EFFECTIVENESS OF USING A FREQUENCY CONVERTER WITH SMOOTH SPEED CONTROL OF AN INDUCTION MOTOR

Kurbonov Nurali Abdullayevich
teacher
Xalikova Xurshida Abdullayevna
teacher
Karshi Engineering and Economic Institute

Annotation: The article discusses the efficiency of a frequency converter when using it for smooth control of the rotational speed of electric drives with an asynchronous motor (AD). The ratios of voltage and frequency of the supply network for various loads are given.

Keywords: network frequency; smooth regulation; artificial characteristics; motor torque; mechanical characteristics.

There are several methods for regulating the rotation speed of an asynchronous motor; among them, frequency regulation is one of the most promising and is being widely implemented at present. Its principle is that by changing the frequency of the supply voltage f_1 of an asynchronous motor (IM), it is possible to change $\omega_0 = 2\pi f_1 / p$ its speed in accordance with the expression, ω_0 obtaining artificial characteristics. This method provides smooth speed control over a wide range, and the resulting characteristics are highly rigid. The frequency method also differs in one more very important property: regulation of the speed of the IM is not accompanied by an increase in its slip, therefore power losses during speed regulation, determined by , turn $\Delta P_2 = P_{эм} - P_2 = M\omega_0 - M\omega = M\omega_0 s$ out to be small [1].

To better use the IM and obtain high energy performance indicators of its operation - power factors, efficiency, overload capacity - simultaneously with the frequency, it is necessary to change the voltage supplied to the IM. The law of voltage change depends on the nature of the load torque M_c.

With a constant load torque, the voltage on the stator must be regulated in proportion to its frequency:

$$U_1/f_1 = const, \qquad (1)$$

For the fan nature of the load, the ratio takes the form:

$$U_1/f_1^2 = const, \qquad (2)$$

and when the load torque is inversely proportional to the speed, it will be written in the form

$$U_1/\sqrt{f_1} = const. \qquad (3)$$

Thus, when implementing the frequency method of regulating the speed of the IM, a frequency converter must be used, which also makes it possible to regulate the voltage on the stator of the IM. [2]

A necessary element of an electric drive (ED) is a frequency and voltage converter, the input of which is supplied with standard mains voltage (220, 380 V, etc.) of industrial frequency $f_1 = 50$ Hz, and an alternating voltage $U_{1рег}$ of adjustable frequency is removed from its input, the values $f_{1рег}$ of which are between each other certain relationships defined by (1), (2) and (3). The output frequency and voltage are regulated using a control signal, the change in which ultimately determines the change in motor speed. [3]

Analysis of the mechanical characteristics of the blood pressure when it is controlled $U_1 / f_1 = const$ according to the simplest law shows that the speed of the ideal idle speed of the blood pressure changes when regulated, ω_0 and te f_1 critical moment remains unchanged, M_k which follows from its simplified expression.

$$М_к = 3U_ф^2/(2\omega_0 x_к) \quad (4)$$

Indeed, since $\omega_0 \sim f_1$ and $x_k \sim f_1$, then the critical moment is $M_к \sim U_1^2 / f_1^2 \sim$ $U_1 / f_1 = const$.

Mechanical characteristics according to their characteristics are divided into two parts: characteristics corresponding to frequencies below the nominal (network) $f_{1ном}$ and above it.

Frequency range $f_1 < f_{1ном}$. In this area for $f_{13} = f_{1ном}$; $f_{14} < f_{13}$ и $f_{15} < f_{14}$ frequencies; and the $U_1 / f_1 = const$ ratio can be fulfilled, since the voltage supplied to the IM is regulated from the nominal (mains) voltage towards a decrease. Therefore $M_к = const$, blood pressure has a constant overload capacity. Note that due to the influence of resistance , R_1 which was not taken into account when deriving formula (4), the torque in the region of low speeds of the IM decreases somewhat, therefore, to maintain the $M_k = const$ voltage at a low frequency, it must change disproportionately to it.

Frequency range $f_1 > f_{1ном}$. Under the conditions of normal operation of the IM, the voltage cannot be increased above the nominal (certificate) voltage. Therefore $U_1 = U_{1ном} = const$, speed control in this area is carried out at , and therefore the critical moment in accordance with (4) will decrease with increasing f_1 ($f_{11} >$ $f_{12} > f_{1ном}$)[4].

Conclusion; The implementation of this speed control method ensures smooth regulation without surges over a wide range, which significantly reduces the starting current and saves electrical energy.

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