https://doi.org/10.26160/2474-5901-2023-36-55-60

MODERNIZATION OF THE ELECTRIC DRIVE OF THE LIFTING MECHANISM OF THE BRIDGE CRANE

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Keywords: overhead crane, lifting mechanism, automated electric drive, regulators, standard settings, sensors.
Abstract. This article is devoted to the problem of improving the electric drive of the lifting mechanism of the bridge crane. The article discusses the main problems associated with the operation of outdated equipment and presents opportunities for its modernization. The main stages of modernization are described with examples of project implementation, as well as the main components necessary to ensure the safety and quality of the upgraded equipment are considered.

МОДЕРНИЗАЦИЯ ЭЛЕКТРОПРИВОДА МЕХАНИЗМА ПОДЪЁМА МОСТОВОГО КРАНА

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Ключевые слова: мостовой кран, механизм подъёма, автоматизированный электропривод, регуляторы, стандартные настройки, датчики.
Аннотация. Данная статья посвящена проблеме совершенствования электропривода механизма подъема мостового крана. В статье рассматриваются основные проблемы, связанные с эксплуатацией устаревшего оборудования и представлены возможности для его модернизации. Описываются основные этапы модернизации с приведением примеров реализации проектов, а также рассматриваются основные составляющие, необходимые для обеспечения безопасности и качества работы модернизированного оборудования.

Lifting cranes are an integral part of the industrial sphere of our country. They are widely used in enterprises specializing in the repair and maintenance, transportation and unloading of bulky cargo. Electric crane drive has been the dominant technology in crane construction for more than a century. But with the development of technology and an increase in the energy supply of motor repair plants, the creation of multi-motor systems with individual drives for each mechanism of overhead cranes has become a necessity. Given the increasing speed of work processes, it was necessary to improve the control system, including automation elements, in order to achieve maximum alignment of movements and increase productivity. In addition, different types of overhead cranes are divided into several groups according to design features. Suspended cranes are attached to the lower shelves of I-beams, and the supporting ones move along rails mounted on crane beams mounted on the ledges of the upper part of the columns of the workshop or on trestles. Effective maintenance and safety at enterprises depend on the quality of equipment. Therefore, the modernization of the electric drive of the

lifting mechanism of overhead cranes, given their important role in production processes, is an important task to increase productivity, reliability and safety in the industrial sector.

A bridge crane is a special lifting equipment that is used to move large and heavy loads. These designs are widely used in industrial premises, car repair stations, warehouses and other enterprises. Structurally, overhead cranes are divided into several groups: suspended and supporting; single and double girders. Cranes are considered to be suspended (Fig. 1,a), which are mounted to the lower shelves of I-beams that are attached with one side to the ceiling. The crane moves along the inner lower shelf of the beam. The supporting models move along rails (Fig. 1, b), which are fixed on crane beams. They are installed on the ledges of the upper part of the columns of the workshop or on overpasses [1].

a b

Fig. 1. Suspension (a) and support (b) types of cranes

The bridge crane mechanism is a complex and technologically advanced system consisting of several components and mechanisms that allow you to move and lift bulky loads. The crane includes crane tracks with rails, beams or bridges, cargo trucks and lifting mechanisms that provide optimal working conditions depending on production requirements. The bridge crane is controlled by a remote control located in the crane cabin or at the bottom of the workshop. The system is driven by an electric drive that moves the trolley and the beam. When the crane is operating, it is necessary to control the movement mechanisms, optimize the pause time, as well as take into account various types of overhead cranes, depending on the design and characteristics. To ensure the safe operation of the system, the motors are equipped with short circuit and overload protection, and electrical equipment can be used at voltages up to 500V. Interruptions in power supply and access to electrical equipment located on the bridge truss are controlled by interlocking contacts, ensuring safe operation. Technical requirements for the composition and parameters of the technical means used are determined by the general nomenclature of electric drives used in the basic version of the bridge crane and its technological functions.

Requirements for the electric drive of the load lifting mechanism:

a) reversible;

c) regulation of the speed of lifting (lowering);

d) limitation of acceleration during start-up and braking.

When forming requirements for the control system (CS), it is necessary to take into account that the CS must provide operation in two modes:

a) in the commissioning mode – for installation and inspection of the crane;

b) mainly during the operation of the crane.

The control system must ensure that the brakes are activated depending on the operating mode. In addition, it is necessary to provide for blocking the operation of electric drives when reaching the extreme positions of the executive bodies (lifting) [2].

One of the main requirements for cranes is the limitation of load capacity. Special devices – load capacity limiters, which form signals prohibiting the operation of the corresponding electric drives, implement this requirement. The indication of the current values of the parameters can be presented on arrow devices or digital indicators, depending on the modification of the device.

In addition, the control system must provide the following protections:

a) against short-circuit currents;

b) from long-term overload currents;

c) from reducing the voltage in the network below the permissible limit.

These protections are necessary to improve the reliability of the mechanical components and mechanisms of the crane under abnormal operating conditions. These protections will ensure normal operating conditions of electric motors, brakes and other electrical devices. Protection against voltage drop in the mains or voltage loss ensures safe operation and the impossibility of spontaneous start of electric motors.

The CS must provide alarm about abnormal operating modes (during overloads, short circuits, etc.), alarm about the operating modes of electric drives and control systems.

The shaft of the electric machine is connected through a coupling to the shaft of the gearbox, which lowers the rotation speed and, at the same time, increases the torque. The output shaft of the gearbox is connected through a coupling with a rope drum. A load-grabbing device is attached to two ropes through a polyspast. The polyspast is designed to reduce the linear velocity [3].

The load lifting mechanism (Fig. 2) consists of an electric motor (1), a brake (3), a gearbox (4), a rope drum (5) and a hook suspension. The rope is attached to the drum using pads and bolts.

In the conditions of modern industry, one of the most important factors ensuring the efficiency and safety of production processes is the quality of equipment. It is especially important to update the electric drives of lifting mechanisms for overhead cranes, as they play an important role in ensuring the safety of production processes and product quality. In the conditions of modern industry, one of the most important factors ensuring the efficiency and safety of production processes is the quality of equipment. It is especially important to update the electric drives of lifting mechanisms for overhead cranes, as they play an important role in ensuring the safety of production processes and product quality.

Thus, it is possible to consider the modernization of the electric drive in order to reduce operating costs and increase the stability of the equipment [4].

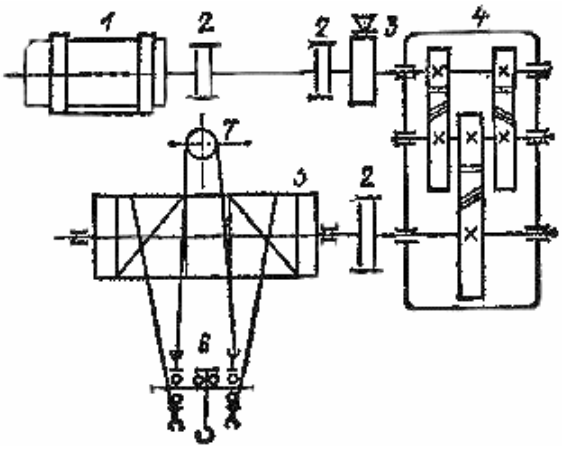

Figure 2. Kinematic diagram of the lifting mechanism: 1 – engine; 2 – clutch; 3 – brake; 4 – gearbox; 5 – drum; 6 – polyspast; 7 – fixed block of polyspast

The main efforts should be directed to the replacement of the following components and electrical parts:

– replace the frequency converter;

– use a new gearbox;

– replace the motor with a phase rotor with a motor with a short-circuited rotor;

– install a joystick-type control panel from the ground, thereby increasing the safety of the operator.

The modernization of the crane will allow you to save money and get rid of the following disadvantages:

– jerks will disappear when lifting and lowering the load;

– the accuracy of stopping the crane at the specified location will appear;

– there will be no overload on the drive, both electrical and mechanical;

– we will get rid of cable breaks and malfunctions of mechanisms;

– efficiency and power factor will increase;

– power consumption will be reduced due to the optimal operation of the frequency converter and the electric motor.

When choosing a converter for the modernization of bridge crane electrical equipment, the SchneiderElectricAltivar71 series of frequency converters (Fig. 3) provides a wide range of possibilities. This series allows you to control asynchronous motors in open and closed speed control systems using the vector flow control algorithm [5]. SchneiderElectricAltivar 71 is a leading manufacturer of frequency converters with extensive experience in the creation and modernization of such devices.

Taking into account the selection requirements, the ATV71HD30N4 converter turns out to be optimal. It provides various motor control laws, including vector flow control with speed feedback (current vector), vector flow control

without speed feedback (voltage or current vector) and the voltage/frequency law (2 or 5 points).

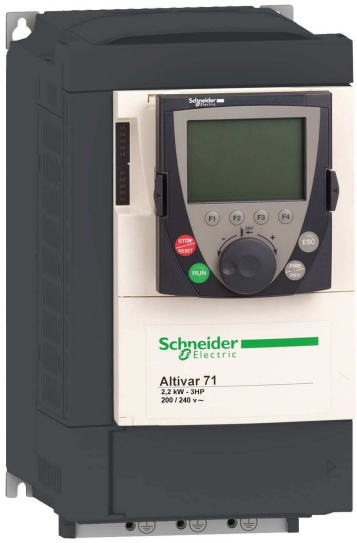

Fig. 3. Frequency converter SchneiderElectricAltivar 71, model ATV71HD30N4

This new frequency converter demonstrates a number of advantages:

1. Reduction of power consumption by 40% due to optimal control of the electric motor together with the frequency converter.

2. Smooth start without starting currents and shocks, which prolongs the life of the electric drive and reduces maintenance costs.

3. Smooth control of the rotation speed of the electric motor allows you to efficiently move loads at different speeds, increasing the productivity of the crane. Also, more accurate positioning of the load is provided and its rocking is excluded, which contributes to safe operation [6].

Thus, the modernization of the electrical equipment of the bridge crane using the new frequency converter SchneiderElectricAltivar71 will achieve the following results: increasing the efficiency of the electric drive of the bridge crane, reducing energy consumption by 40%, increasing the profitability of equipment, preventing emergency stops and unplanned downtime, reducing the cost of operation and maintenance of the bridge crane, increasing the service life of the rope and ensuring safety in the motor repair workshop with minimal injuries in the workplace.

Summing up, it can be concluded that the modernization of the electric drive of the lifting mechanism of the bridge crane operates in a repeated short-term mode with a turn-on duration equal to 40%, that an asynchronous electric motor with a short-circuited rotor is used. Regulation is carried out with a frequency converter, this increases the number of switches per unit of time, and this is lifting and lowering the load, smooth start, which increases the energy efficiency of the working body.

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Received 06.06.2023