EFFICIENCY OF USE OF FREQUENCY CONVERTER WITH SMOOTH CONTROL OF ASYNCHRONOUS MOTOR SPEED

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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 ways to control the rotational speed of an induction motor, among which frequency regulation is one of the most promising and is being widely implemented at the present time. Its principle lies in the fact that, by changing the frequency f_1 of the voltage supplying the asynchronous motor (AM), it is possible, in accordance with the expression $\omega_0 = 2\pi f_1 / p$, to change its speed ω_0, obtaining artificial characteristics. The frequency method also differs in another very important property: the speed control of the AM is not accompanied by an increase in its slip, therefore, the power loss during speed control, determined by $\Delta P_2 = P_{эм} - P_2 = M\omega_0 - M\omega = M\omega_0 s$, turns out to be small [1].

For better use of the IM and obtaining high energy 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 in this case depends on the nature of the load moment 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 moment 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 for regulating the speed of the AM, a frequency converter should be used, which also allows you to regulate the voltage on the AM stator. [2]

A necessary element of an electric drive (ED) is a frequency and voltage converter, the input of which is supplied with a standard mains voltage U_1 (220, 380 V, etc.) of an industrial frequency $f_1 = 50\,\text{Hz}$, as well as an adjustable alternating voltage $U_{1рег}$ from its input, a frequency $f_{1рег}$,is taken, the values of which are between itself in certain ratios defined by (1), (2) and (3). The regulation of the output frequency and voltage is carried out using the control signal $U_У$, the change of which ultimately determines the change in the speed of the motor. [3]
An analysis of the mechanical characteristics of the AM when it is controlled according to the simplest law $U_1 / f_1 = const$ shows that the speed, ω_0 of the ideal idling of the AM changes when f_1 is controlled, and the critical moment M_k remains unchanged, which follows from its simplified expression

$$М_к = 3U_ф^2/(2\omega_0 х_к) \qquad (4)$$

Indeed, since ω_0~ f_1 and x_k ~ f_1 , then the critical moment is $M_к \sim U_1^2 / f_1^2 \sim U_1 / f_1 = const$.
According to their features, mechanical characteristics are divided into two parts: characteristics corresponding to frequencies below the nominal (mains) $f_{1ном}$ and above it.
Frequency range $f_1 < f_{1ном}$. In this region, for frequencies $f_{13} = f_{1ном}$; $f_{14} < f_{13}$ и $f_{15} < f_{14}$; and the $U_1 / f_1 = const$ ratio can be fulfilled, since the voltage supplied to the AM is regulated from the nominal (mains) downwards. Therefore, $M_к = const$ and AM have a constant overload capacity. Note that due to the influence of the resistance R_1, which was not taken into account when deriving formula (4), the moment M_k in the region of low IM speeds decreases somewhat, therefore, to maintain $M_k = const$, the voltage at a low frequency should change disproportionately to it.
Frequency range $f_1 < f_{1ном}$. Under the conditions of normal operation of the IM, it is impossible to increase the voltage in excess of the nominal (passport). Therefore, the speed control in this area is carried out at $U_1 = U_{1ном} = const$, and therefore the critical moment M_k , in accordance with (4), will decrease with increasing f_1(f_{11}> f_{12} > $f_{1ном}$) [4].
Conclusion;
The implementation of this method of speed control provides smooth control without surges in a wide range, which significantly reduces the starting current and saves electrical energy.

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