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Optimized Control of the Speed of Asynchronous Motor of the Feed Grinding Devices Used in Agricultural Enterprises

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ABSTRACT: The article covers the ways of achieving energy savings by controlling the speed of asynchronous electric motors in a frequency method. Frequency control is economical because it increases the efficiency and reduces power loss by adjusting the speed of the asynchronous motor. One of these methods is the method of controlling the speed of the asynchronous motor of feed crushers using a frequency converter. Start and control of the crushers is carried out using a frequency converter, which is set between the automatic and asynchronous motor and is controlled by the rotational frequency of the induction motor, which in addition leads to energy savings. In this case, the start and control of the asynchronous motor of feed crushers is carried out using a frequency converter. Asynchronous motors of feed crushers, the speed of which is adjustable by changing the frequency, along with saving the energy in static modes, saves the energy in dynamic modes as well. When starting the asynchronous motor of feed crushers without direct mains voltage, the starting current is 5-10 times higher than the rated stator current, which leads to an increase in power dissipation in the stator winding, if the inertia torque of the asynchronous motor and working mechanisms is large it lasts a very long time. As a result, the stator coil insulation heats up above the allowable temperature and the insulation fails. As a conclusion, we can say that the frequency control of asynchronous motor in the operation of the asynchronous electric motor of feed crushers used in agricultural enterprises is economical, because the frequency converter allows the adjustment of the speed of the asynchronous motor and increase of the power coefficient of the electric drive.

KEY WORDS: Energy saving, electric drive, frequency converter, optimal control, energy criteria, operating mechanisms, energy efficiency, control systems, efficiency factor, power factor.

I. INTRODUCTION

In the process of development of the electric power industry, which is one of the important manufacturing enterprises of the economy, and the operation of feed grinding equipment in agricultural enterprises, the production of control products based on technologies for providing asynchronous motors, one of the problems is considered to be a feed grinding device, energy and resource production technology. In the development of this sphere, many decrees and resolutions have been adopted, appointed by the President of the Republic.

Among these decrees and resolutions, PQ-2692 dated December 22, 2016 "On additional measures for the prompt renewal of physically and morally obsolete machines of industrial enterprises, to reduce the cost of production" of the President of the Republic of Uzbekistan2 August, President of the Republic of Uzbekistan2. 2017 No. Decision PQ-3238 "On measures to develop modern energy-efficient and energy-saving technologies", No. PF-4947 dated February 7, 2017 for 2017-2021 "Strategy for the further development of the Republic of Uzbekistan", reducing the energy and resource potential of economic development Wide application of new technologies that accelerate energy production, increase production productivity. In addition, in April 1997, the Law of the Republic of Uzbekistan "On the rational load from energy resources" (No. 412-1), Decree of the President of the Republic of Uzbekistan PK-3012 dated February 26, 2017 "Development of energy in the industrial and commercial sector in 2017-2021 years." , this scientific article to a certain extent helps in the implementation of decisions on measures for the further development of the use of renewable energy

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sources in other regulatory legal documents related to this activity. It is known that the sphere of agriculture in our republic is being improved and developed more and more. Today, the demand for feed mills used in agriculture is increasing every year. It is known that 70-80 percent of the output of power plants are electric motors [2]. On this day, ensure reliable control of asynchronous electric motors used in food grinding devices during operation, plan the management of power consumption modes of energy devices based on modern automated electrical appliances, control asynchronous control of asynchronous motors of food grinding devices. The power engineer pays special attention to restoring the cost of equipment repair, fast supply of electricity and energy carriers. For this reason, the use of energy-saving methods in the operation of feed mills is considered one of the diseases of our time [6].

II. SIGNIFICANCE OF THE SYSTEM

The article covers the ways of achieving energy savings by controlling the speed of asynchronous electric motors in a frequency method. Frequency control is economical because it increases the efficiency and reduces power loss by adjusting the speed of the asynchronous motor. One of these methods is the method of controlling the speed of the asynchronous motor of feed crushers using a frequency converter. Start and control of the crushers is carried out using a frequency converter, which is set between the automatic and asynchronous motor and is controlled by the rotational frequency of the induction motor, which in addition leads to energy savings. In this case, the start and control of the asynchronous motor of feed crushers is carried out using a frequency converter.

III. SYSTEM ANALYSIS

One of these methods is the method of controlling the speed of asynchronous motors of feed grinding device using a frequency converter [1]. The starting and operation of feed grinding device is carried out using a frequency converter, which is set between the automatic machine and the asynchronous motor and is controlled by the rotational frequency of the asynchronous motor, which in addition leads to energy savings. In this case, the start and control of the asynchronous motor of feed grinding device is carried out using a frequency converter. Asynchronous electric drives, the speed of which can be adjusted by changing the frequency, can save energy in static modes, as well as efficient use of electricity in dynamic modes [1]. When starting asynchronous motors without direct mains voltage control, the starting current is 5-7 times higher than the rated stator current, which leads to an increase in power dissipation in the stator winding, and if the moment of inertia of the asynchronous motor and the working mechanism is large, the transition process will take a very long time [2].

Fig.1. Control of an asynchronous motor of a universal feed chopper

As a result, the stator coil insulation heats up above the allowable temperature, which leads to the fail of the insulation. Therefore, when starting asynchronous motors, the speed of which is controlled by changing the frequency, controlled by a certain pattern, it prevents the stator current from overheating, and then the induction motor is started normally in the thermal mode [3]. It is known that large electromagnetic moments and currents occur during direct starting of asynchronous motors. Large-amplitude oscillations of electromagnetic moments can create dangerous dynamic loads

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in the stator winding of asynchronous motor, and can cause mechanical stresses in the kinematic chains of an electric drive. Fig. 2 shows closed functional circuit of frequency control using an asynchronous motor of feed crusher.

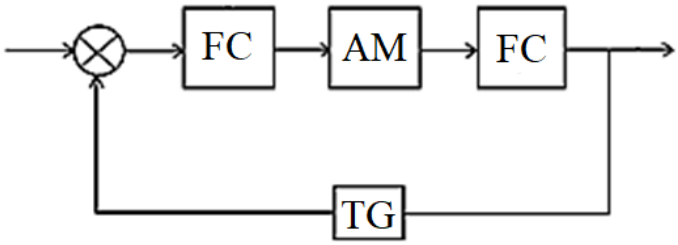

Fig. 2. Closed functional circuit of frequency control using an asynchronous motor of feed crusher: FC- Frequency converter,AM- Asynchronous motor, TG- Taxogenerator, FC – Feed crusher

Therefore, in starting the asynchronous motor of feed grinding devices and ensuring a smooth flow of stops, that is, preventing the formation of large dynamic voltages prolongs the life of the asynchronous motor. As an example, the description of the change in the instantaneous value of the electromagnetic moment $M_*(t)$ at the time of direct starting of the asynchronous motor of feed grinding device used in agriculture is given in (Fig. 3).

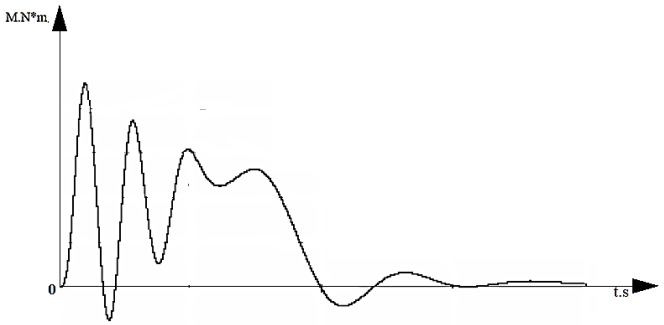

Fig. 3. Oscillogram of instantaneous values of the electromagnetic moment $M_*(t)$ at the direct starting of asynchronous motor of the feed grinding device [4]

In our next graph, in the same situation, the oscillogram of change in instantaneous values of the angular speed $\omega_*(t)$ at the time of direct starting of asynchronous motor of feed grinding device used in agriculture is shown in (Fig. 4).

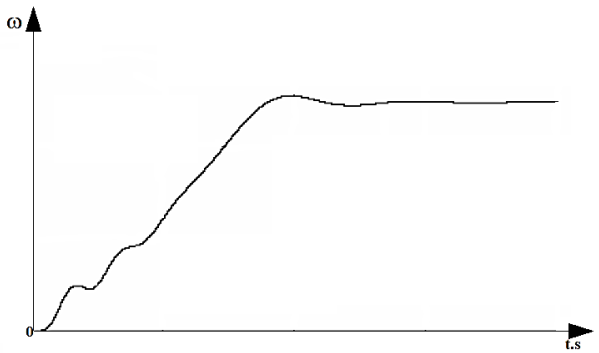

Fig. 4. Oscillogram of the change in instantaneous values of the angular velocity $\omega_*(t)$ at the time of direct starting of the asynchronous motor of the feed grinding device [4]

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At present, one of the ways to optimize the processes of starting and stopping frequency-controlled asynchronous motors and improving its static and dynamic characteristics is to generate a variable amplitude voltage in the stator windings of asynchronous motor. This method is also called the parametric method, which is common due to its positive properties. Its advantage is simplicity and ease of technical production. The problem of optimal parametric control of the asynchronous motor of feed grinding device in agricultural enterprises is realized as follows. We determine the coordinates to be controlled, which can be axes, electromagnetic torque, rotor speed, etc., as well as the optimal control effect during starting the asynchronous motor to the nominal speed and complete stopping of the rotor speed during stopping.

As a control indicator we take the relative value of *γ,* i.e. stator winding voltage. Optimization is carried out on the principle of maximum and based on the mathematical model by the Newton-Rawson method, the frequency of which is assumed to be 50 Hz [5]. When the induction motor is started on an open system, the smooth changes in the stator winding voltage can reduce the shock moments, starting currents, power dissipation and reactive power values consumed [4].

The next graph (Fig. 4) shows the smooth starting of the asynchronous motor of feed grinding device used in agriculture by changing the frequency speed of the asynchronous motor and change in its energy performance [5-7]. Starting the asynchronous motor of agricultural feed grinding devices with a smooth frequency change, the transition processes in the change of quality indicators and energy performance (electrical losses at the input of the frequency converter power circuit) have been considered [2].

IV. METHODOLOGY

In an open system, during smooth start of an asynchronous electric drive whose speed is adjusted by changing the frequency, it can be seen the smooth starting. Therefore, we can see that the frequency change time depends on the starting process and the energy performance [3].

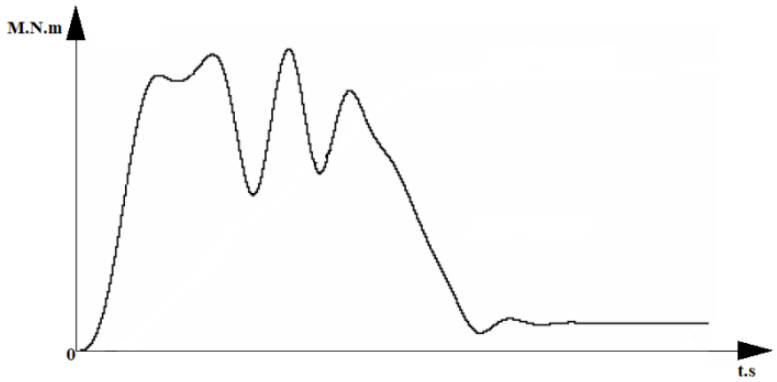

Fig. 5. Oscillogram of instantaneous values of the electromagnetic moment *M**(*t*) during smooth start of asynchronous motor of the feed grinding device by the frequency converter [4]

Fig.5 shows the characteristics of the change in instantaneous values of the angular velocity $\omega_*(t)$ at the start of the control of asynchronous motors of the feed grinding device used in agriculture by frequency converter.

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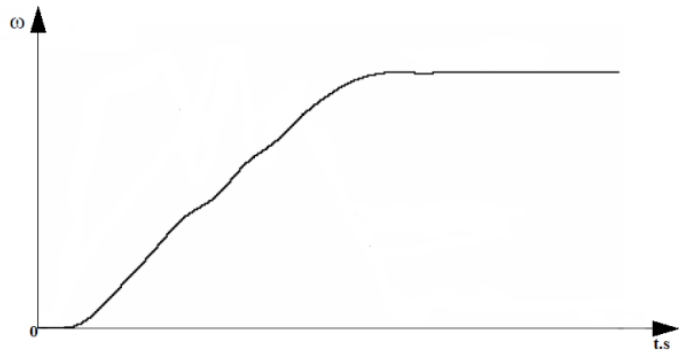

Fig. 6. Oscillogram of the smooth start of asynchronous electric drive, the speed of which is adjusted by changing the frequency of asynchronous motor of the feed grinding device [4]

For all variables of an asynchronous motor, their nominal values are taken as their base parameters, regardless of the rotor speed. The base value of the rotor speed is the ideal operating speed of the nominal frequency [4].

V. EXPERIMENTAL RESULTS

Asynchronous motors of feed crushers, the speed of which is adjustable by changing the frequency, along with saving the energy in static modes, saves the energy in dynamic modes as well [1]. When starting the asynchronous motor of feed crushers without direct mains voltage, the starting current is 5-10 times higher than the rated stator current, which leads to an increase in power dissipation in the stator winding, if the inertia torque of the asynchronous motor and working mechanisms is large it lasts a very long time [5]. As a result, the stator coil insulation heats up above the allowable temperature and the insulation fails. Therefore, when starting asynchronous motors, the speed of which is controlled by a certain pattern, which prevents the stator current from overheating, and then the induction motor is started normally in the thermal mode [6-11]. It is known that large electromagnetic moments and currents occur during direct starting of asynchronous motors. Large-amplitude oscillations of electromagnetic moments can create dangerous dynamic loads in the stator winding of asynchronous motor and can cause mechanical stresses in the kinematic chains of electric drive. Therefore, in starting the asynchronous motor of feed crushers ensuring a smooth flow of stops, i.e. the prevention of the formation of large dynamic voltages prolongs the service life of the asynchronous motor.

VI. CONCLUSION

As conclusion we can say that during the operation of the asynchronous electric motor of feed grinding device used in agriculture, optimal control of static and dynamic modes of the asynchronous motor was achieved, that is, saving power consumption through frequency control, adjusting the speed of the asynchronous motor, increasing the efficiency of the electric drive by smooth starting and stopping the electric drive, and reducing the power loss of the asynchronous motor were achieved.

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