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SIMULATION OF ELECTRIC DRIVE OF RING SPINNING MACHINES

The analysis of the operating modes of the electric drive of the ring spinning machines is carried out, the drawbacks of the open-loop control systems are revealed and the tasks are set to optimize the operation of the electric drive of the ring spinning machines. Computer simulation for open and closed control system of electric drive of ring spinning machines has been performed.

Keywords: ring-spinning machine, asynchronous motor, electric drive, automation, frequency converter, computer simulation.

Today it is impossible to imagine an electric drive without sensors, automatic regulators, controlled converters and other elements that allow achieving large ranges of regulation of the parameters of electric drives of various machines and mechanisms. Such control systems of electric drives usually have two or more external loops made with feedbacks for speed, current, voltage, etc. Feedback enables the interconnection between the input and output of the drive control system, which is necessary to achieve automation of the drive. Feedbacks are performed based on various parameter sensors [1, 11]. In this work, the object of the study was a ring spinning machine of the P-114-Sh series, which was installed at the "Textile Plant" in Khujand, the Republic of Tajikistan. The purpose of the work was to study the ways and methods of automation of the electric drive of the ring-spinning machine of the P-114-Sh series and thereby optimize the operation of the machine as a whole.

The main ways to optimize the operating modes of ring spinning machines include the following [1, 7]:

- introduction of microprocessor control systems;
- increasing the automation of production processes;
- automatic control and regulation of the operating parameters of the electric drive of the spinning machines.

Of the above optimization paths, the last method was adopted for research, i.e., automatic control and regulation of the operating parameters of the electric drive [7].

The relay-contactor control system of an electric drive is a very reliable system with a simple circuit and accessible elements, but it has a number of disadvantages, for example [2, 4]:

- large size of control system elements;

– inability to perform complex management functions;

– inability to automate the control and monitoring of the parameters of the electric drive with high accuracy.

The ring-spinning machine of the P-114-Sh series contains two electric motors, M_1 and M_2. The M_1 electric motor is used to drive the hook-and-loop fan, and the M_2 motor is the main drive of the machine. As electric motors, asynchronous machines of the AO2-32-2 series with a power of 4 kW, 2940 rpm and AOT2-61-4 with a power of 10 kW, 1460 rpm were used. It should be noted that the AO2, AOT2 series of asynchronous motors began to be produced at the end of the 50s of the last century, and now these series have long been discontinued.

Today, with the development of power electronics, a wide variety of frequency converters are produced, from simple to complex, in the flesh up to a microprocessor control and monitoring system [9, 10]. In the course of the study, a review of frequency converters of Russian and foreign companies were carried out and, as a result, general advantages were identified, such as [5, 6]:

– high accuracy of speed regulation;

– energy saving;

– stabilization of the rotation speed when the load changes;

– smooth engine start;

– the ability to remotely monitor the drive;

– the ability to connect directly to the controlled variable sensor.

Computer simulation of the electric drive was carried out on the basis of the MATLAB/Simulink program [7, 8]. This program is very well known among scientists of all industries, and is also widely used for modeling electrical objects and equipment. To simulate the electric drive of the ring-spinning machine, we took the asynchronous motor of the main drive of the machine. A computer model for studying the start of an asynchronous motor with direct start is shown in Figure 1. This model was taken from the MATLAB Help menu, where anyone can get acquainted with these models [2, 3, 13, 14].

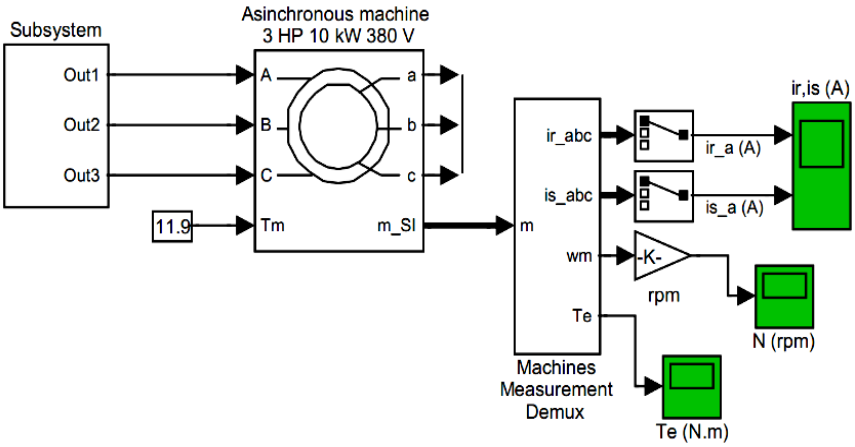

Figure 1. Computer model for the study of direct start of an induction motor

The simulation results of direct start are shown in Figures 2 and 3.

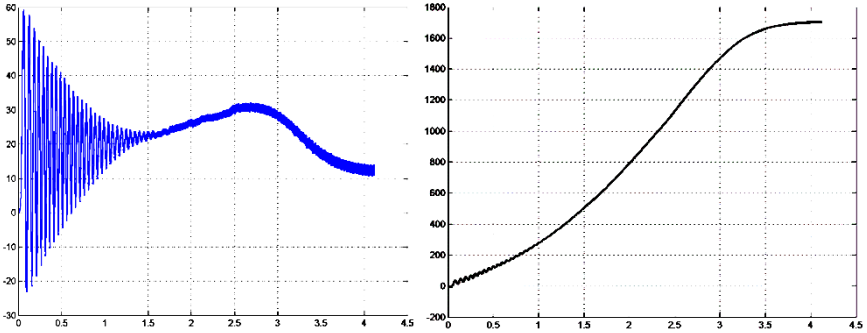

Figure 2. Graphs of transient processes of the electromagnetic torque and speed of an asynchronous motor with direct start

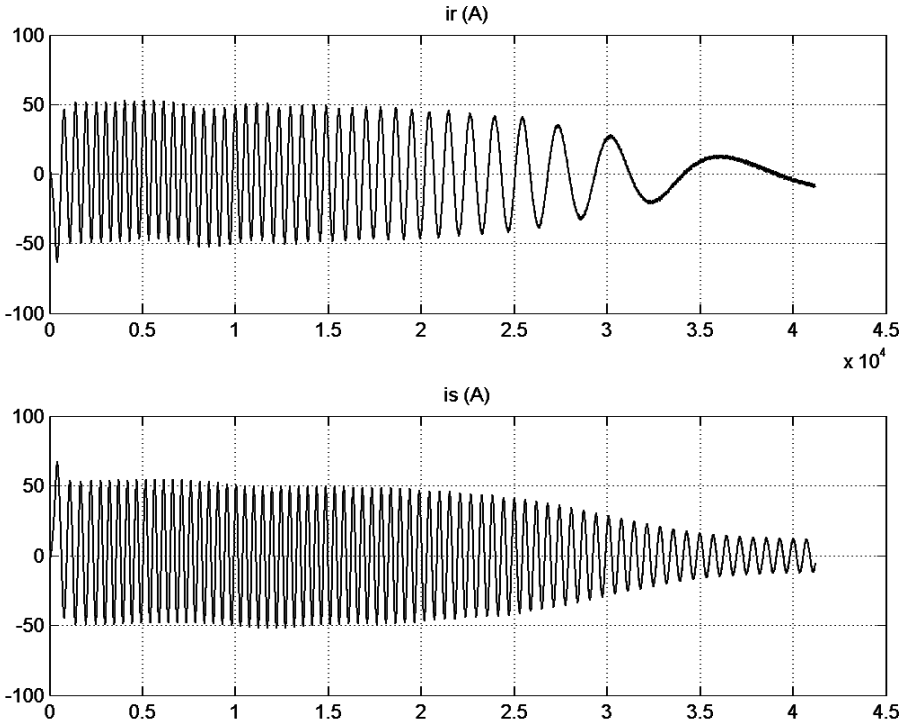

Figure 3. Graphs of transient processes of rotor and stator current

As can be seen from Figure 3, with a direct start of the electric drive, there are surges in the current and torque of the electric motor. These surges lead to heating of the motor windings and wear of its insulation [6, 12]. Therefore, it is necessary to implement soft start or variable speed drives to eliminate the above problems. When modernizing any types of machines, it is necessary to take into account economic factors that may affect the technical solution of the problem.

In Figure 4 shown the model of variable speed electric drive.

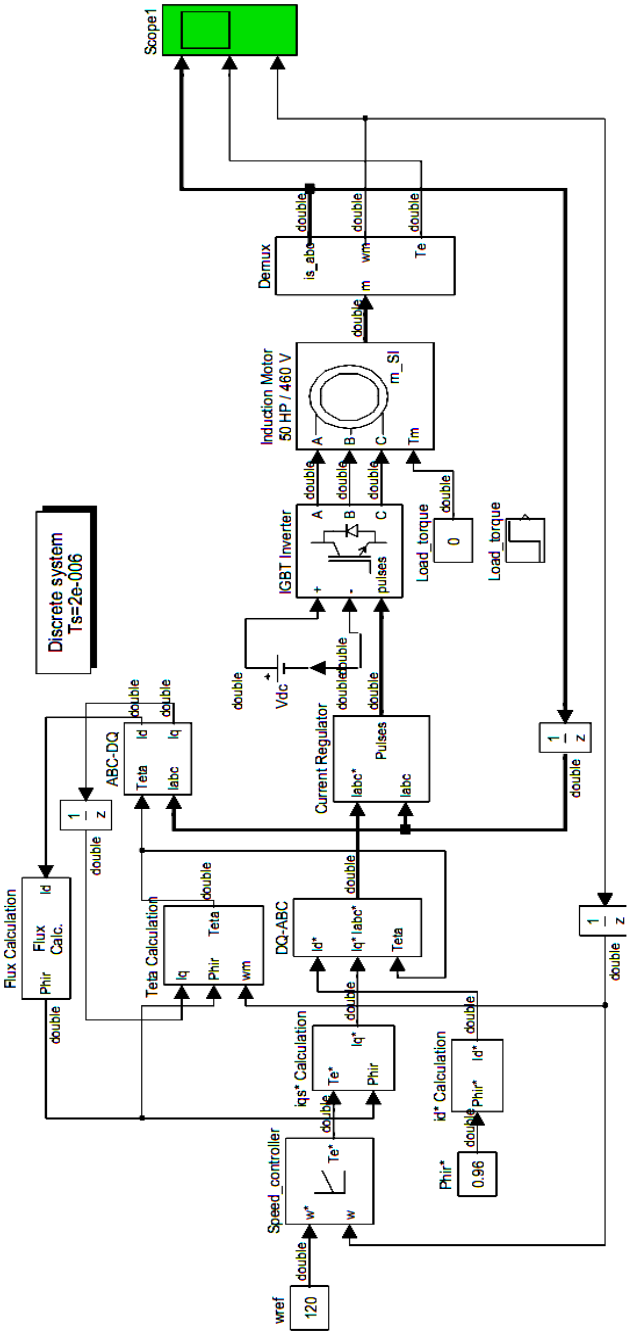

Figure 4. Computer model for studying a closed-loop electric drive

The simulation results of a closed frequency electric drive are shown in Figure 5.

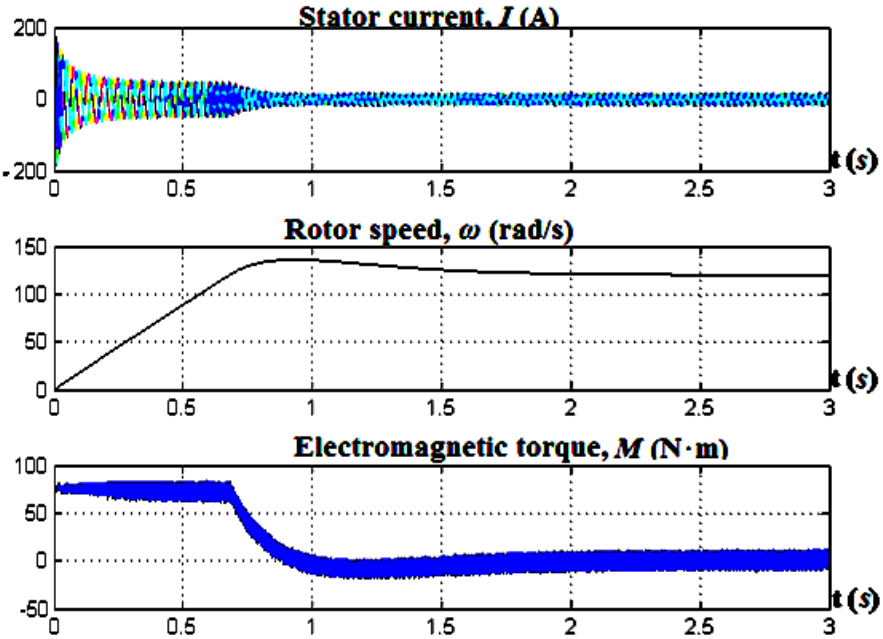

Figure 5. Graphs of transient processes of stator currents, speed and torque of induction motor in a frequency control system

The simulation results showed that with a direct start, the electromagnetic moment of an induction motor increases abruptly and changes by an alternating value (see Fig. 3), which leads to unstable operation of the engine during start-up and vibration in the machine as a whole. When starting with a frequency converter and a closed-loop control system, it was revealed that the alternating values of the electromagnetic torque are eliminated, and the maximum value of the starting torque is strictly within the limitation region (see Fig. 5). The starting currents of the stator of the machine will also smoothly change when starting the steel, which leads to an increase in the technical resource of the conductive parts of the electrical equipment.

The unconditionally closed inverter-motor system solves complex tasks such as automatic motor speed control, programmed control, high-precision signal processing, etc. The introduction of feedbacks into the system expands the control range, increases its smoothness, improves the statistical and dynamic properties of the system, increases the accuracy of the task signals processing, as well as the stability and speed of the electric drive system.

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