IMPROVING THE ENERGY EFFICIENCY OF PUMP UNITS IN THE WATER INDUSTRY

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Abstract. *An analysis of methods for regulating the parameters of power units of pumping stations of urban water supply systems is presented. It is shown that the energy efficiency of pumping units can be increased by taking into account real water consumption regimes in the water supply network. An example of analysis of the operational parameters of the power unit of a pumping station of a city water supply system is considered.*

Keywords: *water supply, power unit, pumping station, regulation, energy efficiency.*

INTRODUCTION

The water supply and distribution system is an important complex of water supply structures, which ensures the transportation of water to the territory of the supplied facilities, distribution throughout the territory and delivery to the points of selection by consumers. The power units of pumping stations (PS), as one of the main structural elements, largely determine the operational capabilities and technical level of the water supply system as a whole, and also significantly determine the energy and economic indicators of its operation.

MATERIALS AND METHODS

Water supply and sanitation systems are among the most energy-intensive housing and communal services facilities, where the main consumers of electricity are pumping stations (PS). In these systems in Uzbekistan, 120...130 billion kWh of electricity is consumed annually for pumping clean and polluted water by pumping units [1]. In the cost structure for the provision of water supply and sanitation services, energy costs can reach 50%, including non-productive costs up to 20%. An important cost component in the cost structure is water losses during its distribution and transportation to consumers, which can reach at least 30% of the total volumes. Increased pressures in the network create additional losses, which reduces the energy efficiency of the system as a whole by [2]. Therefore, the issue of increasing the energy efficiency of pumping equipment in water supply and wastewater systems is a priority [3].

RESULTS AND DISCUSSION

The low energy efficiency of water supply systems when pumping water is explained by a number of reasons related to the power units of pumping stations [4]:

- discrepancy between the characteristics of the pumps used and the variable hydraulic conditions of the networks;
- the use of units with low efficiency due to their wear and tear or being initially structurally or technologically imperfect under the conditions of their use;
- the use of energy-ineffective methods for regulating the operating modes of pumping unit-network systems.

The problems faced by utility companies in Uzbekistan in ensuring the required technological parameters in water supply networks (WSNs) are, as a rule, similar. Increasing the number of storeys, connecting new consumers, and the state of trunk networks have led to the need to install regulation systems to ensure the necessary parameters at the level of district and block networks. The selection of pumps was often made taking into account development prospects, so their performance and pressure parameters were overestimated. It has become common to bring pumps to the required characteristics by throttling using valves, which leads to irrational losses of electricity. However, pumps are not replaced; most of them operate with low efficiency. The wear and tear of PS equipment has exacerbated the need for their modernization or reconstruction to increase efficiency and reliability while ensuring the required operating conditions. One of the main directions of technological energy saving in various technical systems is the use of energy efficient technologies.

One of the modern power units is complicated by significant differences in the pressure characteristics of centrifugal pumps (CP) and BC. One of the modern methods of regulating the parameters of power units is frequency regulation, which ensures a change in the speed of rotation of the impeller.

The purpose of this work is to substantiate the parameters and energy saving modes of the water supply system during the operation of pumping units of the PS of the second lift, based on its mathematical modeling using modern information technologies, methods of statistical analysis and mathematical modeling.

When performing the work, the following tasks were set:

1. Perform an analysis of the actual operating modes of the pumping station in a residential area and summarize the available information on the efficiency of its operation.

2. Justify the choice of an objective criterion for assessing the energy efficiency of the pumping station in a residential area with the development of recommendations to determine the energy saving potential.

3. Develop a mathematical model of the functioning of a combined pumping unit when equipped with an adjustable drive.

4. Develop an energy-efficient way to control the pumping unit to ensure optimal parameters, taking into account the nature of the distribution of water consumption in a residential area over time.

As an example, we consider a pumping station in one of the districts of Simferopol with an average daily supply of 2500 m3/day, and a constantly maintained pressure of 60 m due to the installation of an inverter in the drive of the pumping unit. 9504 values of hourly flow rates at a given pumping station in a residential area were considered as initial values. That is, the parameters were considered for a period of 9504 hours of operation, which corresponded to 396 days of operation during 2022 and January 2023. The parameters that were determined experimentally correspond to the parameters of the operating points, which were determined by the intersection of the pressure characteristics of the NS power unit with the characteristics of the aircraft. These operating points correspond to the supply of consumer demand at a certain pressure, which is determined from the hydraulic characteristics of the aircraft.

During statistical processing of the resulting data array, the maximum, minimum and average values were determined, and the variance in the sample was assessed. To assess the impact of seasonality on the pumping system supply, operational parameters were analyzed separately for winter, spring, summer and autumn. To assess the impact of weekly unevenness, HC submissions on weekdays and weekends were considered separately. In this work, after obtaining a given amount of data, it was also necessary to identify the unevenness of water consumption in the service area of the PS of the second rise.

To visually present numerical information and analyze the results of statistical analysis of data on the operation of pumping units, we will use computer visualization. Since when analyzing data, it is difficult to discern any pattern in the numerical values, especially if the volume of data is significant.

CONCLUSION

Water supply and sewerage systems are among the most energy-intensive housing and communal services facilities, where the main consumers of electricity are the power units of the PS. Therefore, an important direction for increasing the energy efficiency of water supply systems is to improve systems for regulating the parameters of power units.

An analysis of the most used modern methods for regulating the parameters of power units using inverters has been carried out, their advantages and disadvantages have been shown. It is substantiated that further improvement of these control methods should be based on the study of the operational parameters of power units in order to identify the laws of distribution of these parameters over time.

A stepwise method is proposed for regulating the parameters of the power unit of the PS using an inverter, which makes it possible to significantly reduce the pressure in the PS under operating conditions that differ from the maximum water consumption mode. The results obtained showed the energy efficiency of the proposed stepwise control method. For the PS discussed in the article, the energy efficiency of the power unit can be increased by 9.7%, resulting in energy savings of up to 30 thousand kWh per year.

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