ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

Issues of effective provision of consumers with water and energy resources

Ishnazarov O.Kh., Hoshimov U.H., KhushievS.M

DSc, Chief researcher of the Scientific and Technical Center of JSC "Uzbekenergo", Tashkent, Uzbekistan
Doctoral student of the Scientific and Technical Center of JSC "Uzbekenergo", Tashkent, Uzbekistan
Senior Researcher of the Scientific and Technical Center of JSC "Uzbekenergo", Tashkent, Uzbekistan

ABSTRACT: The article poses and solves the problem of ensuring the stability of the water and energy supply. Separately, the main consumers of electrical energy of water supply and gas supply systems are studied. The operating mode of the pumping unit and gas cooling systems, ensuring stability and energy efficiency, has been determined.

KEY WORDS: energy saving, pumping unit, compressor unit, gas cooling unit, variable frequency drive, gas temperature, seasonality.

I. INTRODUCTION

Currently, reliable provision of consumers with water and energy resources is of paramount importance. This problem can be solved by ensuring the stability of the mode of operation of pumping stations (water supply) and compressor stations (gas supply).

The main consumer of electrical energy in pumping stations are pumping units, and in compressor stations (with a gas turbine engine) air coolers for gas. Let us consider in more detail the mode of their work separately.

II. ENSURING THE STABILITY OF THE PUMPING STATION

A pump installation as a control object can be simply represented as two interconnected elements - a pump unit and an equivalent pipeline (Fig. 1), while the minimum number of parameters describing the state of the control object includes throttling when adjusting the performance of the pump unit: (3, 4) and the characteristic of the unit (1); when adjusting the performance of pumping units by an adjustable electric drive by changing the speed of rotation of the units: the characteristic of the pipeline (3) and the characteristics of the unit.

It is known that by covering or opening the shutter, they change the steepness of the characteristics of the Q-H pipeline (Fig. 1), which depends on its hydraulic resistance. Covering the shutter, increase the steepness of the characteristics of the pipeline, while the operating point of the pump A1 is moved to position A2. In this case, the flow decreases to the value Q2, the pressure developed by the pump increases to the value H2, and the pressure on the pipeline behind the gate decreases to the value H’2. The decrease in pressure behind the gate is due to the pressure loss ΔH in the gate. Increasing the degree of opening of the shutter, reduce the steepness of the characteristics of the pipeline. As expected, the feed rate increases, the pressure developed by the pump decreases, and the pressure in the pipeline behind the gate increases. This method of regulation, called throttling, is considered to be ineffective, since additional energy costs are required to overcome the additional hydraulic resistance in the gate.

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 5, Issue 11, November 2018

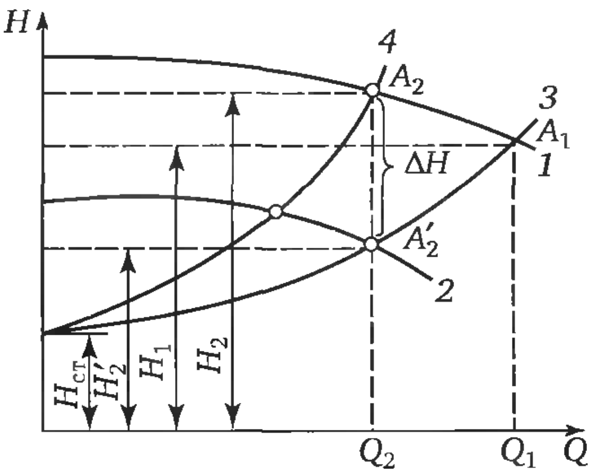

Fig. 1. Regulation of the operation mode of the centrifugal pump:

1 - characteristic of the Q-H pump at rated speed; 2 - the same with a reduced speed; 3 - the characteristic of the pipeline with the full opening of the shutter; 4 - the same with a decrease in the degree of opening of the shutter; H_1 is the head corresponding to the flow rate Q_1; Hст - static component of pressure.

This leads to excessive electricity consumption, because in this case, the pump creates a duct, which is then artificially reduced by the valve. In addition, each pump has an optimal mode of operation, and an increase in resistance to the output flow can lead to a decrease in pump efficiency (an increase in energy consumption) and a decrease in its reliability.

The world experience of the last 20-25 years shows that along with a variety of ways to save energy in pumping plants, one of the most effective solutions is to reduce power losses by eliminating throttling, which not only saves electricity, but also provides many important technological opportunities. A more economical method of regulation is to change the rotational speed of the pumps.

According to Figure 1, as the pump speed changes, the position of the Q-H pump characteristic changes. By reducing the speed, the Q-H characteristic is moved down, parallel to itself. In this case, the operating point, moving along the characteristic of the pipeline, takes the position A’2, therefore, the flow decreases as well as the pressure in the network and the pressure developed by the pump.

Increasing the speed increases the flow and pressure of the pump, as well as the pressure in the network. This method of regulation is more economical, but requires the use of a special adjustable electric drive.

To date, there is no doubt that better energy performance gives the introduction of frequency-controlled drive.

Figure 2 shows a block diagram of a variable-frequency electric drive of a pumping unit.

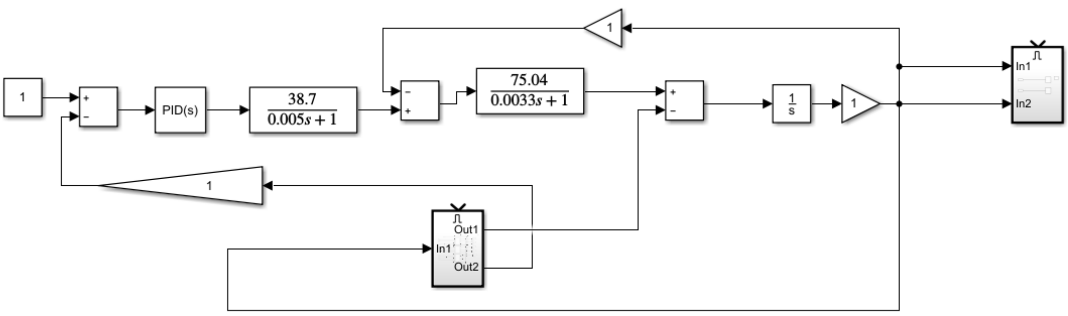

Fig. 2. Structural diagram of the frequency-controlled electric pump unit

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

Thus, the frequency regulation creates the ability to control the speed of the electric motor of the pump unit in accordance with the nature of the load. This, in turn, allows avoiding complex transient processes in electrical networks, ensuring equipment operation in the most economical and stabling mode.

III. ENSURING THE STABILITY OF THE OPERATING MODE OF THE COMPRESSOR STATION

Reducing the energy intensity of the transport of natural gas is currently provided by gas cooling systems after it is compressed at a compressor station. Air coolers have become widespread in the gas industry. However, in such pipelines there is an increase in the temperature of the transported gas as a result of a significant deterioration in heat exchange with the environment caused by the pollution of the apparatuses during their operation. Increasing the temperature in the gas pipeline requires an increase in the power of gas pumping units to compress gas at subsequent compressor stations, which leads to excessive consumption of fuel gas and acceleration of gas-turbine engines

$$\frac{\rho_1}{\rho_2}=\frac{T_2}{T_1} \qquad (1)$$

where ρ_1 and $\rho_2$is the gas density at gas temperatures T_1 and T_2.

Therefore, to reduce the temperature of the gas to a regulated value, a larger number of fans are put into operation by air cooling devices, which leads to an increase in the consumption of electricity used to drive the fans.

From this it follows that energy savings can be achieved by improving the operating conditions of the fans. The desired effect can be obtained by reducing the hydraulic resistance of the flow section of the air-cooled apparatus and improving the aerodynamics of the overall structure, which consists in improving the flow conditions of the heat-exchanging tubes of the air-cooling apparatus .

The cooled gas is 10-15 ° C higher than the average annual temperature, which is the optimum annual average annual temperature. Estimated annual, quarterly and monthly temperature of the cooling device is determined by the following formula

$$\mathrm{T_в}=\mathrm{T_a}+\delta\cdot\mathrm{T_a} \qquad (2)$$

где Ta-the average air temperature in the interval is determined in accordance with SNiP 2.01.01-82.; δTa – determined by regional climatic conditions. Based on statistical data based on data from δTa to 2 ° C.

The specific gravity of the flow of 1 cubic meter of gas is determined by the following formula (Н/м)

$$q_{газ}=0{,}215\rho_{газ}g\frac{p_0D_{вн}^2}{zT}, \qquad (3)$$

where $\rho_{газ}$– gas density, kg/m^3; g– free fall rate, g=9,81 м/s^2; p_0– pipeline gas pressure, MPa; $D_{вн}$- internal diameter of the pipeline, sm; z– gas compression ratio; T– absolute temperature, К (T=273+t, where t– gas temperature, °C).

From formula 3 it can be seen that increasing the temperature in gas pipelines will reduce the amount of gas in the volume. In this case, the main gas pipelines will be reduced to a useful operating ratio. The temperature of the gas compressor station to the main gas pipelines depends on the natural climate of the station where the station is located.

Table 1

Change of parameters of compressor station depending on temperature in the section of months

Months	Energy consumption relative to the maximum value, **%**	Energy consumption relative to the minimum value, **%**	Climate data of the region				
			Day		Night		Relative humidity %
			min	max	min	max	
January	68,61	157,43	-2	12	-5	8	72
February	65,14	146,94	-1	17	-7	6	71

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

March	68,23	125,01	7	22	-3	14	63
April	68,11	125,7	10	31	3	20	55
May	80,2	118,7	23	39	12	26	39
June	85,93	106,93	33	42	17	27	26
July	100	100	35	46	24	31	25
August	77,88	107,67	36	44	17	28	31
September	65,91	103,2	14	40	5	25	36
October	54,58	120,81	16	31	5	14	45
November	58,36	142,68	8	30	0	15	65
December	64,79	183,21	-2	23	-6	6	69

We see that the energy consumption in air coolers depends on the ambient temperature and humidity. As a result, an increase in air humidity of up to 20% can be achieved by reducing energy consumption. The humidity used to increase the humidity of the air is calculated by the following formula

$$G = L \cdot \rho_{\text{хаво}} \cdot (d_{\text{ташқи}} - d_{\text{ички}})$$

Here: G is the humidity indicator, g / s (kg / s);

L - fan capacity, m^3/s;

$\rho_{\text{хаво}}$ – air density;

$d_{\text{ташқи}}$ – ambient humidity, g / kg;

$d_{\text{ички}}$ – humidity of internal air, g/kg;

Humidity is determined by the following formula

$$d = 622 \cdot \text{Р}_{\text{н}}/(\text{Р}_{\text{б}} - \text{Р}_{\text{н}})$$

Here$\text{Р}_{\text{н}}$- air pressure, kPa;

$\text{Р}_{\text{б}}$ – actual air pressure (barometer), kPa.

Thus, the optimum value of air humidity depends on the natural climate of the region in which the compressor station operates.

The degree of cooling in the cooling system is expressed by the following formula

$$\Delta Q_{\text{сов}} = (t_{11}^{''} - t_{12}^{''}) = m \cdot (Q_{11\text{в}} - Q_{1\text{св}}) + (n - m) \cdot (Q_{12\text{в}} - Q_{11\text{в}}), \tag{4}$$

where $t_{11}^{''}$ и $t_{12}^{''}$ - natural gas temperatures before and after cooling respectively; m – number of cooling fans; n - total number of cooling fans.

It can be seen that the compressed gas does not correspond to the required interval $t_{12}^{''}$ due to the high temperature of the gas-cooling units in the summer period, so it can be shown that the air temperature has increased in recent years. Most of the existing compressor stations were commissioned several decades ago and thus equipped with low power gas cooling system.

In view of the above, it is desirable to increase the efficiency of refrigeration units at compressor stations using additional cooling systems together with the free convection method. The function of the additional cooling device is performed by spraying the irrigated water onto the operating cooling devices. Sprinkled water increases the humidity of the air and increases the efficiency of the cooling process and increases energy efficiency. Taking into account the power consumption of the water pump pump 2.2 kW, the energy consumed by water is about 5% of the energy consumed.

In general, it can be said that the increase in cooling efficiency by increasing the humidity of the compressor station at high temperatures by cooling the air. As a result, the energy efficiency of the cooling device is increased and the energy consumption is reduced. At the same time, it is believed that the adverse effects associated with an increase in the gas temperature at the outlet of the compressor station are prevented.

IV. CONCLUSION AND FUTURE WORK

In conclusion, it is worth noting that the regulation of the speed of rotation of the pumping unit, as well as the additional humidification of the air, will allow consumers to consistently provide water and energy resources.In addition to the stable supply of consumers with water and energy resources, the proposed solutions allow reducing consumption of energy resources from 15 to 25%.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

REFERENCES

[1] Kamalov.T.S., "Frequency-controlled electric drive of pumping stations of machine irrigation systems". Publishing house "FAN" Academy of Sciences of the Republic of Uzbekistan, Tashkent 2014 y.

[2] Leznov B.S. Energy saving and adjustable drive in pump and blower installations. - M .: Energoatomizdat, 2006.

[3] Khushiev S.M. "Energy saving modes of pumping stations in the water supply system". FarPI scientific-technical journal Tom 21. No. 4, 2017.

[4] Kalinin A.F., Kuptsov S.M., Lopatin A.S. Determination of the thermodynamic characteristics of natural gas for solving energy technological problems // NTS. Sectoral energy and energy saving problems. - M .: IRTS Gazprom, 2004. - № 1. - p. 3-10.

[5] Novoselov V.F., Golyanov A.I., Muvtakhov E.M. "Typical calculations in the design and operation of gas pipelines." Ufa. Publisher UNI. 1986.-94 p.

[6]Abuzov F.F., Aliyev R.A., Novoselov V.F. and others. “Technique and technology of transport and storage of oil and gas”. Moscow. Bosom. 1988.- 320 p.

[7] SNiP 2.05.06-85 Trunk Pipelines. Moscow 1997.

[8] Korshak A.A., Shmanov N.N., Makhmotov E.S. and others. Trunk pipelines. Ufa. Publishing LLC DesignPolygraphService. 2008. - 448 p.

[9]Ustinov E.V. Reducing the energy consumption of air coolers for gas / E.V. Ustinov // Gas industry. - 2011. - № 8. - p. 54-57.

[10]Elov, A. System of automatic control of air-cooled apparatuses / A. Elov // Equipment and technologies for oil and gas complex. - 2009. - № 3. - p. 43-47.

[11]Alimov, S.V. Modernization of fans ABO - gas in the reconstruction of CS MG / A.O. Prokopets, S.V. Kubarov, V.A. Malanichev, E.V. Ustinov // Gas industry. - 2009. - № 4. - p. 54-56.