply causing an increase of energy loss, leading to overheating of the electric motor and internal damage. This allowed inclusions motor frequency is reduced in proportion to the number of outages.