DESIGNING OF INVERTER AC DRIVES HAVING HIGHER SPEED OF RESPONSE

Brazhnikov A.V., Belozerov I.R.

Siberian Federal University, Krasnoyarsk, Russia

One of the essential features required of the rolling mill electrical drives is their high speed of response. That is necessary for the decrease of the crop ends body during the rolling and can be obtained by the reduction of the acceleration and braking periods of a rolling mill.

The decrease of these periods can be obtained by the overstating of the rolling mill electrical drives power. The realization of this mode requires the higher capital investments for making the electrical drive systems.

This paper authors have worked up an alternative method of the increase of the speed of response for the frequency controlled electrical drives based on induction motors. This method does not require any overstating of the drive systems power. According to this mode the increase of such electromechanical systems speed of response is obtained by the joint application of the phase-pole control method (PPM) and classical frequency control principle in these systems during the regulation of the induction motor rotation speed. The description of PPM is presented, for example, in [1, 2].

In the case when PPM is used the inverter AC drive system must have the number of phases equal to six or more (i.e. the system must be based on the induction motors and frequency converters having the number of phases more than five) to achieve the possibility of PPM realization. Moreover the magnetic circuit and/or stator winding set of the multiphase (i.e. having the number of phases equal to six or more) induction motors must be made with some peculiarities to achieve the same aim. The description of these peculiarities is presented in [1, 2].

PPM bases on the increase in the electrical angles between the voltages (or currents) of the nearest phases of a frequency converter by a factor of some whole number $H > 1$ without any change in the converter voltage (or current) amplitude and frequency. The integer H is the parameter of PPM. During PPM application, when the parameter H changes, the effect adequate to the synchronous change in the drive phase number (i.e. the number of phases) and the motor pole number (i.e. the number of poles) appears. In this case the value of the parameter $H > 1$ shows by what factor the actual motor pole number increases, when the given PPM version is used, in comparison with the case when some traditional control mode is used (i.e. when $H = 1$). Therefore the value of the parameter H defines the parameters of the induction motor mechanical characteristic (such as the synchronous speed of rotation, maximal torque, etc.).

It is possible to achieve various versions of PPM for one and the same phase number of the AC drive system.

In consequence of all the above listed the PPM application allows to obtain not one, but a few natural static mechanical characteristics of a multiphase induction motor (without any change in the amplitude U and frequency F of the frequency converter voltage). The additional use of the classical frequency control method allows to make the transition from one mechanical characteristic to another one not stepwise, but smooth.

In this case (i.e. when PPM is used and $U * F = const$) the synchronous rotation speed of an induction motor is inversely proportional to the value of the parameter H, and the motor maximal torque is almost proportional to the above mentioned value.

The joint application of PPM and the frequency control method allows to decrease the acceleration and braking periods of the motor. The extent of this decrease depends on the drive phase number. If drive phase number tends to infinity, this time period diminishes by a factor of 1.55.

The proposed method of the increase of the drive system speed of response is expedient for application not only in the field of the rolling mill drives, but also in a number of other machines and mechanisms (for example, in drives of robots, some drilling rigs, etc.).

REFERENCES:

1. A.V. Brazhnikov, and N.N. Dovzhenko, “Control Potentials and Advantages of Multiphase AC Drives”, Proceedings of 29th Annual IEEE Power Electronics Specialists Conference “PESC ‘98”, Fukuoka, Japan, May 17-22, 1998, vol. 2, pp. 2108 – 2114.

2. A.V. Brazhnikov, and I.R. Belozyorov, “Over-Phase Control of Inverter Multiphase AC Linear Drives”, Book of Abstracts of 8th International Symposium on Linear Drives for Industry Application “LDIA‘2011”, Eindhoven, the Netherlands, July 3-6, 2011, pp. 122-123.