RELATIONSHIPS OF ADJUSTING PARAMETERS OF ASYNCHRONOUS MOTORS INSTALLED IN INDUSTRIAL ENTERPRISES WITH PHASE ROTOR ASYNCHRONOUS MOTORS

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The article analyzes the relationship between the values that coordinate induction motors installed in industrial enterprises with asynchronous phase rotor motors. In the analysis, the asynchronous motor of the phase rotor mainly changes the stator current with increasing rotor current, rotor speed, efficiency and the optimal value of the rotor resistance.

Key words: *induction motor, phase rotor, induction motor, stator, rotor, torque, rotor resistance, current, load, relative unit, rotor rings, switching.*

Asynchronous motors installed in industrial enterprises work with high efficiency coefficients only at certain times during continuous work processes. The reason is that we choose an asynchronous motor based on the load applied to the motor shaft, at the time of selection, it is selected according to the highest load in one cycle. In addition, the mechanical power supplied to the motor shaft

$$P = M_q \cdot \frac{n}{9.55} \quad (1)$$

Here: Mq-motor shaft resistance torque,

n-motor shaft rotation speed.

As can be seen from the formula (1), the power is directly proportional to the two values, and if we take the resistance moment at its value, we do not have the opportunity to choose the speed of rotation of the shaft arbitrarily. Because asynchronous motors are single-pole 3000 rpm, two-pole 1500 rpm, three-pole 1000 rpm, four-pole 750 rpm, five-pole 600 rpm, six-pole 500 rpm, eight-pole 375 rpm A motor with the specified shaft speed may not always match the standard motors being manufactured. As a result, we are forced to choose a motor with a greater power than the calculated power, which lowers the efficiency of the motor. Sometimes a gearbox is used to adjust the shaft rotation speed to the power. This leads to the addition of another device to the technological process, which again reduces the overall efficiency. Because the efficiency of the gearbox is 94-96%, and the result means that the overall efficiency decreases to 6-7%. It can be seen that both solutions are not satisfactory solutions, therefore, an asynchronous motor control, i.e. motor shaft speed control, is an acceptable solution for them. There are two ways to control the speed of an induction motor shaft. The first way is performed by changing the speed of the rotating magnetic field generated in the stator. This is done by changing the frequency of the alternating current in the network and changing the amount of voltage. To change the frequency of the network, first the alternating current is converted to direct current, in this process 8-10% of energy is lost. In the second process, constant current is converted into alternating current through an inverter, as a result of which energy is lost again. In addition, the combined price of the vipermeter and inverters is equal to the price of the motor, and it is not always an alternative answer. An autotransformer can be used to control the mains voltage, but it requires the installation of an autotransformer control system and an autotransformer with a power greater than the motor power, which is an economically inefficient way.The second way is to control the speed of the motor shaft by connecting additional resistance to the rotor shaft of the asynchronous motor through rings. Ring asynchronous motors are called phase rotor asynchronous motors. The phase rotor asynchronous motor belongs to the class of variable speed electric machines. It is pointless to install it on electrical systems where constant speed change is not required. But it is effective if it is used in electric drives whose speed changes several times in one work cycle. The main disadvantage of asynchronous motors with a phase rotor is that the external resistance of the rotor connected through the loop is not automatically controlled, or it is necessary to adjust it only according to the load value using a rheostat. There is an automatic system that does this but it is expensive. This affects the widespread use of phase rotor asynchronous motors.

The analysis of the energy parameters of the motor shows us the advantages and disadvantages of the motor. For this reason, we will analyze the working processes of the phase rotor asynchronous motor.

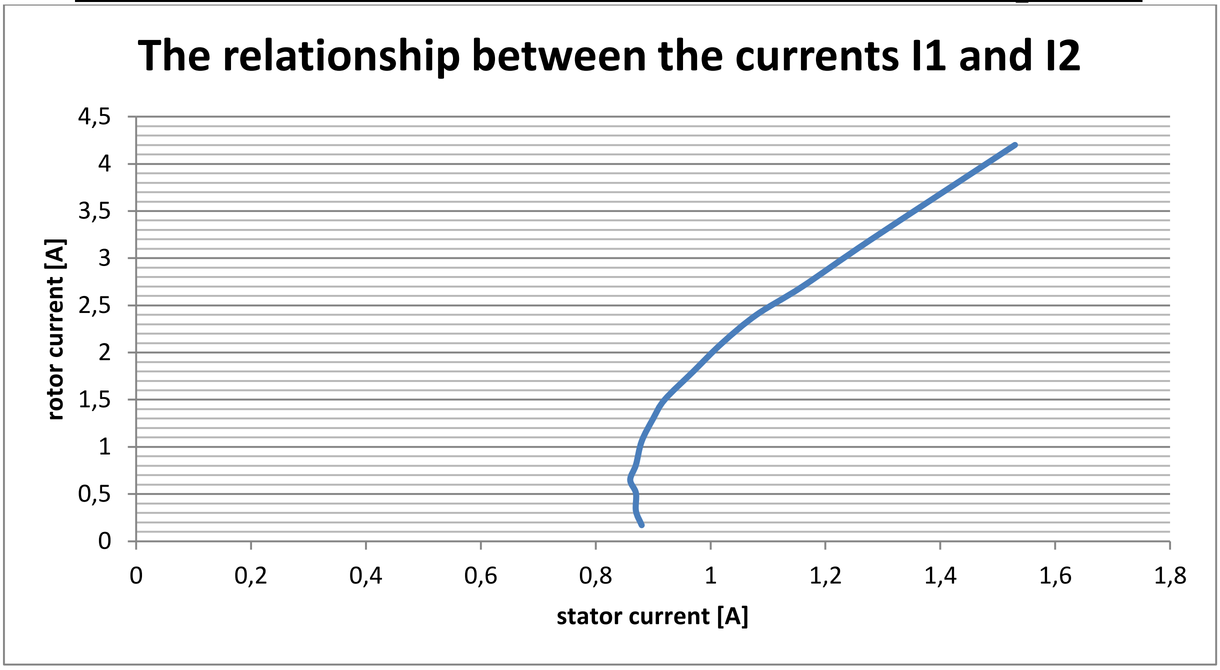
Analysis 1. Let's consider the characteristics of the load, putting the rotor resistance at the nominal resistance.

[1]

1-table.

Corresponding stator and rotor currents in the load on the motor shaft of a phase-rotor asynchronous motor in relative units.

M/M_n,	M_n, [N*m]	I_1, stator toki [A]	I_2, rotor toki [A]
0.1	0,19	0,88	0,17
0.2	0,38	0,87	0,32
0.3	0,58	0,87	0,51
0.4	0,76	0,86	0,65
0.5	0,91	0,87	0,81
0.6	1,15	0,88	1,06
0.7	1,34	0,9	1,3
0.8	1,53	0,92	1,5
0.9	1,72	0,97	1,8
1.0	1,92	1,02	2,1
1.1	2,1	1,08	2,4
1.2	2,3	1,16	2,7
1.3	2,49	1,28	3,2
1.4	2,68	1,53	4,2



Graph 1. Connection between stator and rotor currents.

The analysis from graph 1 and table 1 shows that when the stator current is increased from 0.1 range to 1.4 times compared to the nominal value, the change of these values is considered a large value mainly in the rotor circuit, where the stator current increases by 1.7 times and the rotor current increases by 24.7 times. If we compare the loss of active power in the rotor and stator alone, the increase in the stator circuit by 2.89 times, and the loss in the rotor by 610 times, will lead to a decrease in the efficiency of the asynchronous motor. In addition, the increase in the amount of released heat leads to the destruction of the insulation in the stator and rotor circuits of the asynchronous motor and the rapid failure of the motor. One of the advantages of phase rotor asynchronous motors is that when the rotor current increases, we can reduce this amount by changing the rotor resistance.

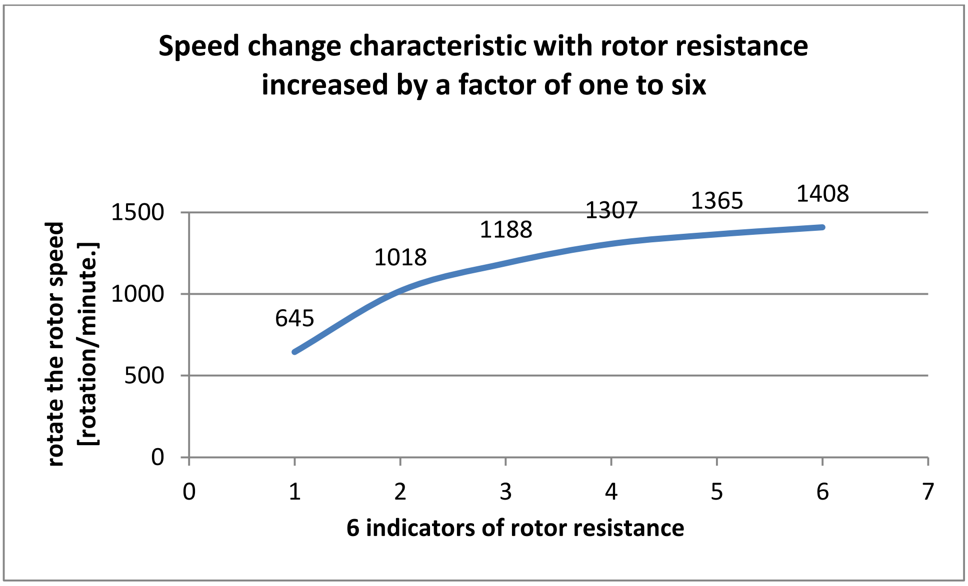
Analysis 2. Analysis of the choice of external resistance suitable for the rated torque of a phase rotor asynchronous motor.

2-Table

The rotor rotation speed was measured in the rotor resistance of the phase rotor asynchronous motor in six units.

place	6	5	4	3	2	1
n / rotation/minute.	1408	1365	1307	1188	1018	645

Table 2 and graph 2 show that the motor speed has decreased by more than two times, which means that the performance of the performed work has also decreased by more than two times. So, the conclusion is that as we increase the value of the rotor resistance, we see that the rotor rotation speed decreases, and if the rotor rotation speed starts to decrease, we change the resistance in the opposite order, i.e. reduce the ability to change it. For example, it can be seen that when the load of the phase rotor asynchronous motor in the experiment increased by 1.4 times from the 0.1 range, the rotor rotation speed decreased by 2.18 times, while the rotor resistance was at the 1 indicator. When we increase this value to the 6th indicator, we can see that the rotor speed returns to its nominal value.[2]



Graph 2. Rotor rotation speed corresponding to the rotor resistance of an asynchronous motor with a phase rotor.

Table 3.

The rotor speed and electrical parameters were measured in the rotor resistance of the phase rotor asynchronous motor in six units.

M/Mn,	Mn, [N*m]	n, rotation/minute.	I1, stator current[A]	$cos\varphi$	I2, rotor current[A]	P1,electric power [W]	P2, mechanical power [W]	FIK,%	Mn, [N*m]	Mn, [N*m]	Mn, [N*m]	Mn, [N*m]	Mn, [N*m]
0,1	0,19	1480	0,88	0,23	0,17	81,96	29,43	35,909	0,18	0,19	0,21	0,253	0,399
0,2	0,38	1466	0,87	0,28	0,32	98,64	58,31	59,108	0,37	0,39	0,43	0,506	0,798
0,3	0,58	1449	0,87	0,33	0,51	116,26	87,96	75,66	0,55	0,59	0,65	0,759	1,197
0,4	0,76	1439	0,86	0,38	0,65	132,34	114,5	86,496	0,73	0,78	0,868	1,012	1,596
0,5	0,91	1428	0,87	0,42	0,81	147,97	136	91,119	0,92	0,98	1,08	1,265	1,995
0,6	1,15	1410	0,88	0,48	1,06	171,05	169,7	91,219	1,1	1,18	1,3	1,518	2,394
0,7	1,34	1400	0,9	0,53	1,3	193,16	196,4	91,22	1,28	1,37	1,5	1,771	2,793
0,8	1,53	1380	0,92	0,57	1,5	212,36	221	91,3	1,46	1,57	1,73	2,024	3,192
0,9	1,72	1361	0,97	0,61	1,8	239,61	245	91,4	1,65	1,77	1,95	2,277	3,591
1	1,92	1340	1,02	0,64	2,1	264,35	269,3	91,6	1,83	1,9	2,1	2,53	3,99
1,1	2,1	1313	1,08	0,67	2,4	293,02	288,6	90,76	2,01	2,16	2,38	2,783	4,389
1,2	2,3	1276	1,16	0,69	2,7	324,12	307,2	89,36	2,2	2,36	2,6	3,036	4,788
1,3	2,49	1226	1,28	0,71	3,2	368,02	319,5	86,821	2,38	2,56	2,821	3,28	5,187
1,4	2,68	1141	1,53	0,72	4,2	446,1	320,1	71,746	2,56	2,75	3,038	3,54	5,586

Based on the given values, we adjusted the phase rotor asynchronous motor in the relative unit by changing the load in the range of 0.1 to 1.4 ratio and changing the rotor resistance from 1 to 6 indicators and obtained the torque change. Based on the obtained values, the following variable graph was created. It can be seen from the graph that there is a high and efficient solution for the small value of the rotor resistance. To explain this, the most optimal solution of the 6 changes is crossed by the curve, so the conclusion is that when the load reaches one relative unit, the optimal resistance value is in the optimal solution when the value of the resistance is at the 4th indicator. The efficiency is high when our load is satisfied from 0.6 load to 1 load ratio. For this reason, it is desirable that the load is usually given in values. One more conclusion should not be forgotten, in the process of changing the rotor resistance of a phase rotor asynchronous motor, it is necessary and important to take into account commutation processes. Because according to the conclusion of Table 1, the rotor current increases by 24.7 times, in this process, the value of the commutation current can change times, that is, since the rotor circuit consists of inductive and active resistance, the electromechanical time constant is equal to The value of the inductance of the rotor core L depends on the induction of the stator magnetic field, this value does not change in a large range, but we change the active resistance r of the rotor circuit in the range from 1 to 6, that is, as the load increases, the rotor resistance decreases. As a result, the electromechanical time constant increases, which leads to rapid failure of the rotor circuit switching devices. It is necessary not to forget this aspect, especially at high load it is impossible to reduce the active resistance sharply.

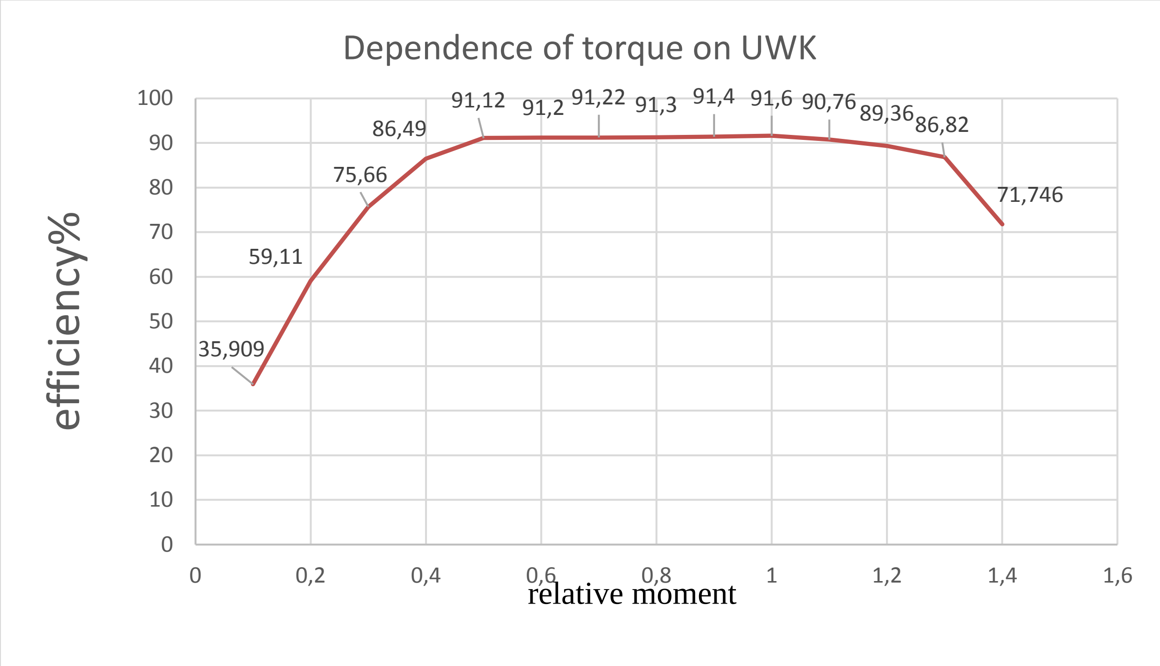
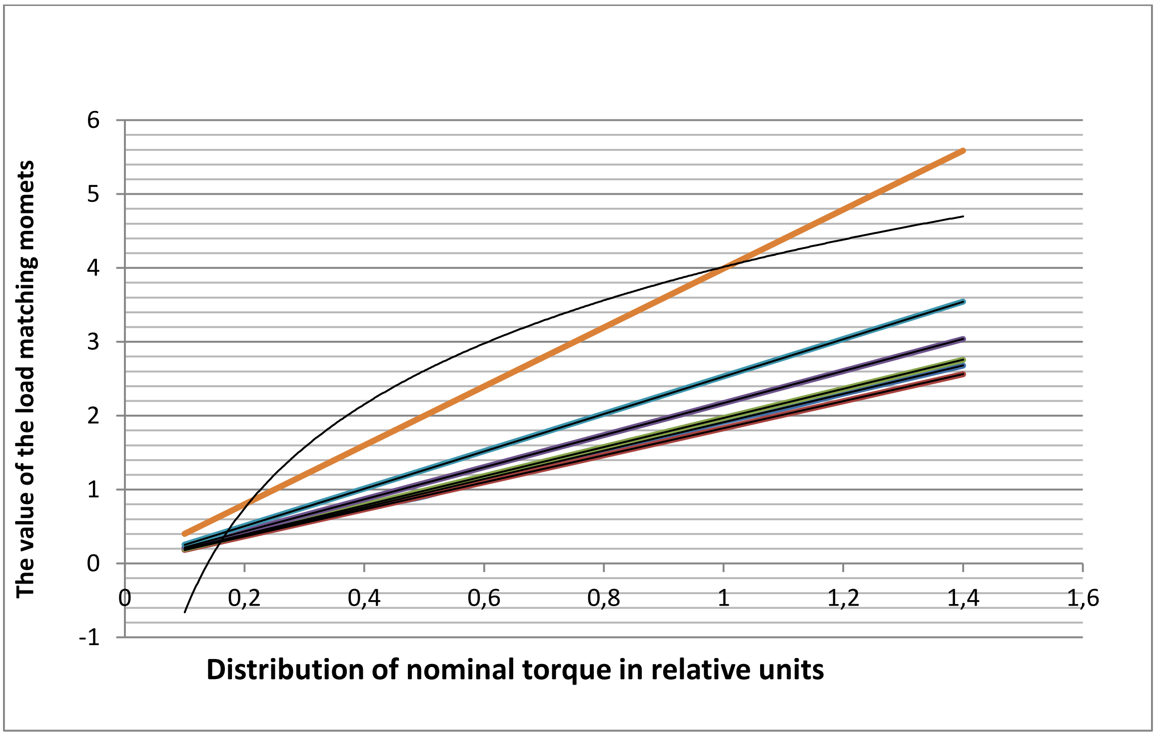


Chart 4. Useful performance coefficients corresponding to the relative torque values of the phase rotor asynchronous motor. The UWK of the phase rotor asynchronous motor tends to its nominal value after the load torque increases from the relative value of 0.5, this value reaches the nominal UWK value at the relative value of 1.1.



Graph 5. Selection of phase rotor asynchronous motor rotor resistance.

Based on the results obtained in table 3 and graph 5, it can be said that the results obtained in the six indicators of the phase rotor asynchronous motor show that the 6 straight lines are the torques of the resistances in the six indicators in relative units, among which only one value is that is, it crossed only one of the curves characterizing the motor load. This is the 1st indicator resistance characterizing the line, it is the rotor resistance for a phase rotor asynchronous motor

Summary. The main feature of the article is to find the nominal value of the rotor resistance of the phase rotor asynchronous motor, and the main electrical indicators of the motor were taken into account when choosing this value. In the experiment, we changed the rotor resistance in a 300 W phase rotor asynchronous motor. The result is that the more we increase the rotor current, the more the loss increases, as a result, the UWK decreases. The increase in nominal rotor current continues until the stator current reaches the nominal value. Our second conclusion is that by changing the rotor resistance, the motor speed can only be increased to the nominal value. The third conclusion is that by changing the rotor resistance, UWK can be kept at its nominal value from 0.5 load to 1.1 load. The fourth conclusion is that by changing the rotor resistance to several values, the optimal value, the value corresponding to the passport value, was found.

The results obtained in this article were obtained with the help of CBM-software in the "Induction machine 0.3 kW" laboratory of the Department of "Electrical Mechanics and Technologies" of the Bukhara Institute of Engineering Technology.

List of used literature.

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RELATIONSHIP BETWEEN THE COORDINATION PARAMETERS OF ASYNCHRONOUS MOTORS IN SPACE ROTORS IN INDUSTRIAL ENTERPRISES.