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# Analysis in a closed system of Frequency controlled Electric drives

**Shavazov A.A., Sayfullaeva L.I. Tuxtaev B.B.**

PhD, Heads of laboratories. Institute of energy problems Academy of Sciences of the Republic of Uzbekistan
Ch. Aytmatov str., 2-B Tashkent 100084, Uzbekistan
Junior scientific researcher Institute of energy problems Academy of Sciences of the Republic of Uzbekistan
Ch. Aytmatov str., 2-B Tashkent 100084, Uzbekistan
MA student. Tashkent State Technical University Named After Islam Karimov. University 2 A Street Tashkent 100095, Uzbekistan

**ABSTRACT:** The working state of frequency-operated asynchronous motor of irrigation pump in the closed system with feedback by velocity are considered. The system issue coefficient, provided a constancy of given value, loading coefficient of motor for voltage control pro rata control frequency are determined. The article analyzes the content schemes of the frequency moder device, value units, ie voltage, frequency. Rational Race developed for electrical output, managed as a result of the analysis.

## I. INTRODUCTION

In order to introduce energy-saving technologies for energy efficient use and electrical energy savings, decrees of the President of the Republic of Uzbekistan No. PP-2343 dated May 5, 2015 "On the program of measures to reduce energy consumption and the introduction of energy efficient technologies in the economy and social sector sectors for 2015-2019" [one]. Based on the adopted resolutions in pumping stations of pumping stations and energy of the Ministry of Water Management, a program was developed and approved the program for the implementation of electrical installations for the energy efficient and energy-saving use of electrical energy for 2015-2025 [1].

## II. LITERATURE SURVEY

Asynchronous motor develops significant electromagnetic moments in transient processes, several times higher than nominal and even critical. These moments are the reason of occurrence of dangerous mechanical stresses in elements of kinematic circuit of electric drive system. Conditions of electromagnetic transients in asynchronous motor, and first of all its undamped field, have significant influence on duration of these processes. Neglecting electromagnetic transients when analyzing these modes leads to incorrect estimation of moments acting in electric drive system, significant errors in determining losses in the motor, etc.

The operating mode of an asynchronous motor (AD) in a frequency-controlled electric drive system is determined by mutual variation of the following related parameters: input - frequency and voltage; internal stator and rotor currents, flux and absolute slip parameter; output - rotation speed and torque on the shaft. The ratio of the voltage to the frequency determines the law of the frequency control. The operating mode of an asynchronous motor (AD) in a frequency-controlled electric drive system is determined by mutual variation of the following related parameters: input - frequency and voltage; internal stator and rotor currents, flux and absolute slip parameter; output - rotation speed and torque on the shaft. Values of input parameters-frequency and voltage must be changed so that under the influence on the value of internal parameters the given speed at any torque of resistance on the shaft is ensured.

Famous laws of controls The voltage ratio to the frequency is mainly investigated on the basis of the management principle in the opening system. In such an open frequency control system as the control frequency decreases, the flow, the maximum moment, the stiffness of the mechanical characteristic and the engine control range is reduced.

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## III. MATERIAL AND METHODS

Consider the static mode of the operation of the frequency-controlled blood pressure in the closed system with feedback in speed. The block diagram of such a closed system is shown in the figure. Here, FFCH, RF, PH, FP and N - frequency converter; frequency regulator; voltage regulator; functional converter and pump; $K_f$ и $K_{df}$ - coefficients of transmissions of the AE and hell over the frequency channel; $K_\gamma$ and $K_{d\gamma}$ - the coefficients of transmissions of the AE and hell over the voltage channel; $K_{fp}$ and $K_s$ - transmission coefficients of the FFCH and speed meter; $U_s$- specifying speed of rotation AD voltage; $U_{uf}$ и $U_{u\gamma}$ - voltage controls through frequency and voltage channels; $U_{fv}$ - feedback voltages; ω, $\omega_o$ and Δω - the angular velocities of rotation of the rotor, the fields of the stator and the absolute gliding blood pressure; $F=F/F_v$ and $\gamma=U/U_v$ - relative frequency and voltage.

At Fig.1. functional diagram of automatic frequency control of asynchronous electric drive with IF with FFCH link, controlled rectifier and autonomous voltage inverter is given, where are indicated: IT - intensity problems for formation of transition processes in a system, RF - the regulator of frequency, RV - the regulator of voltage, IF and IS - measuring instruments of frequency and speed, FFC- the functional converter the providing required law of change of tension on the stator as frequency and the nature of change of the moment of loading, Ms - the loading moment on an engine shaft; F = f/fn, ω and U - relative frequency, angular speed and motor voltage, $U_yF$ and $U_yU$ - control voltages RF and RV. We believe that RF and RV regulators contain the main elements - control objects, measuring elements, regulating bodies or actuators and amplifiers.

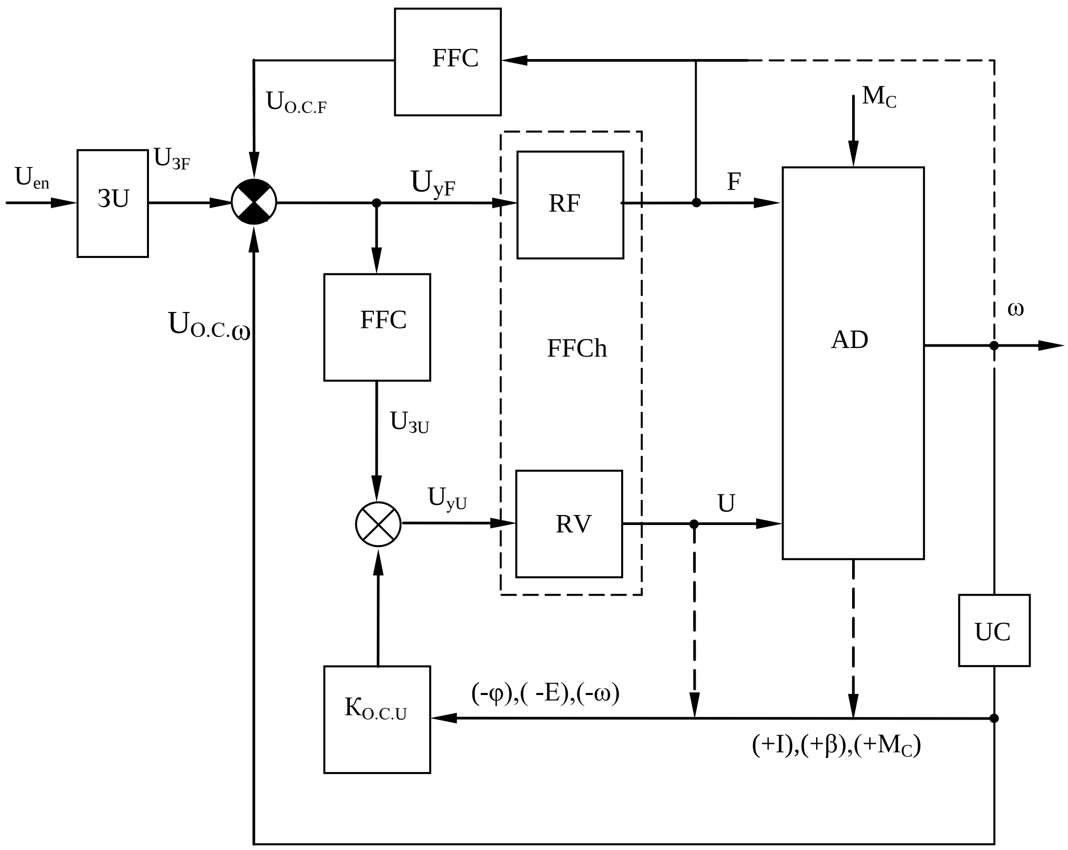


Fig.1. Functional diagram of "FFCH-AD" system with stabilization of flow and speed of AD

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According to the drawing, the transfer coefficient of hell over the voltage channel will be

$$K_{Д\gamma} = \frac{\Delta\omega}{U_{н}\gamma} = \frac{\omega_{он}}{U_{н}\gamma} S, \quad \textbf{(1)}$$

Where S - is a relative gliding blood pressure.

As can be seen from (1) the transmission coefficient $K_{d\gamma}$ of the variable - depending on S and the frequency ratio to the voltage.

In [1], it is shown that to control the performance of the irrigation pump, it is advisable to control the voltage in proportion to the frequency, that is, $\gamma$=F. In this case, the characteristic of the FP will be linear, and (1) will be recorded with an accuracy of slip in the form of $K_{d\gamma}=\omega_{ov}S_v/U_v$=const.. Thus, the specified values of all system transmission coefficients are constant.

The control frequency channel determines the synchronous angular speed of rotation, and the voltage channel is an absolute sliding of the engine. The difference $\omega_o$-$\Delta\omega$ gives the angular speed of rotation of the AE shaft. A feature of this system is that the engine rotation speed through the feedback circuit affects the frequency and voltage simultaneously.

Note that when regulating the required relationship between the frequency and voltage using the FFCH, in the general case, you can receive the original parameter as a frequency and voltage. However, in terms of the effect of perturbations in the supply network and the load on the engine speed, the system in which the initial parameter is the frequency, and the voltage is adjusted to the frequency function. In such a system, the dynamic change in the rotational speed will be less, since the speed of rotation of the engine depends primarily on the frequency, which is determined by the inverter control system and does not depend on perturbations in the supply network and load, and the voltage is a parameter defined not only by the IF control system But and the whole power scheme. That is why in the above closed system, the frequency is the initial parameter.

According to the above drawing, the angular speed of rotation of the engine will be

$$\omega = KU_3,$$

Where

$$K = \frac{K_f K_{дf} - K_{фп} K_{\gamma} K_{1\gamma}}{1 + (K_f K_{дf} - K_{фп} K_{\gamma} K_{1\gamma}) K_{oc}} \quad (2)$$

-Coefficient transfer of a closed system. Here, the specified constant values of the coefficients $K_f$, $K_\gamma$, $K_{ffch}$, and $K_s$ can be chosen based on the condition of the requirement set to the system, and the remaining coefficients are constant.

We find what should be the coefficient of transmission of a closed feedback system in the speed of the speed in this system in this system in the operating range of the pumping speed of the pump unit from $F_{min}$ to F=1 was not lower than the nominal irrigation coefficient ($\lambda_v$) of the engine in a natural scheme inclusion. To do this, it is necessary to pre-find the minimum frequency and moment of the engine.

In irrigation pumps, the reduction in the speed of rotation in order to regulate productivity is possible to a certain minimum value, in which the pump pressure (P) becomes equal to the static pressure ($P_s$). The pump performance (p) is dropped to zero. Based on this condition, we define the minimum control frequency [2]

$$F_{min} = \sqrt{H_{ст} / H_{o}}, \quad (3)$$

Where $N_o$ - but the pressure at Q=0 and $\omega=\omega_v$.

The torque of the blood pressure at a variable frequency obtained on the basis of the T-shaped substitution scheme taking into account (2) at $\gamma$=F is recorded as

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$$M = \frac{K_M r_2^` X_{\mu H}^2 (F-\beta)}{KU_3 \beta D^2}, \quad (4)$$

Where

$$D = \sqrt{\left(\frac{r_1 r_2^`}{F\beta} - X_s X_r \sigma\right)^2 + \left(\frac{r_2^`}{\beta} X_s + \frac{r_1}{F} X_r\right)^2}, \quad (5)$$

$X_s = X_{iv} + X_{\mu v}$; $X_r = X^`_{2H} + X_{\mu v}$ ; $\sigma = 1 - X_{\mu H}^2 / X_s X_r$; $r^`_1$ and $X^`_{1v}$ $X_s$ - active and nominal inductive resistance phase of the stator winding; $r^`_2$ and $X^`_{2n}$ the above active and nominal inductive resistance phase of the rotor winding; $X_{\mu H}$ - nominal inductive resistance of the magnetizing contour; β=FS -parameter of absolute slip; $K_M = mU_v/9{,}81$; m-number of phases.

Exploring (4) to maximum, we get

$$a\beta^2 + b\beta + c = 0, \quad (6)$$

Where

$$a = \left[\left(\frac{r_1}{F}\right)^2 + (X_s\sigma)^2\right] X_r^2 + 2 r_1 r_2^` X_{\mu H}^2 / F^2,$$

$$b = 2\left[\left(\frac{r_1}{F}\right)^2 + X_s^2\right] r_2^` / F, \qquad c = -Fb/2.$$

From (6) We define the critical value of the absolute slip parameter

$$\beta_{k1,2} = \frac{b}{2}(-1 \pm \sqrt{1 + 2aF/b}). \quad (7)$$

## IV. SIMULATION&RESULTS

As can be seen from (7), that the roots (6) are positive. The condition for the positivity of the valid root we need (the critical value of the absolute slip parameter is found) will be with the positivity of the sign in front of the radical, that is

$$\beta_k = \frac{b}{2}(-1 + \sqrt{1 + 2aF/b}). \quad (8)$$

By setting this expression to place β in (4) we will find the maximum moment ($M_k$) of the engine.
The recessibility coefficient of blood pressure at the minimum control frequency will be

$$\lambda_{(F=Fmin)} = M_{k(F=Fmin)} / M_H, \quad (9)$$

Where $M_n$ is determined from (4) at f=1 and $\beta = S_H$ .
From the condition $\lambda_{(F=Fmin)} = \lambda_H$, we get

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$$k = \frac{S_H D_H^2 \left[F_{min} - \beta_{k(F=F\,min)}\right]}{\gamma_3 \lambda_H (1 - S_H) D^2_{(F=F\,min)} \beta_{k(F=F\,min)}}, \quad (10)$$

Where $\gamma = U_3/U_{3H}$ and $k = K/K_n$ - relative specifying voltage and the coefficient of transmission of the system closed in speed; $\lambda_n$ - Rated coefficient of blood pressure pressure in the opening system, determined from the catalog; $D_n$ is determined from (5) at F=1 at $\beta = S_v$.

## V. CONCLUSION

Thus, according to (10), the value of "k" is determined, which ensures the constancy of the control coefficient of the blood pressure over the entire range of changes in the control frequency in the closed feedback system with feedback speed of the engine.

The development of rational systems of adjustable electric drives providing the most economical mode of operation of irrigation pumps is an important national economic task.

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