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CONTROL OF STATIC AND DYNAMIC MODES OF ASYNCHRONOUS MOTOR OF FODDER GRINDING DEVICES

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Abstract:

Objective. 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.

Methods. 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.

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. 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.

Conclusion. 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.

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

Introduction. As we know, today the agricultural sector in Republic is improving and developing rapidly. The asynchronous motor of feed grinding devices currently used in agriculture can be operated in several ways. For example, when we use feed grinding devices, used in agriculture, to grind corn seeds, very large current

steps are generated in the asynchronous motor of feed grinders, which is called the starting current or the current in the brake rotor. The starting current is 5-10 times higher than the rated current, has a short-term effect, and after acceleration, the current in electric motor drops to a minimum value. Therefore, during the operation of the feed grinding device, different methods of starting are used to reduce the starting current of the asynchronous motor of the device. In addition, a number of measures must be taken to stabilize the supply voltage.

Methods. 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]. 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 in the stator winding of asynchronous motor, and can cause mechanical stresses in the kinematic chains of an electric drive.

Fig. 1 shows closed functional circuit of frequency control using an asynchronous motor of feed crusher.

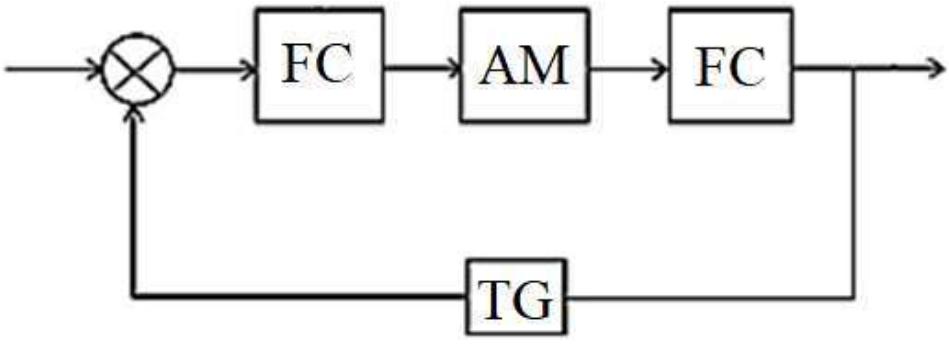

Fig. 1. Closed functional circuit of frequency control using an asynchronous motor of feed crusher:
FC- Frequency converter,AM- Asynchronous motor, TG- Taxogenerator, FC – Feed crusher

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. 2).

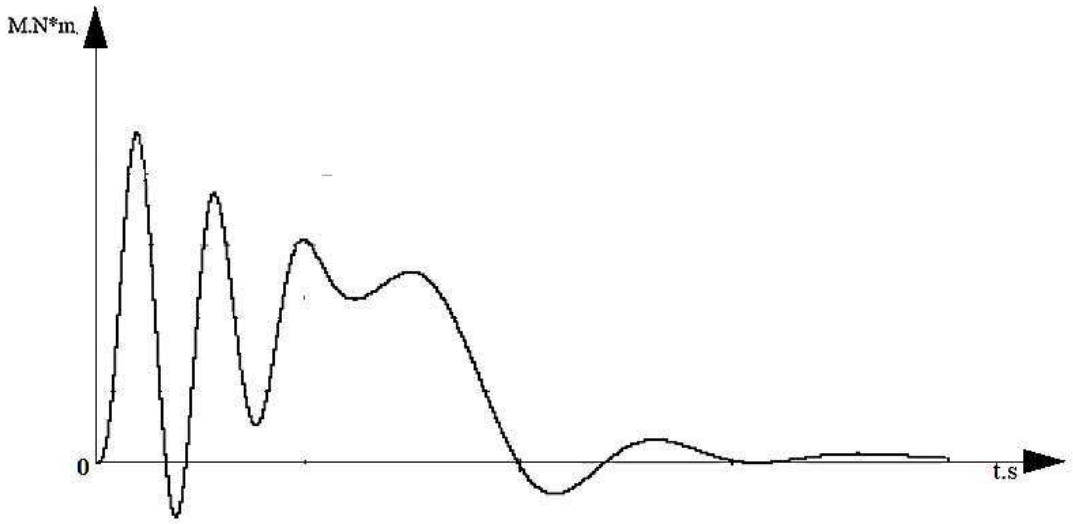

Fig. 2. Oscillogram of instantaneous values of the electromagnetic moment $M_*(t)$ at the direct starting of asynchronous motor of the feed grinding device [4]

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. 3).

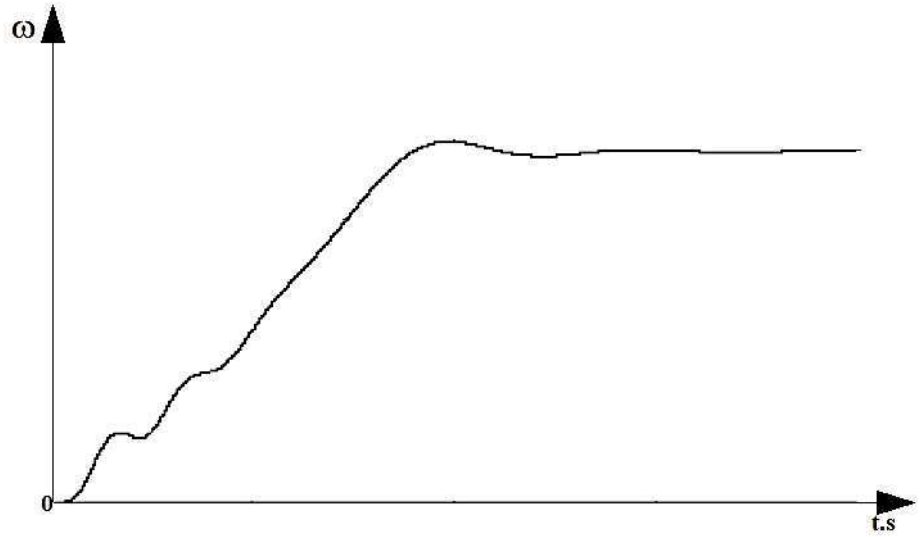

Fig. 3. Oscillogram of the change in instantaneous values of the angular velocity $\omega_*(t)$ at the time of direct starting of the asynchronous motor of the feed grinding device [4]

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].

Results. 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].

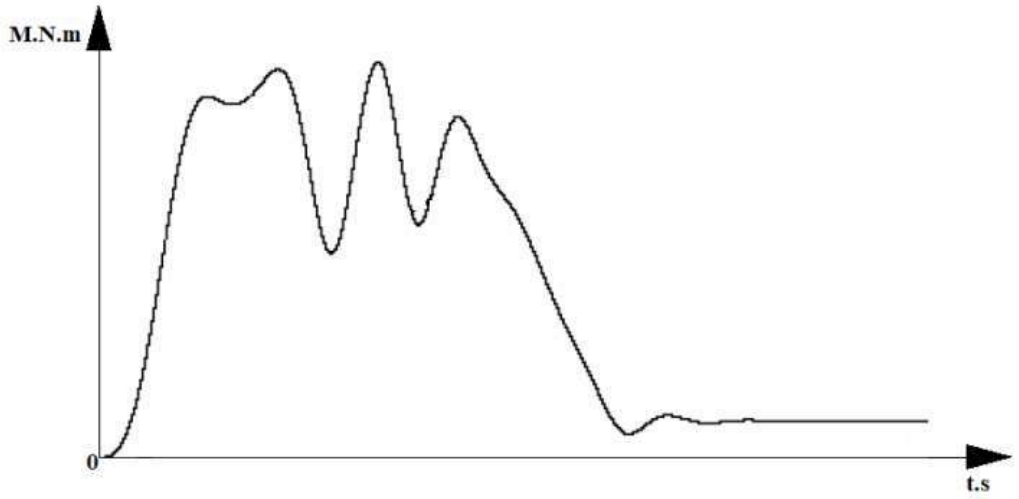

Fig. 4. Oscillogram of instantaneous values of the electromagnetic moment *M*(t)* during smooth start of asynchronous motor of the feed grinding device by the frequency converter [4]

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.

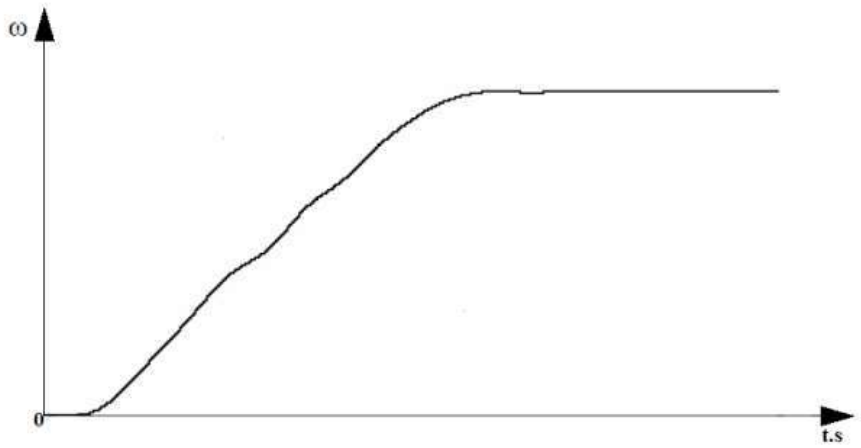

Fig. 5. Oscillogram of the smooth start of asynchronous electric drive, the speed of which is adjusted by changing the frequency of asynchronous motor of the feed grinding device [4]

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].

Discussion. 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.

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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CONTENTS

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

N.Khalikova, S.Pulatova	
A research of consumer opinions in forming the important factors of fur garments……..	3
N.Khalikova, S.Pulatova	
Literary analysis new technologies of women's outer clothing from carakul….	9
Sh.Korabayev, H.Bobojanov, S.Matismailov, K.Akhmedov	
Study of aerodynamic characteristics of cotton fiber in separator of pneumo-mechanical spinning machine……	14
Sh.Korabayev	
Research of the movement of fibers in the confusion between the air channel and the rotor in a pneumo-mechanical spinning machine……..	18
M.Mirsadikov, M.Mukimov, K.Kholikov, N.Karimov, Sh.Mamadjanov	
Analysis of technological parameters and physic-mechanical properties of interlock knitted fabric knitted from cotton-nitron yarn……	23
M.Mirsadikov, M.Mukimov, K.Kholikov, N.Karimov	
Study of technological parameters and physical-mechanical properties of rib fabric knitted from spinning cotton-nitron yarn…….	32
N.Karimov	
Analytical calculation of the deformation state of the saw gin saw teeth bending under the action of a load……..	38
Z.Ahmedova, A.Khojiyev	
Analysis of headwear and beret in fashion……	42
N.Khusanova, A.Khojiyev	
Creation of a new model of women's coat……	51
M.Abdukarimova, R.Nuridinova, Sh.Mahsudov	
Method of designing special clothing based on approval of contamination assessment methodology……	59
Sh.Isayev, M.Mamadaliyev, I.Muhsinov, M.Inamova, S.Egamov	
Practical and theoretical analysis of the results obtained in the process of cleaning cotton from impurities……	67

GROWING, STORAGE, PROCESSING AND AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES

D.Saribaeva, O.Mallaboyev	
Scientific basis for the production technology of fruit lozenges (marshmallow)	74
R.Mohamed, K.Serkaev, D.Ramazonova, M.Samadiy	
Development of technology to incorporate dehydrated murunga leaf powder in paneer cheese……..	79
B.Adashev, D.Salikhanova, D.Ruzmetova, A.Abdurahimov, D.Sagdullaeva	
Indicators of blending of refined vegetable oils…….	87
O.Ergashev, A.Egamberdiev	
Choosing acceptable parameters for experiment on new energy-saving vacuum sublimation drying equipment……..	92

A.Eshonto'rayev, D.Sagdullayeva, D.Salihanova	
Determining the effectiveness of soaking almond kernels before processing..	**97**
CHEMICAL TECHNOLOGIES	
Sh.Kiyomov, A.Djalilov, R.Zayniyeva	
Adhesion of a thermoreactive epoxy waterful emulsion film former on metal..	**102**
A.Djalilov, Sh.Kiyomov	
Synthesis of a non-isocyanate urethane oligomer based on phthalic anhydride……..	**107**
T.Abdulxaev	
Water vapor adsorption isotherm on zeolite AgZSM-5……	**114**
F.Juraboev, B.Tursunov, M.Togaeva	
Study of the catalytic synthesis of o-vinyl ether based on monoethanolamine and acetylene……	**120**
S.Mardanov, Sh.Khamdamova	
Solubility of components in the system NaClO3 CO(NH2)2-NH(C2H4OH)2 - H2O…….	**124**
D.Salikhanova, Z.Usmonova, M.Mamadjonova	
Technological basis of activated carbon production process through processing of plum seed waste……..	**128**
N.Alieva	
Analysis of the effect of adhesive substances on paper strength……	**134**
Sh.Rahimjanova, A.Hudayberdiev	
Optimization of heating of mixtures of oil and gas condensate by hot flows of fractions in tubular heat exchangers……..	**138**
M.Mehmonkhanov, R.Paygamov, H.Bahronov, A.Abdikamalova, I.Eshmetov	
Binding materials for creating coal granules and their colloid-chemical characteristics……..	**146**
A.Khurmamatov, S.Boyturayev	
Analysis of oil dust released during processing of metal surfaces under laboratory conditions……	**152**
M.Kalilayev, Sh.Bukhorov, A.Abdikamalova, I.Eshmetov, M.Khalilov.	
Study of foam formation in polymer solutions depending on the content and nature of surfactants…….	**159**
MECHANICS AND ENGINEERING	
Sh.Pozilov, O.Ishnazarov, R.Sultonov	
Frequency adjustment of well pumping equipment……..	**167**
H.Kadyrov	
Control of vibration parameters on the tank wall of oil power transformers in operation……..	**179**
S.Khudayberganov, A.Abdurakhmanov, U.Khusenov, A.Yusupov	
Methodology for assessing the level of train safety…….	**185**
Sh.Abdazimov, N.Muminjanova	
Use of integrated technologies in vocational education…….	**189**
M.Uzbekov, O.Bozarov, E.Begmatov, M.Begmatova	
Analytical analysis of the optimal dimensions and energy parameters of the impeller of a nozzle hydraulic turbine…….	**196**
B.Boynazarov, F.Nasretdinova, M.Uzbekov	

Analysis of solar energy devices.....	**205**
D.Mukhtarov, R.Rakhimov	
Determining comparative efficiency in composite film solar dryers.....	**213**
P.Matkarimov, D.Juraev, S.Usmonkhujaev	
Stress-strain state of soil dams under the action of static loads.....	**221**
A.Khayrullaev	
Microcontroller-based remote monitoring of overhead power lines.....	**228**
A.Mamaxonov, I.Xikmatillayev	
Design of a resource-efficient chain drive structure for the device drive that distributes the seed in the bunker to the linters.....	**237**
A.Yusufov	
Analysis of existing methods and approaches to the assessment of residual resources of traction rolling stock.....	**243**
A.Djuraev, F.Turaev	
Determination of the friction force between the composite feeding cylinder and the fiber rove.....	**249**
A.Kuziev	
Forecasting the prospective volume of cargo transportation for the development of the transport network.....	**253**
N.Pirmatov, A.Panoev	
Control of static and dynamic modes of asynchronous motor of fodder grinding devices.....	**260**
ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION	
K.Ismanova	
Systematic analysis of the state of control of the technological processes of underground leaching.....	**267**
K.Shokuchkorov, Y.Ruzmetov	
Analysis in solidworks software of the strengths generated in the underground part of the wagons as a result of the impact of force on the entire wheels of wagons.....	**273**
A.Yuldashev	
The processes of gradual modernization of the state administration system in uzbekistan over the years of independence.....	**278**
ECONOMICAL SCIENCES	
O.Khudayberdiev	
Fourth industrial revolution in the textile and garment manufacturing.....	**287**
N.Umarova	
Methodology for assesment of external factors affecting the financial security of building materials industry enterprises.....	**293**