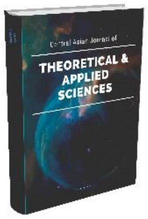

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Analysis of Working Modes of Well Pumping Equipment Eectr

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Annotation: *In the article, the neural network control algorithm is used, and the energy-saving conditions are presented using the methods of pump monitoring and control. It is possible to improve the efficiency of well pumps using artificial neural network control.*

Keywords: *Centrifugal pump, neural network control, conducts control, pressure.*

Introduction

The development of the world economy causes the demand for electricity to grow. In order to adequately meet the demand for electricity, there is a demand for energy-efficient devices. Therefore, it requires the use of modern cost-effective methods in all types of electrical control equipment.

Currently, the use of underground water sources based on wells is a common technical solution in the design of industrial and individual water supply systems. In this case, the water supply system is based on the use of well pumps and automation equipment with electric drives that control the object with the specified quality indicators [1].

Regulating the operating modes of pumping units for Q wells is carried out using frequency converters with PID controllers adjusted to maintain the specified pressure [2].

The operation modes of the pump device depend on the change of water consumption or waste water flow. The operating modes of the pump units of industrial enterprises are mainly determined by the technological process of the enterprise. Pumping stations of industrial enterprises can also work with a clear night-time mode of water consumption [3].

The main way to increase the productivity of well pumping equipment is to optimize the operating modes of the pumping equipment, to ensure the stable operation of the pump and the electric motor at full load, high efficiency indicators depend on reducing the waste in the conductors and the control system (BQ) [4] .

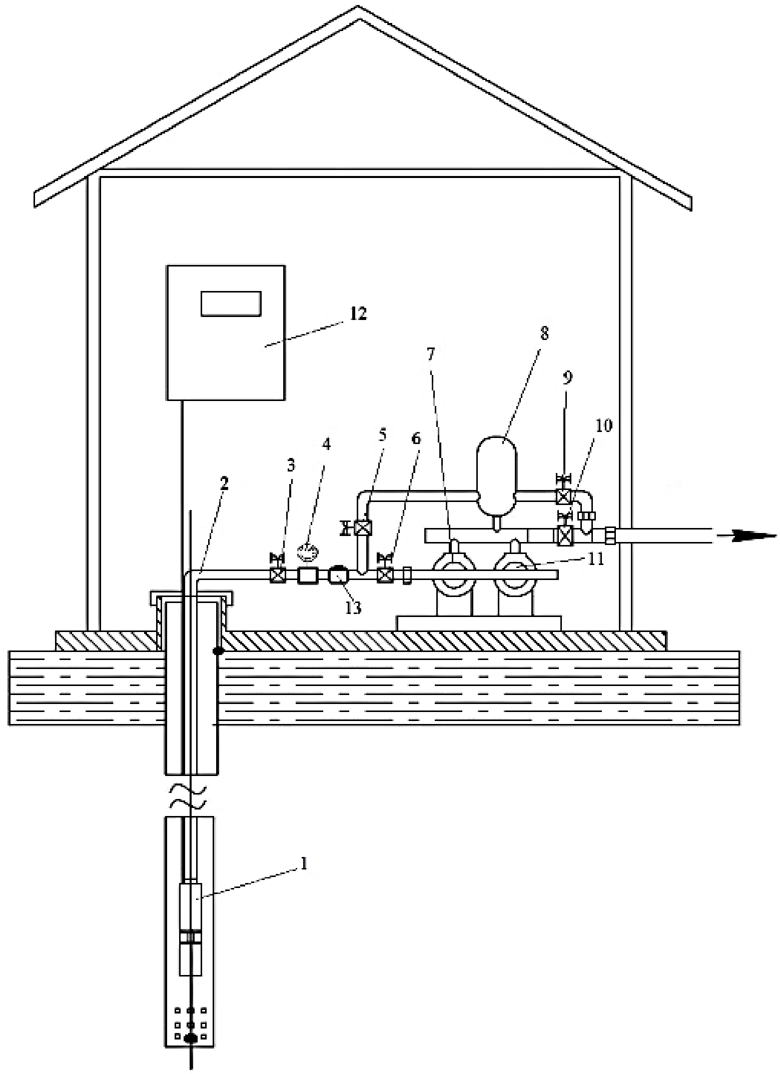
Accordingly , inspection and instrumental measurements of water supply well pump system (E Ts V 10-63-150) of " KVARTS " A/J enterprise were carried out . The 1-day mechanical and energy parameters obtained as a result of instrumental measurements (load graph, FIK, power coefficient and average current value) are presented in Table 1.

The water supply system of "KVARTS" A/J enterprise is supplied by underground water taken from 6 wells located on the territory of the enterprise . These wells are located at a depth of 85 m to 140 m and draw groundwater with an average contact time (several weeks to a year) in the soil body. The inspected well is located in the northern part of the enterprise . The depth of the well is 85 m. The installed pipe diameter is 100 mm . In the well , a submersible pump of type E Ts V 10- 63 - 150 is located at a depth of 50 m from the surface (during operation, the depth of the water level is 5 m from the surface).

Table 1

No	Time	Instrumental measurement data					
		Tok, A I medium	Cosp	Active power, R_f, kW.	Reactive power, Q_r, kVar	Total power S, kVA.	Production Q, $m^3 \cdot s$
1	7:00 a.m	50.03	0.84	27.98	17.56	33.03	66.06
2	8:00 a.m	50.48	0.85	28,36	17.48	33,32	66,64
3	9:00 a.m	49.76	0.85	28.11	16.97	32.84	65,68
4	10:00 a.m	48.98	0.85	27.73	16.61	32,32	64,64
5	11:00 a.m	49.01	0.85	27.73	16.64	32,34	64,68
6	12:00 p.m	49.39	0.86	28.03	16.63	32.6	65.2
7	13:00	49	0.85	27.8	16.51	32,34	64,68
8	14:00	49.22	0.86	28.04	16.4	32.49	64.98
9	15:00	49.55	0.86	28,17	16.6	32.7	65.4
10	16:00	51,53	0.84	28.9	17.92	34.01	68.02
11	17:00	51.17	0.85	28.88	17.49	33.77	67.54
12	18:00	51.41	0.85	28.87	17.82	33.93	67.86
13	19:00	50.6	0.85	28.58	17.27	33,39	66,78
14	20:00	50	0.85	28.2	17,13	33	66
15	21:00	50.29	0.85	28,31	17.32	33,19	66,38
16	22:00	49.74	0.85	27.96	17,19	32.83	65,66
17	23:00	49.5	0.85	27.9	16.98	32.67	65.34
18	0:00:00	48,68	0.85	27.57	16.48	32,13	64.26
19	1:00 a.m	48.6	0.85	27.41	16.66	32.08	64.16
20	2:00 a.m	48,49	0.85	27,29	16.7	32	64
21	3:00 a.m	48,48	0.85	27.4	16.52	31.99	63.98
22	4:00 a.m	48.32	0.85	27,33	16.43	31.89	63.78
23	5:00 a.m	48,58	0.85	27,28	16.83	32.06	64.12
24	6:00 a.m	49.62	0.84	27.77	17.34	32.74	65.48

The technological scheme of the well pump is presented in Fig . 1 . In all well chambers of the enterprise , analog devices are available only for measuring local pressure, water flow and groundwater level. Additional sensors were needed to effectively measure power even at remote well sites . Mobile measuring equipment was used for this.



1 - picture. Technological scheme of the well pump.

1 - well pump, 2 pipeline, 3 , 5, 6, 9, 10 - Gate valve , 4 - monometer, 7 , 11 - centrifugal pump , 8 - filter , 1 2 - storage cabinet, 13 - Water meter.

According to the results of the inspection , it was determined that the regulation of the operation of the pump units is carried out by adjusting the opening-closing angle of the gate (valve , door valve). That is, when the consumption of water increases, the gate is switched to a fully open state, and as the consumption decreases, it is closed depending on the pressure. In this case, a valve is used at the output of the pump, which regulates the hydrodynamic resistance of the system [5,6] . In addition, it was found that in order to maintain the required pressure in the pipeline, it is done by changing the number of pump units on and off.

Water consumption tables are characterized by unevenness coefficients. The maximum coefficient of unevenness

$$K_{\text{макс}} = Q_{\text{макс}} / Q_{\text{ўр}}$$

where $Q_{\text{макс}}$, $Q_{\text{ўр}}$-maximum and average values of water consumption.

The minimum coefficient of unevenness

$$K_{мин} = Q_{мин} / Q_{ўр}$$

here $Q_{мин}$- minimum water consumption. $Q_{ўр}$depending on the time period to be taken, the uniformity coefficients can be hourly, daily, etc.

According to the analysis of the obtained data, Figure 2 shows the average daily water consumption diagram.

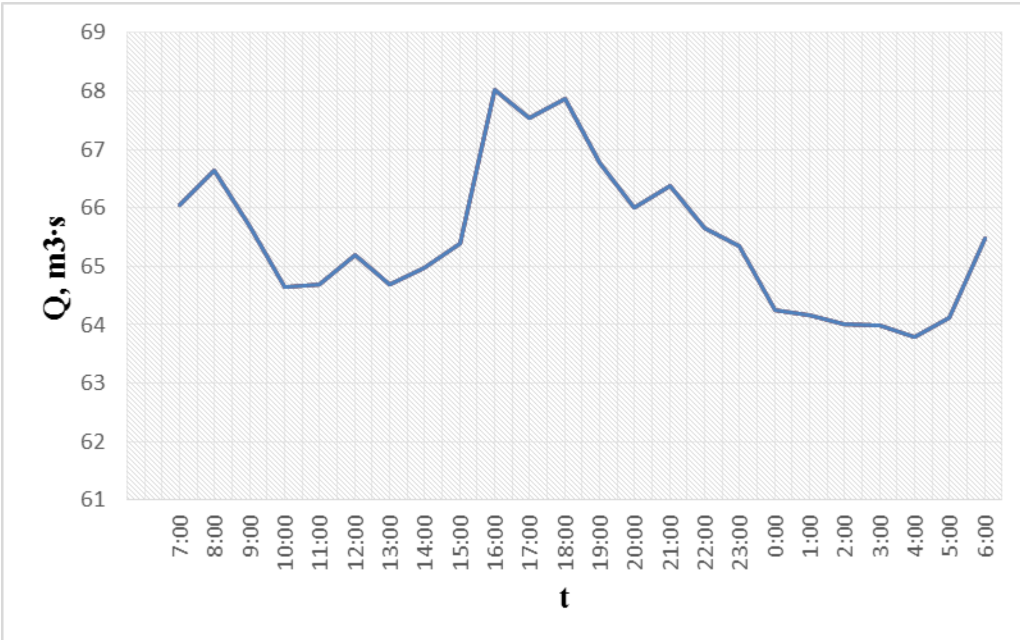


Figure 2. Daily diagram of water consumption

Figure 3 shows the average monthly water consumption diagram.

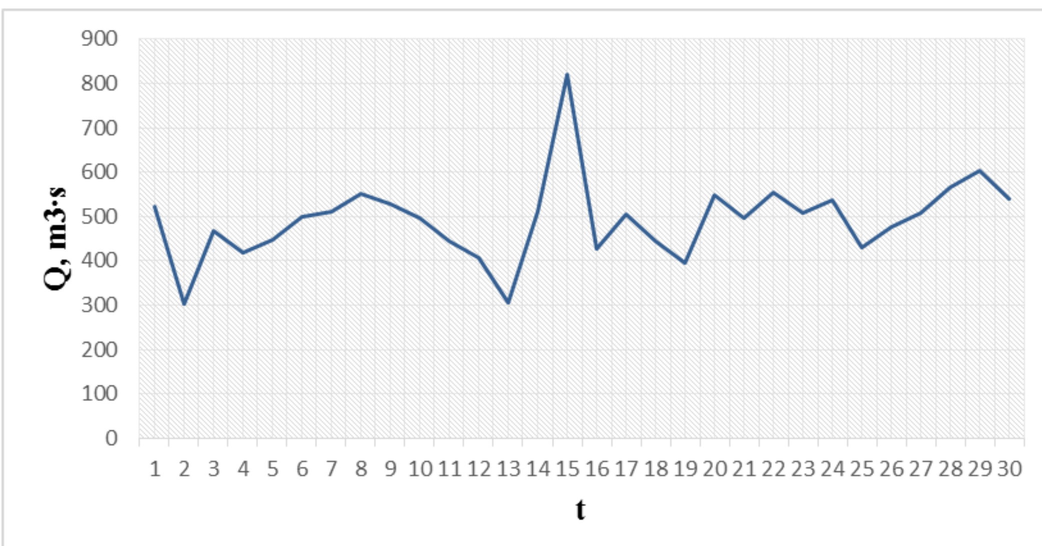
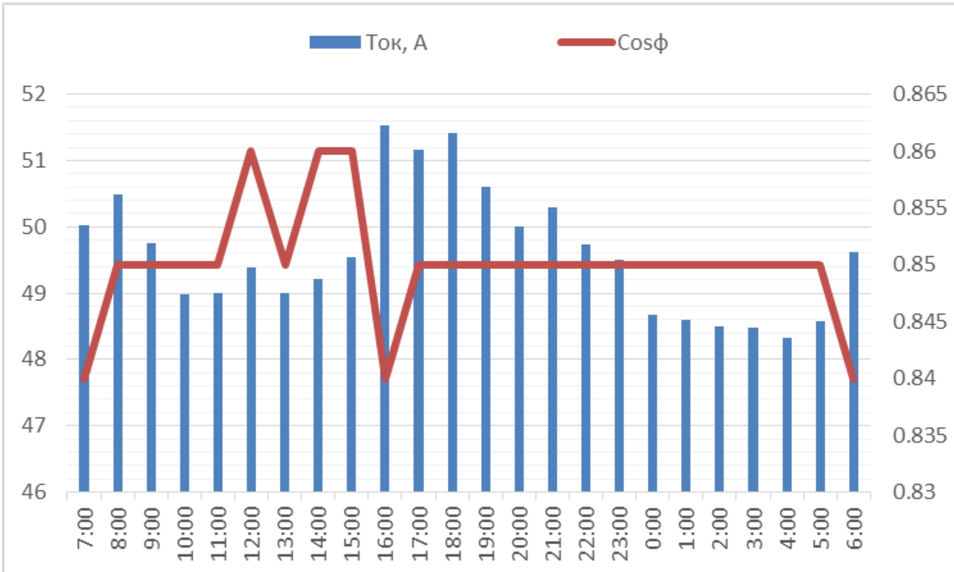


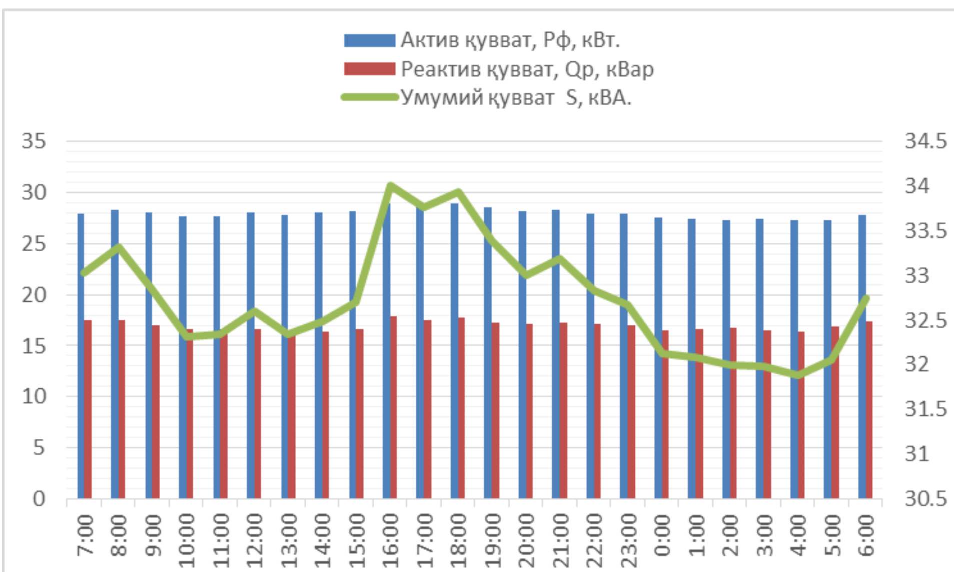
Figure 2. Monthly diagram of water consumption

The system of well pumps at the enterprise consists of two turbopipes (technical, drinking) and a set of facilities and services that produce water for supply and distribute it to consumers; the amount of water supplied should meet the consumption requirements. This well pump complex consists of pipelines, a non-return valve, a hydrant valve gate (zadvizhka) and pumping equipment (Fig. 1).

In order to determine the actual operating mode of the well pump, experimental work was carried out on the well pump of the water supply systems of "KVARTS" A/J . Based on the analysis of the generalized experimental data in Figures 4.5 energy parameters obtained from the instrumental measurement results of the well pump are presented.



4th century Current and power factor of the well pump instrumental measurement



5th century Active, reactive and total power of the well pump instrumental measurement

"QUARTZ" A/J the analysis of the experimental studies conducted on the water supply well pump shows that the operating mode of the well pump depends on the water consumption. As can be seen from the daily diagram of water consumption, there is a noticeable water demand. Factors affecting the uneven regime of water consumption can be divided into the following.

- The company has 3 shifts in 1 day. Water demand increases during shifts;
- Seasonally irrigated lands increase water consumption during hot periods of the year.

Therefore, in case of uneven water consumption, the pressure regulation in the pipe is carried out by changing the opening-closing angle of the valve.

In addition, the factors affecting energy consumption can include the following:

- obsolete existing pumps;
- does not have an automatic control system;
- lack of automated dispatching control systems;
- non-coordination of the operating modes of the pump electric motor with the technological process;

In short, complex automation of the studied well system, as a result of regulation of their modes with the help of frequency converters and specialized control algorithms, allows to achieve energy savings by eliminating excess pressure during the acceleration of the pump motor and reducing electricity costs.

Optimization of the operating modes of the studied well pumps made it possible to achieve energy savings of up to 52% due to the reduction of excess pressure and up to 2.0% due to the reduction of starting power during engine acceleration.

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