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Energy Saving in Electric Drives and Control of These Processes in the Sphere of Housing and Communal Services

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Abstract –**This article is devoted to increasing the energy efficiency of electric drives of installations of enterprises of housing and communal services, by justifying the use of systems of asynchronous and synchronous drives with frequency converters.**

It is shown that when throttling, the energy of the flow of a substance held back by a latch or valve does not perform any useful work. The method of solution based on the use of a frequency converter as part of a pump unit is considered, which allows setting the necessary pressure or flow rate, which ensures energy saving and reduction of losses of the transported substance.

The results of power consumption, showing the efficiency of the application of frequency-controlled electric drives, are received.

Keywords – housing and communal services, pumping unit, frequency-controlled electric drive

I. INTRODUCTION

Currently, the efficient use of energy in general and electricity in particular, as well as the energy efficiency of electric drives come to the fore in the context of today's global economy. Energy saving (rationalization of energy production, distribution and use) has become in recent years one of the important directions of technical policy in all developed countries.

II. PURPOSE OF THE RESEARCH

Improving the energy efficiency of electric installations byhousing and communal services companies justify the use of systems of asynchronous and synchronous drives with frequency inverters and electric energy efficiency rating at the design stage.

Application of frequency converter in the structure of the asynchronous and synchronous electric equipmenthousing and communal services companies provide energy savings at the expense of smooth start-up modes, improve and control the power factor (for asynchronous electric), good electromagnetic compatibility with the mains power (reducing distortion coefficient voltage sine wave and keeping it within the limits set guests) and the possibility of the drive in the four quadrants of the mechanical characteristics (braking energy recovery in the mains supply).

The need for energy saving today - the basis of energy saving.

A basic of energy saving at the enterprises is known that about 80% of the electricity consumed by the industrial enterprise, accounted for AC motors - synchronous or asynchronous squirrel cage.

One of the most effective methods to solve this complex problem is the implementation of modern systems of frequency regulation of electric drives and automation in water supply systems.

This method allows for a high degree of deterioration of the material and technical base of the housing and communal services dramatically improve the energy efficiency of the work, improve service quality and significantly reduce accidents, freeing up funds for refinancing and the planned equipment upgrade and overhaul of communication [1].

Illustrate well-known energy and technological inefficiency of throttle control the water supply pump. Power consumed by the pump is determined by the formula:

$$P= (Q \cdot H \cdot g \cdot \rho)/\eta \qquad (1)$$

where P is power, kW; Q is flow, м^3/s;H ispressure, м;g isacceleration of gravity, м/s^2;ρ isdensity of the liquid medium, kg/м^3;η ispump efficiency.

Fig. 1 shows the performance characteristics of a centrifugal pump with throttle and speed control. Curve 1 characterizes the work of unregulated electric drive on the rated speed, the curve 3 describes the line work at full throttle. Flow rates and water pressure are shown in Fig. 1 in relative units when used as a basic value of the nominal flow rate Q_{nom} and nominal head N_{nom}. If the nominal flow rate and pressure pump works at point A, and the power consumed by the pump is proportional to the square *0KAL* rectangle. With the reduction of consumption in the unregulated electric drive (Fig. 1 shows an example of water consumption, amounting *0,6* N_{nom}) due to a throttle control line resistance change occurs (curve 4), the pump operates at a point in the curve 1, which leads to an increase in pressure, which becomes larger than the

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nominal pump power and proportional to the area of a rectangle *0DBF*, it differs insignificantly from the power consumed at nominal flow rate, hence, at reduced power consumption varies little or no change [2, 4].

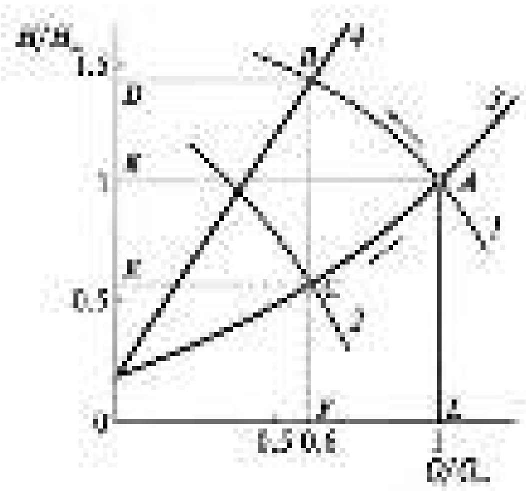

Fig. 1. Features of the centrifugal pump performance throttling and frequency regulation

Features energy-saving control in the regulation of the drive speed in comparison with the throttle control is illustrated in Figure 1. By reducing the pump speed running while reducing costs at the point on the curve 2 at a fixed characteristic line (curve 3). The power consumed by the electric drive in this case is proportional to the square *0ECF* rectangle that clearly illustrates the possibility of a substantial reduction of energy consumption in the implementation of regulated electric pumps. Along with this decrease as the pressure and flow of water in the system, this reduces the losses (leakage) of water.

As stated above, the steady operation of the pumping unit at a constant speed drive motor is determined by the intersection point of the pump curve corresponding to this frequency, and characteristics of line connected to the pump.

A characteristic of the pump is dependent on the pressure H and theflow rate$Q$, which reliably can be represented as:

$$H = H_{0n} \cdot (\omega/\omega_{nom})^2 - C \cdot Q^2 \qquad (2)$$

where $H_{0н}$ is pump head with Q= 0 and$\omega = \omega_{nom}$;ω_{nom} is nominal motor speed;C is constructive pump rate,$C=(H_{0n}-H_{nom})/Q_{nom}^2$;$Q_{nom}$and H_{nom} is nominal flow rate and pressure.

Highway characteristic defined by the following expression:

$$H = H_c + R \cdot Q^2 \qquad (3)$$

whereH_c is static pressure (backpressure) corresponding to Q = 0 (closed valve);R is highway resistance coefficient, $R=(H_{nom}-H_c)/Q_{nom}^2$.

Characteristics methods centrifugal pump control highway and shown in Fig. 2.

Power consumed by the pump unit from the network:

$$P_1 = P_m / \eta_1 \qquad (4)$$

where P_m – on the pump motor shaft power,$P_m=M_c \cdot \omega$;M_c– static moment load on the motor shaft;η_1– engine efficiency.

Feed control throttle valve based on the change in line resistance. In this case, $\omega=\omega_{nom}$=constω_{nom} operating mechanism moves the point at Q-H characteristics corresponding to the rated motor speed in the downward flow to the intersection point of the new line feature (points 1, 2 and 3 in Fig. 2).

In electric mode flow control operating point moves along the same characteristic line (points 4, 5, 6, 7 in Figure 2). When this flow decreases with decreasing and pressure required, which leads to a static power reduction required for a predetermined operation of the pump water flow, compared to the throttle control.

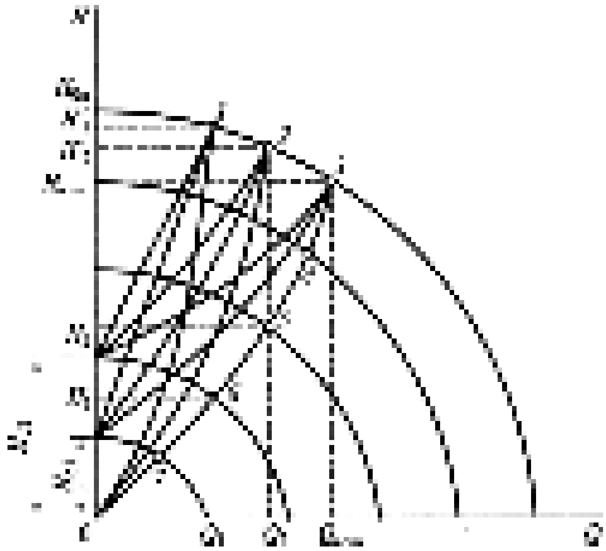

Fig. 2. Characteristics of a centrifugal pump control methods:*1,2,3*– operating points with throttle control supply;*4,5,6,7*– when adjusting the operating points of feed due to change of the engine speed

As shown in Table. 1, with an increase in static pressure h_c reduced energy savings when implementing variable-frequency induction motor, however, for any value of h_c process automation system maintains constant system pressure regardless of the flow, thus avoiding unnecessary excess pressure inherent throttle control.

TABLE I. CENTRIFUGAL PUMP ELECTRIC POWER CONSUMPTION WHEN THE THROTTLE AND SPEED CONTROL, DEPENDING ON THE FLOW RATE AND STATIC PRESSURE

Consum ptionQ_*	**P_1**					
	Throttle Regulati on	***Frequencyregulation***				
		h_c=0	***h_c=0.2***	***h_c=0.4***	***h_c=0.6***	***h_c=0.8***
0	0.43	0	0.04	0.11	0.2	0.31
0.2	0.56	0.01	0.08	0.18	0.3	0.42
0.4	0.69	0.08	0.16	0.28	0.41	0.55
0.6	0.82	0.24	0.35	0.45	0.58	0.7
0.8	0.95	0.56	0.64	0.71	0.8	0.87
1	1.08	1.08	1.08	1.08	1.08	1.08

This is very important, because in a communal area for the existing systems are not in an emergency condition, each extra atmosphere and the pressure of 10 m water column, causing an additional 2 ... 7% of water loss due to leakage. [3]

To evaluate the effect of initial static moment (μ_{0s}) shows the dependence on the $P_{1*} = f(Q_*)$ power consumption in Table 2 for the throttle and speed control with μ0s of $\mu_{0c} = 0$ and $h_c = 0$.

TABLE II. CENTRIFUGAL PUMP ELECTRIC POWER CONSUMPTION FOR THE DIFFERENT CONTROL MODES FOR THE INITIAL STATIC TORQUE $M_{0S}=0$ AND THE STATIC WATER PRESSURE OF $H_C=0$

Control method	***Q***					
	0	***0.2***	***0.4***	***0.6***	***0.8***	***1***
$P_{1*}$with throttle control	0	0.22	0.44	0.66	0.88	1.08
$P_{1*}$with frequency regulation	0	0.01	0.08	0.24	0.56	1.08

Comparing the data in table 1 and 2, we can see that with a decrease in the gain μ_{0s} power consumption when using variable frequency drives is reduced.

Note that when the fan moment static load (when $\mu_{0s} = 0$ and quadratic dependence microseconds μ_s on speed), the relative flow rates, pressure, torque and power of the motor shaft (when used as a basic unit of the nominal values) may be expressed in the angular speed function the following expressions, which are sometimes referred to as the laws of similarity:

$$Q_* = Q / \mathrm{Q}_{nom} = \omega / \omega_{nom} \tag{5}$$

$$H_* = H / \mathrm{H}_{nom} = (\omega / \omega_{nom})^2 \tag{6}$$

$$M_* = M / \mathrm{M}_{nom} = (\omega / \omega_{nom})^2 \tag{7}$$

$$P_{m*} = P_m / \mathrm{P}_{nom} = (\omega / \omega_{nom})^3 \tag{8}$$

whereω_{nom},M_{nom},P_{nom}isnominal rotational speed, engine torque and power respectively.

Pump efficiency at the same time is considered to be permanent.

It can be noticed that the application of throttling the flow of matter energy, pent valve or valve, is simply lost without doing any useful work. The use of the frequency converter as a part of the pump unit allows you to simply set the desired pressure or flow rate that will ensure not only energy savings, but also reduced the loss of the transported substances. In industrialized countries, it is almost impossible to find the induction motor without a frequency converter.

III. CONCLUSION

Solving the problem of reducing energy consumption, it is necessary, first of all, go back to the basics of the problem and reduce the irrational use of power technology units. One of the most effective methods to solve this complex problem is the implementation of modern systems of frequency regulation of electric drives and automation.

The high efficiency of frequency converters for the control parameters and optimization of the various process systems confirmed by many years of internationalpractice. Regulated electric drive is recognized as one of the most effective energy-saving technologies.

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