ENERGY AUDIT OF INDUCTION MOTORS

Mirzayev Uchqun, Istamov Og'abek
Senior Lecturer, student. Jizzakh polytechnic institute
Uzbekistan, Jizzakh city
E-mail: uchqun8822@gmail.com

ABSTRACT

Conducting energy audits of asynchronous motors is a key factor in achieving energy savings. This paper describes the calculation methods.

Keywords: frequency-controlled asynchronous motor, electric drive, torque.

The most common case is the frequency-controlled asynchronous motorized automated electric drive, while other methods performed at a certain frequency are the special case h of frequency control .

We describe the analysis and calculation method of asynchronous motor operation with minimum power dissipation in frequency-adjusted automated electric drive systems.

To calculate the operating and adjustment characteristics of frequency-adjustable electric drives and to analyze the adjustment characteristics , we present the analytical relations expressed by the magnetic flux and determine that the magnetic power dissipation in electric motors is related to determine the optimal value of the magnetic flux . To simplify the analytical relationship obtained for the T-shaped equivalent circuit and vector diagram, we give only for the harmonics k = 1. The relative value of the magnetic flux of an induction motor

$$\varphi = \frac{\Phi}{\Phi_к},$$

while the relative values of frequency and torque

$$F = \frac{f}{f_к}, \mu = \frac{M}{M_н}$$

and torque.

The applied current of the rotor:

$$I_{PF\varphi} = \sqrt{\frac{P_{ЭМ.Н}}{m_1 r_P}\beta\varphi},$$

this here R em.n - nominal electromagnet q uvvat , m 1 - of the stator phases soni ;

$$\beta\varphi = d\varphi^2 - \sqrt{(a\varphi^2)^2 - c}$$

$$a = \frac{m_1 E_{сн} r^1 p}{2P_{ЭМ.Н} x_p^{12}} ç = \frac{r^{12} p}{x_p^{12}},$$

absolute slip;

E sn - nominal value of stator EMF .

Magnetizer current

$$I_{OF,\varphi} = \frac{E_{OH} F\varphi}{\sqrt{r_{O1}^2 + x_{O1}^2 \gamma}}.$$

Magnetizer contour active and inductive Resistance (3. 2) equation d a n :

$$r_{OF,\varphi} = \frac{r_\mu F - \sqrt{(r_\eta F - 4x_{OF,\varphi})^2}}{2}$$

henceforth

$$x_{OF,\varphi} = F\sqrt{\frac{E_{C.H.}^2 \varphi^2}{I_{O\varphi}^2}} - \left(\frac{\Delta P_{ст.н} \varphi^2}{m_1 I_{OF}^2}\right)$$

Δ R sm.n. - nominal losses in stall

I OP - F = When 1 b (magnetization) curves from the line

K = 1,315 -

Stator current

$$I_{CF.\varphi} = E_{C.H.\varphi}\sqrt{\frac{(x_{OF.\varphi} + x_P^1 F)^2 + (r_{OF.\varphi} + \frac{r_P^1 F}{\beta\gamma})^2}{(r_{OF.\varphi} + x_{OF.\varphi}^2)(\frac{r_P^{12}}{\beta^2\varphi} + x_P^{12})}},$$

Slip

$$s_{F.\varphi} = \frac{\beta\varphi}{F}.$$

Electromagnetic losses:

$$\Delta P_{ЭМ.F.\varphi} = m_1 r_c E_{C.H.\varphi}^2 \frac{(x_{OF.\varphi} + x_{\mu F}^1)^2 + \left(r_{OF.\varphi} + \frac{r_P F}{\beta\varphi}\right)^2}{(r_{OF.\varphi}^2 + x_{OF.\varphi}^2)\left(\frac{r_P^{12}}{\beta^2\varphi} + x_P^{12}\right)} + \Delta P_{ЭМ.Н}\beta_\gamma + \Delta P_{ст.н}\varphi^2 F^K.$$

General waste:

$$\sum \Delta P_{F,\varphi} = E_{C.H.\varphi}^{2}{}^{2}\left(m_1 r_c + \frac{\Delta P_{куш.н}}{I_{C.H}^{2}}\right)\frac{(x_{OF.\varphi} + x_P^1 F)^2 + \left(r_{OF.\varphi} + \dfrac{r_P^1 F}{\beta\varphi}\right)^2}{(r_{OF.\varphi}^2 + x_{OF.\varphi}^2)\left(\dfrac{r^1 P}{\beta^2\varphi} + x_P^{12}\right)} + \Delta P_{ЭМ.Н}\beta_\gamma +$$

$$\Delta P_{ст.н}\varphi^2 F^K + M_H \omega_H (F - \beta_\gamma),$$

where the $I_{CH}, \omega_H, M_H, \Delta\mathrm{P}_{куш.и}$ – nominal values of stator current, synchronous speed, mechanical torque, and additional losses.

$$P_{\partial F.\varphi} = M_H \omega_H (F - \beta_\gamma),$$

this here M n - of the engine nominal torque on the shaft .

Required power

$$P_{nF..\varphi} = E_{OH}^2\left(m_1 r_c + \frac{\Delta P_{куш.н}}{I_{CM}^2}\right)\varphi^2\,\frac{(x_{OF.\varphi} + x_{\mu F}^1)^2 + \left(r_{OF.\varphi} + \dfrac{r_P^{12} F}{\beta\varphi}\right)}{(r_{OF.\varphi}^2 + x_{OF.\varphi}^2)\left(\dfrac{r_P^{12}}{\beta^2\varphi} + x_P^{12}\right)} + \Delta P_{ЭМ.Н} F + \Delta P_{ст.н}\varphi^2 F^K \quad .$$

Expression of CE and power factor of motor indicators:

$$\eta_{F,\varphi} = \frac{P_{\partial F\varphi}}{P_{\eta F,\varphi}} = \frac{M_{\partial н}\omega_{он}(F - \beta_\varphi)(x_{OF,\varphi} + x_P^1 F)^2 + (r_{OF,\varphi} + \dfrac{r_P^1 F}{\beta_\varphi})^2}{\Delta P_{ЭМ.Н} F + \Delta P_{ст.н}\varphi^2 F^2 + E_{CH}^2\varphi^2(m_1 r_C + \dfrac{\Delta P_{ЭОБ.Н}}{I_{CH}^2})(r_{OF,\varphi}^2 + x_{OF,\varphi}^2)(\dfrac{2_{PF}^1}{\beta\varphi} + x_P^{12})} \quad .$$

$$\cos\varphi_{F,\varphi} = \frac{P_{nF,\varphi}}{m_1 U I_{CF,\varphi}} = \left[\frac{E_{CH\varphi}(m_1 r_c + \dfrac{\Delta P_{ЭОБ.Н}}{I_{CH}^2})(x_{OF,\varphi} + x_{p\varphi}^1)^2 + (r_{OF,\varphi} + \dfrac{r_{pF}^1}{\beta\varphi})^2}{m_1 U(r_{OF,\varphi} + x_{OF,\varphi}^2)(\dfrac{r_p^{12}}{\beta\varphi} + x_p^{12})} + \frac{\Delta P_{ЭМ.Н} F + \Delta P_{ст.н}\varphi^2 F^K}{m_1 U E_{CH.\varphi}}\right] x$$

$$x\sqrt{\frac{(r_{OF,\varphi}^2 + x_{OF,\varphi}^2)\left(\dfrac{r_p^{12}}{\beta\gamma} + x_\rho^{12}\right)}{(x_{OF,\varphi} + x_P^1 F)^2 + \left(r_{OF,\varphi} + \dfrac{r_p^{12} F}{\beta\varphi}\right)^2}}$$

Energy indicator

$$\eta_{F,\varphi}\cos\varphi_{F,\varphi} = \frac{P_{\partial F,\varphi}}{m_1 U I_{CF,\varphi}} = \frac{M_{\partial H}\omega_{OH}(F - \beta\varphi)}{m_1 U E_{CH}\varphi}\, x \sqrt{\frac{(r_{OF,\varphi}^2 + x_{OF,\varphi}^2)\left(\dfrac{r_p^{12}}{\beta_\varphi^2} + x_p^{12}\right)}{(x_{OF,\varphi} + x_{PF}^1) + \left(r_{OF,\varphi} + \dfrac{r_p^1 F}{\beta\varphi}\right)^2}}$$

The voltage U corresponding to the defined values of F and s $^{\varphi}$

can be defined as follows:

$$U = \sqrt{2x_C^2 F^2 I_{CF,\varphi}^2 - A_{F,\varphi} + (2x_C^2 F I_{CF,\varphi}^2 - A_{F,\varphi})^2 - A_{F,\varphi}^2 - \frac{4}{m_1^2} x_C^2 F^2 P_{PF,\varphi}^2},$$

here $A_{F,\varphi} = I_{CF,\varphi}^2 (x_C^2 F^2 + r_C^2) - E_{CH}^2 F^2 \varphi^2 - \frac{2}{m} r_C P_{nF,\varphi}.$

The optimum value of current for different frequencies F is sufficient for g opt level of accuracy (error not greater than 2%) analytical without calculations method, DR can be determined without studying the EMF, X = SH (X) function.

In this case, we assume that the square of the stator current of an induction motor is equal to the sum of the squares of the applied current of the rotor and the magnetizing current.

$$I_{CF,\varphi}^2 = I_{P\varphi}^{12} + I_{O\varphi}^2$$

Of the rotor listed toki esa okimga reverse is proportional to :

$$I_{P\varphi}^1 = \frac{\Delta P_{\text{ЭМ.Н}}}{m_1 E_{CH} \varphi}, \quad (14)$$

To express the square of the magnetizing current by current, we use the formula:

$$I_{O\varphi}^2 = I_{OH}^2 \frac{\gamma^2}{K_M - (K_M - 1)^2 \varphi},$$

where K M is the selection coefficient of the curve I 2 OX to be more accurate.

Based on the above initial cases, we obtain an approximate expression of electromagnetic losses:

$$\Delta P, \varphi = \frac{B}{\varphi^2} + C \frac{\gamma^2}{K_M (K_M - 1)\varphi^2} + D\varphi^2 F^2,$$

here $B = (r_c + r_p^1)\Delta P_{\text{ЭМ.Н}} / m_1 E_{CH}^2 : C = 3r_C^2 I_{OH}^2 : D = \Delta P_{CTH}.$

by taking some addition from the expression and making it equal to zero, making some changes:

$$\varphi^2 + \text{в}\varphi^2 + c_\varphi \varphi^2 + d_F \varphi^2 + e_\varphi = 0, \quad (17)$$

here

$$\text{в} = \frac{2K}{1 - K_\mu}; c_F = \frac{cr_\mu + DF^k K_\mu^2 - B(K_\mu - 1)}{DF^K (K_\mu - 1)^2};$$

$$d_F = \frac{2BK_\mu}{DF^k (K_\mu - 1)}; e_F = \frac{B}{DF^K} \left(\frac{K_\mu^2}{K_\mu - 1} \right);$$

Solving Equation (3.17), we obtain the general analytical expression of the optimal current, in which the power dissipated in an asynchronous motor in frequency-controlled systems is the smallest, and the CE is the highest:

$$\varphi_{\text{ОПТ}} = \sqrt{\frac{\text{в}+A}{4} + \sqrt{\left(\frac{\text{в}+A}{4}\right)^2 - \text{у}\frac{\text{в}\varphi - dF}{A}}},$$

$$A = \sqrt{8\varphi + \text{в}^2 - 4c_F};\varphi = \sqrt[3]{-q+\sqrt{q^2-p^2}} + \sqrt[3]{-q-\sqrt{q^2+p^3}} + \frac{c_F}{6},$$

here $$q = -\left(\frac{C_F}{6}\right)^3 + \frac{C_F(4d_F - \text{в}^2) - d_F^2}{16}, p = -\left(\frac{C_F}{6}\right)^2;$$

by substituting the values obtained into, it is possible to obtain in the optimal mode the values of the quantities and parameters of interest to us, with the electromagnetic loss being the smallest (minimum).

References:

1. Mirzaev, Uchkun and Abdullaev, Elnur, Mathematical Description of Asynchronous Motors (April 15, 2020). International Journal of Academic and Applied Research (IJAAR), 2020, Available at SSRN: https://ssrn.com/abstract=3593185 or http://dx.doi.org/10.2139/ssrn.3593185

2. Alisher Boliev, and Uchkun Mirzaev. "Technical and Economic Indicators of a Microhydroelectric Power Station in Agriculture." International Journal of Engineering and Information Systems (IJEAIS) ISSN (2020): 51-56.

3. Mirzaev, Uchkun and Davron, Uktamov and Abdurauf, Axmedov, The Structure Of The Energy Passport Of Industrial Consumers (2021). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X Vol. 5 Issue 3, March - 2021, Pages: 207-209, Available at SSRN: https://ssrn.com/abstract=3820385

4. Mirzaev, Uchkun and Diyor, Hiloliddinov, Methodology Of Energy Audit In Uzbekistan (2021). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X Vol. 5 Issue 3, March - 2021, Pages: 197-199, Available at SSRN: https://ssrn.com/abstract=3820392

5. Mirzaev, Uchkun and Ashraf, Davirov and Akbarbek, Abirov, Energy Audit Basics, Energy Audit Tasks And Energy Audit Methods (2021). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X Vol. 5

Issue 3, March - 2021, Pages: 185-188, Available at SSRN: https://ssrn.com/abstract=3820389

6. Nurbek, Kuchkarov and Abdurauf, Axmedov, Test Methods For Current Transformers For Protection With Low Residual Magnetization Intended For Operation Under Transient Short-Circuit Conditions. (May 30, 2020). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X Vol. 4, Issue 5, May 2020, Pages: 44-47, Available at SSRN: https://ssrn.com/abstract=3794530
7. Abdurauf, Axmedov and Izadla, Murodlaev, Surface Losses in Electrical Machines (June 30, 2020). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X Vol. 4, Issue 6, June 2020, Pages: 83-86, Available at SSRN: https://ssrn.com/abstract=3794525
8. Abdurahim, Pardaboev, Energy Saving in the Operation of Electric Motors (June 30, 2020). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X; Vol. 4, Issue 6, June – 2020, Pages: 60-63, Available at SSRN: https://ssrn.com/abstract=3794623
9. Urinov, Shuhrat and Zohid, Qulboyev, Power Losses in Electric Machines (June 30, 2020). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X, Vol. 4, Issue 6, June – 2020, Pages: 87-89, Available at SSRN: https://ssrn.com/abstract=3794675
10. Abdullaev, Elnur and Azim, Umirzakov, The Main Energy Saving Measures In Industrial Enterprises And Their Effectiveness (2021). International Journal of Engineering and Information S ystems (IJEAIS) IS S N: 2643-640X Vol. 5 Issue 3, March - 2021, Pages: 189-191, Available at SSRN: https://ssrn.com/abstract=3820381