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ENERGY SAVING IN PUMPING STATIONS

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Abstract:

This article shows the easiest and relatively inexpensive way to adjust the speed of rotation of induction motors - the ability to adjust the speed using two-speed asynchronous motors with a variable number of poles. Comparison and analysis of the main energy characteristics of two-speed single-winding and double winding asynchronous motors is carried out. Based on the data obtained, two-speed motors with a variable number of poles are proposed as an asynchronous motor as part of an electric drive.

Keywords: Two-speed asynchronous motor, variable number of poles, rated power, power factor, efficiency.

METHODS: Currently, special attention is paid to improving the reliability of power supply systems in the electric power industry, as well as the development and implementation of energy-saving technologies, ways to reduce electricity losses.

The main consumers of electricity in our country are industrial enterprises and housing and communal services. Most of the electricity is consumed by the electric drives of pumps and fans. The cost of electricity for water supply and sewerage enterprises is 40-50% of the total operating costs using surface water. When using groundwater, this figure rises to 70-80%. Statistics show that 5-15% of energy is wasted in the process of extracting clean and waste water. In some cases, this figure rises to 20-50% [1].

The consumption and pressure of water for housing and communal services constantly fluctuates during the day, the maximum consumption is observed in the morning and evening hours, the minimum - at night. An approximate daily schedule of water consumption in a small settlement is shown in Figure 1. There are also seasonal and technological changes in water consumption. When water consumption is stable, that is, water consumption and pressure are in the same steady state. As the flow rate increases or decreases, it becomes necessary to change the flow rate and water pressure, i.e. adjust the speed.

When regulating the efficiency of a pumping station, the number of switching on and off of pumping units reaches 40-50 per day. This number of starts is unacceptable for powerful units (for example, the number of large pumping units with a capacity of 2500-5000 kW is limited to 50-70 per year), in addition, several devices do significantly affect the quality of electricity in the network. Therefore, it is necessary to regulate the rotational speed of asynchronous motors at pumping stations [2].

In world practice, there are several ways to control the speed of asynchronous motors, including an asynchronous valve stage, a thyristor frequency converter, as well as two-speed asynchronous motors.

In multi-speed electric drives based on asynchronous motors, where the number of poles in the stator is variable, there is no need to additionally change the supplied energy and there is the only adjustment method that does not require additional slip, as a result of which their efficiency can be high [3].

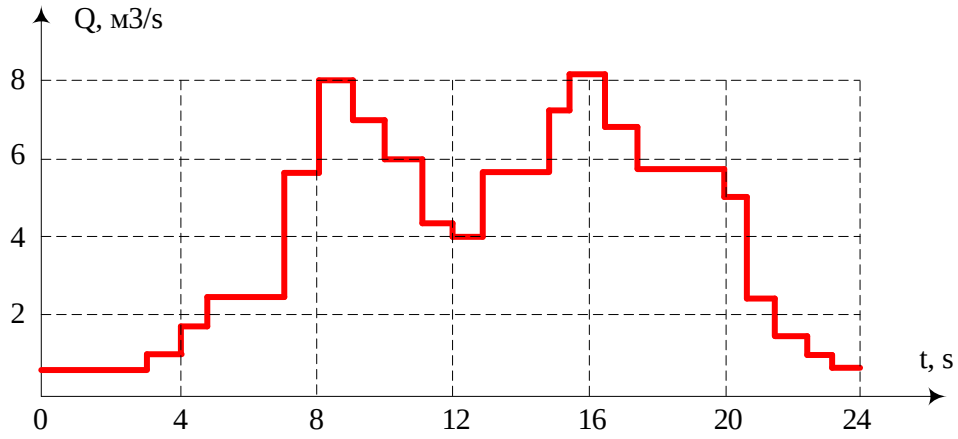

Figure 1. Daily graph of water consumption

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The speed control method using two-speed asynchronous motors is the simplest and relatively inexpensive method. In addition, direct starting of low range motors results in a voltage drop of more than 30%. In this case, firstly, the torque generated by the electric drive decreases, and secondly, electronic and microprocessor devices that register the voltage drop disconnect the electric drive from the network. The use of electric drives with a two-speed induction motor simplifies the step-by-step process of creating high-power motors.

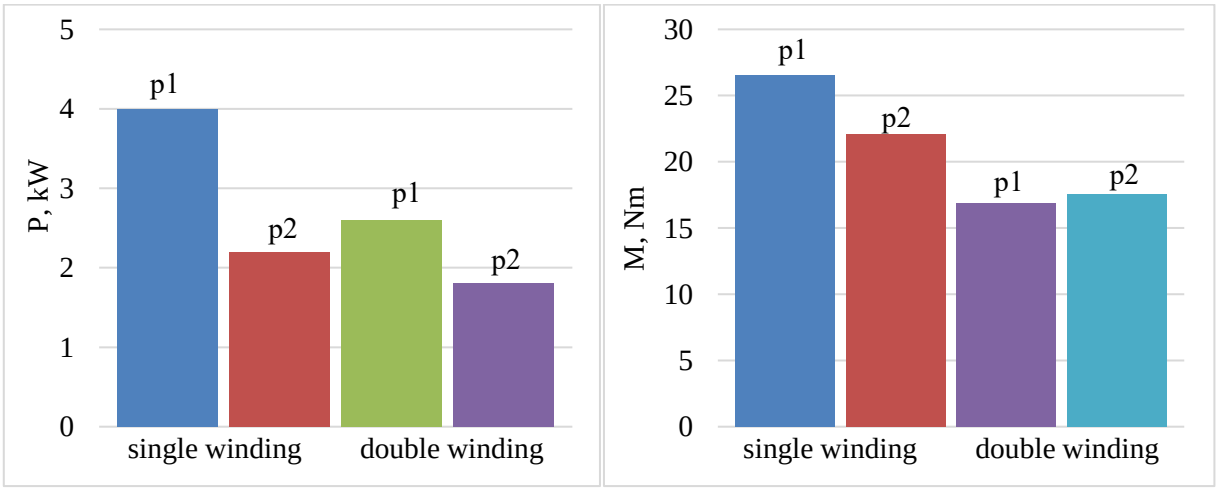
Two-speed motors can be one-stroke or two-stroke. Comparison of two-speed motors with one coil and double winding coils with the same power shows that motors with two coils are more expensive than motors with one coil - 30-40% for electrical steel and 40-50% for coil copper, plus motor efficiency and cosφ decreases on average by 10-15%.

Table 1 compares the energy characteristics of two-speed induction motors with single winding and double winding, type DP112B. The number of poles of a two-speed variable coil motor p_1 = 2 has a net power value of 4 kW on the pole side and the corresponding efficiency and the cosφ value was 79% and 0.84, respectively, while the rated current was 8.7 A, while on the p_2 = 3 pole side, the net power value was 2.2 kW and the corresponding efficiency and the cosφ value was 74% and 0.83, respectively, and the rated current was 5.2 A. (Fig. 2).

The net power value on the p_1 = 2 pole side of a two-speed motor with double winding coils is 2.6 kW and the corresponding efficiency and the cosφ value was 78% and 0.7, respectively, while the rated current was 6.8 A, p_2 = 3 on the pole side, the net power value was 1.8 kW, and the corresponding efficiency and the cosφ value was 76% and 0.73, respectively, and the rated current was 4.6 A.

Energy characteristics of a single winding and double windings two-speed asynchronous motors of the DP112B type

2p	P, kW	I, A	η, %	cosφ	M, Nm
single winding					
4	4	8,7	79	0,84	26,5
6	2,2	5,2	74	0,83	22,1
double windings					
4	2,6	6,8	78	0,7	16,9
6	1,8	4,6	76	0,73	17,6



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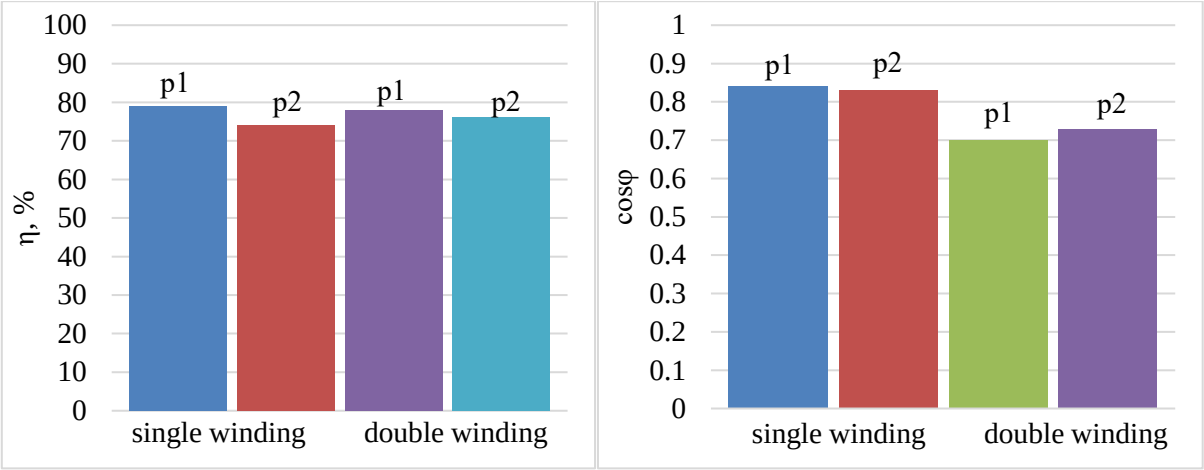

Figure 2. Energy characteristics of a single winding and double windings two-speed asynchronous motors type DP112B

The energy performance of a variable coil motor with pole number is higher than that of double motors with the same coil size. Therefore, it is recommended to produce asynchronous motors with a variable number of coils, a small number of outputs and changeover contacts, and a simple technology for production and repair.

Such motors should have relatively little difference from traditional single speed motors in terms of weight, size and energy performance, and can be used in place of two split speed two speed motors as well as simple single speed motors for a variety of applications. From the above, it follows that the ratio of the number of pole pairs to meet the needs of two-speed motors in pumping stations is 2/3, 3/4, 4/5, and so on. It is advisable to manufacture coils with a variable number of poles [4].

Thus, the use of two-speed motors in the electric drive of pumping station mechanisms without additional elements, for example, without this or that type of converters, makes it possible to create a new energy-saving technology, as a result of which it becomes possible to save electricity.

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