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Energy Saving in Asynchronous Motors Used for Devices of Fodder Shredders

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ABSTRACT: The article covers data on achieving energy efficiency at the expense of frequency control of the speed of asynchronous motor of equipment for fodder grinding. Frequency control provides energy saving because it increases the efficiency of an asynchronous motor by straightening the speed of an asynchronous motor and reduces power losses. The start and control of equipment for fodder grinding using a frequency converter, which is installed between the machine and the electric motor, and controls the speed of the motor is shown. Before, front-tooth (gear) gearboxes were used to change the speed of an electric motor, which, in turn, led to various difficulties. In case of necessity of reducing or increasing the number of revolutions of the electric motor due to the peculiarities of the production technology, the use of additional mechanisms in the electric drive, in turn, led to an increase in the power of the electric motor. Using frequency converters, the speed can be directly regulated by changing the frequency of the electric motor. One of the advantages of this method is that, since current and torque are closely related, the frequency converter can reduce the starting current when starting the motor. The motor starts smoothly, and it allows saving energy during startup.

KEY WORDS: energy saving, electric drive, frequency converter, optimal control, working mechanisms, energy efficiency, coefficient of efficiency.

I. INTRODUCTION

As we know, the agricultural sector of our republic is increasingly being improved and developed at present. The asynchronous motor of fodder grinding equipment currently used in agriculture can be driven in several ways. Agricultural fodder shredders are used, e.g., to grind corn, wheat, millet and other grains. The asynchronous motor of these shredders generates very large current jumps known as starting current or braked rotor current. The starting current is 5-10 times higher than the rated current, acts for a short time, and after acceleration, the current in the electric motor drops to a minimum value. Therefore, during the operation of a fodder shredder, various starting methods are used in order to reduce the starting current of the asynchronous motor of the equipment. In addition, a number of measures should be taken to stabilize the supply voltage. Currently, the asynchronous motor of equipment for fodder grinding, used in the example of one of the agricultural enterprises JSC "Bukhoroparranda", can be started in several ways.[1].

II. SIGNIFICANCE OF THE SYSTEM

Start and control of fodder grinding devices is carried out using a frequency converter, which is installed between the machine and the asynchronous motor. The shredder is controlled by the rotation speed of an asynchronous motor, which further leads to energy savings. This is done using a frequency converter when starting and controlling the asynchronous motor of fodder grinding devices. Along with saving electricity in static modes of asynchronous electric drives, the speed of which can be adjusted by changing the frequency, it is possible to effectively use electricity in dynamic modes [2]. When starting asynchronous motors without direct control of the mains voltage, the starting current is 5-10 times higher than the rated stator current, which leads to excessive power losses in the stator winding.

III. SYSTEM ANALYSIS

If the moment of inertia of the asynchronous motor and working mechanisms is large, then the transition process takes a long time [3]. As a result, the stator winding insulation will heat up above the permissible temperature and lead

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to insulation failure. For this reason, when starting fodder grinding devices with asynchronous motors, the speed of which can be adjusted by changing the frequency, starting by frequency control according to a certain law prevents the stator current from exceeding, and then the asynchronous motor starts normally according to the thermal mode [4]. It is known that large electromagnetic moments and currents arise when direct starting an asynchronous motor of fodder grinding devices. Fluctuations of electromagnetic moments of large amplitude can create dangerous dynamic loads in the stator winding of an asynchronous motor, as well as cause mechanical stress in the kinematic circuits of the electric drive [7]. Therefore, ensuring a smooth transition of starting and stopping the asynchronous motor of fodder grinding devices, that is, preventing the formation of large dynamic stresses, extends the service life of the asynchronous motor. Fodder grinding devices consist of mechanisms and parts that perform a specific job. All mechanisms and parts of feed grinding devices are driven by asynchronous electric motors. One of these methods is a method of controlling the rotation speed of an asynchronous motor of fodder grinding equipment using a frequency converter [1].

Fig. 1. General view of controlling an asynchronous motor of a universal fodder shredder using a frequency converter

One of such devices is a closed functional diagram of frequency control of asynchronous motors of fodder grinding devices, used in the example of the enterprise of JSC “Bukhoroparranda”, shown in Fig. 2.

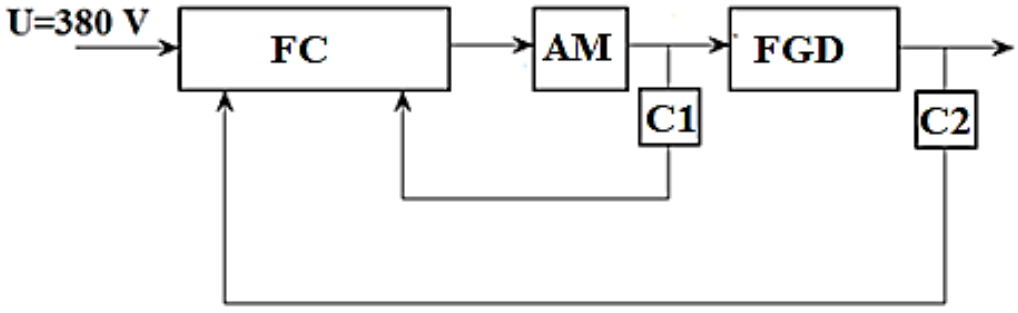

Fig. 2. Closed functional diagram of frequency control of an asynchronous motor for fodder grinding devices [5, 6]: Power supply U=380 V; FC – frequency converter; AM - asynchronous motor; C1-C2 – speed sensors; FGD – fodder grinding device

The automatic machine is connected to a voltage network of U=380 V, and a frequency converter is installed between the automatic machine and the motor, which regulates the rotation speed of the asynchronous motor of the shredder. During the starting of the asynchronous motor, the motor runs smoothly and the asynchronous motor runs without excessive loads. In addition, energy is saved during starting. Therefore, the implementation of the control method is carried out automatically [2-3]. In the process of controlling the rotation speed of the asynchronous motor of the fodder

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grinding devices based on frequency converters, the asynchronous motor in the fodder grinding devices moves smoothly during their starting, as a result of which the asynchronous motor in the fodder grinding devices prevents too much fodder from passing at the same time and prevents the asynchronous motor from stopping operation during the grinding process. In addition, electricity is saved 3-4 times in the asynchronous motor of the fodder grinding device. Before the use of this type of device, gears (sprockets) were used to perform this task. This, in turn, caused various difficulties [4, 5]. If, due to the peculiarities of production technology, it is necessary to reduce or increase the speed of an asynchronous motor, then the use of additional mechanisms in the electric drive, in turn, will lead to an increase in the power of the asynchronous motor.

IV. METHODOLOGY

With the help of frequency converters, the speed can be regulated directly by changing the frequency of the asynchronous motor of the shredder. One advantage of this method is that since there is a close relationship between current and torque, the frequency converter can reduce the starting current. The operating principle of the device for smooth starting the rotation speed of the asynchronous motor of the shredder is based on thyristor voltage regulators, which can be distinguished from each other by the adjustment scheme, change algorithms depending on the load on the asynchronous motor, and service functions. Since smooth starters use phase control methods, they allow the start of electrical circuits represented by heavy starting modes “nominal - nominal”. In such launchers, power factor correction and energy-saving mode are installed, which allows increasing the number of launches [6, 7].

V. EXPERIMENTAL RESULTS

This is an ideal solution, both functionally and technically, providing the best results with a smooth start, without connection to an envelope contactor, remaining constant in control circuits, with the exception of mechanical switching, which means there is absolutely no sparking of contacts, which is very useful in explosive industries. Technically, the area of its application is universal and can be used for dynamic braking and motor reversing. Three-phase control allows optimizing the operation of the electric motor using specified algorithms, thereby improving the energy characteristics of the electric motor. Therefore, the smooth start of the asynchronous motor of fodder shredders ensures efficient starting of motors and prevents failure of fodder shredders. Smooth starting of asynchronous motors is desirable only if the specified rating is accurately selected for the effective use of fodder grinding devices. The criteria for such a choice are usually the type of load of the asynchronous motor, starting frequency and rating data. Therefore, it is important to consider their future application when choosing smooth starters for asynchronous motors in fodder plants. Smooth start modes of an asynchronous motor in fodder shredders can be divided into the following three groups:

- starting time in normal mode is from 10 to 20 seconds, the value of the startup current is $3{,}5xI_{nom}$ level;
- heavy mode is characterized by loads with a slightly higher moment of inertia. Starting currents are limited to $4.5xI_{nom}$ and the acceleration time is 30 seconds;
- very heavy mode requires very high moments of inertia. Starting currents can reach up to 5.5 times, and acceleration times can be well above 30 seconds.

In addition, the obtained data can be used during the operation of various protective devices (phase imbalance, overload, etc.). This type, as well as similar devices and tools, can be combined into a single control system for the asynchronous motor of a fodder grinding device. Currently, one of the ways to optimize the processes of starting and stopping asynchronous motors, the speed of which is controlled by changing the frequency, and improving the static and dynamic characteristics of an asynchronous motor in fodder grinding plants is to generate a voltage of variable amplitude in the stator windings of an asynchronous motor [1-3]. This method is also called parametric method and is widely used due to its positive aspects. Its advantage is its simplicity and ease of technical manufacturing. The problem of optimal parametric control of an asynchronous motor of the fodder shredders at agricultural enterprises is implemented as follows. We determine the controlled coordinates, which can be axes, electromagnetic torque, rotor speed, etc., and the optimal control action during the process of starting an asynchronous motor to the rated speed, as well as a complete stop of the rotor rotation speed during the stopping process [2]. As a control indicator we take γ, i.e., the relative value of the stator winding voltage. Let us carry out optimization according to the maximum principle and, based on a mathematical model using the Newton-Raphson method, the frequency is assumed to be 50 Hz [5-7]. As a result of a smooth change in the voltage of the stator winding when starting an asynchronous motor of fodder grinding plant in an open-loop system, the values of impulse torque, starting currents, power losses and consumed reactive power can be reduced [4-6]. As an example, we give the following: at one of the agricultural enterprises, namely at the JSC “Bukhoroparranda” enterprise, three-phase asynchronous motors with short-circuited rotor 4A100L6U3, 4A100S4U3, 4A112MA6U3, 4AIRM06U3, 4AIRM11V6U3, etc. are currently used in fodder grinding plants. Their power is from 2 ,2 kW to 30 kW, and the voltage

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is 220/380 V. In the process of controlling the asynchronous motor of the fodder grinding device through a frequency converter at the JSC "Bukhoroparranda" enterprise, we achieve energy saving in the following way. In the course of our research, we came to the conclusion that by adjusting the rotation speed of the asynchronous motor of fodder grinding devices through frequency converters, we can save up to 20% of the electricity consumed in the process. We can see this in our calculations as follows. In the process of conducting experimental studies during direct operation of an asynchronous motor of a shredder with a power of P = 30 kW, when measured with the "Energomir" measuring device, it was determined that it consumed current I_1= 22.5 ampere per hour when operating in load mode. When running a shredder of the same power and the same load through a frequency converter, it consumes I_2 = 4.5 ampere per hour. Calculations show that the power consumption is 23.4 kW, i.e., 20% less. In addition, when calculating the amount of energy savings for one year for fodder grinding devices with a power of P = 30 kW, operating 12 months a year, it will be as follows:

E_2 (1 year, kW*h) = 30 kW*(20%/100)*20 hour*27 days*12 months = 38880 kW*h.

When calculating the amount of energy savings in monetary terms, i.e., in UZS, based on 1 kW*h = 450 UZS, we get the following.

E_2 (1 year, UZS) = 38880 kW*h*450 UZS = 17496000 million UZS can be saved at the expense of energy.

VI. CONCLUSION

In conclusion, we can say that due to the frequency regulation of the asynchronous motor of fodder feed grinding devices used at the JSC "Bukhoroparranda" enterprise, energy savings were achieved and economic efficiency amounted to 17,496,000 million UZS.

REFERENCES

1. Khoshimov A.A., Saidakhmedov S.S. Basics of electricity. -T.: TSTU. 2003.
2. Khomudkhanov M.Z., Majidov S.M. Electrical engineering and fundamentals of its control. -T.: Ukituvchi, 1970.
3. Aripov N.M. Automated electric drive. Science and technology. 2002.
4. Nurali Pirmatov, Abdullo Panoev, G.Samatova, and O'lmasbek Berdiyorov. Determination of methods of achieving the energy savings through mathematical modeling of static and dynamic modes of electromagnetic energy conversion in asynchronous motors used in feed crushers.E3S Web of Conferences383, 04046 (2023) https://doi.org/10.1051/e3sconf/202338304046 TT21C-2023
5. Baratov R, Pirmatov N, Panoev A, ChulliyevYa, Ruziyev S and Mustafoqulov A.Achievement of electric energy savings through controlling frequency convertor in the operation process of asynchronous motors in textile enterprises IPICSE 2020 IOP Conf. Series: Materials Science and Engineering 1030 (2021) 012161 IOP Publishing doi:10.1088/1757-899X/1030/1/012161
6. Pirmatov N., Panoev A. Frequency control of asynchronous motors of looms of textile enterprises E3S Web of Conferences, 2020, 216, 01120.
7. Yefimov A.A., Shreiner R.T. Edited by R.T. Schreiner. Active converters in adjustable alternating current electric drives. -Novouralsk: NSTI, 2001. -250 p.