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ANALYSIS OF THE DRIVES OF PUMPING STATIONS IN THE SOUTHERN PART OF THE ANGREN COAL MINE OF UZBEKUGOL JSC

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Abstract: *This article presents the results of a comprehensive analysis of the operation of pumping station drives in the southern part of the Angren coal mine of Uzbekugol JSC. The modes of operation and designs of pumps of various types are considered, including CPSH 850-240, D320-50, D1200-125 and GR170-30. The study covers the performance characteristics of these pumps, as well as their adaptation to the specific conditions of the coal mine. Special attention is paid to the impact of climate change on the operating modes of pumping units. Changes in the amount and intensity of precipitation, as well as fluctuations in the level of groundwater and drainage waters, significantly impact the operating conditions of pumping stations. These factors require detailed analysis to ensure the reliability and efficiency of pumping plants in a changing climate. The study includes an analysis of the current pump operating modes, identification of problems and shortcomings in existing drive systems, as well as the development of recommendations for their improvement. In particular, the possibility of introducing new technologies and materials, as well as adapting pump operating modes to changing hydrological conditions, is being considered. In addition, the article presents the results of modeling various scenarios of pumping station operation under changing climatic conditions. The proposed optimization measures include improving the structural elements of pumps, increasing their energy efficiency and reliability, and introducing automatic control and regulation of operating modes. The study's main purpose is to develop recommendations for improving the stability and efficiency of pumping stations at the Angren coal mine in a changing climate. The presented results and conclusions can be useful for specialists in the field of operation and maintenance of pumping units, as well as for developers of new technologies in the field of hydraulic systems.*

Keywords: *Pumping station drives, Angren coal mine, Climate change impact, Operating modes, Groundwater fluctuations, Drainage waters, Reliability, Efficiency.*

Annotatsiya: *Ushbu maqolada "O'zbekugol"AJ Angren ko'mir konining Janubiy qismidagi nasos stansiyalari haydovchilarining ishlashini kompleks tahlil qilish natijalari keltirilgan. Har xil turdagi nasoslarning ishlash rejimlari va dizaynlari, shu jumladan CPSH 850-240, D320-50, D1200-125 va GR170-30 ko'rib chiqiladi. Tadqiqot ushbu nasoslarning ishlash xususiyatlarini, shuningdek ularning ko'mir kesishning o'ziga xos sharoitlariga moslashishini o'z ichiga oladi. Iqlim o'zgarishlarining nasos qurilmalarining ish rejimlariga ta'siriga alohida e'tibor qaratilgan. Yog'ingarchilik miqdori va intensivligining o'zgarishi, shuningdek er osti va drenaj suvlari darajasining o'zgarishi nasos stantsiyalarining ish sharoitlariga sezilarli ta'sir ko'rsatadi. Ushbu omillar o'zgaruvchan iqlim sharoitida nasos qurilmalarining ishonchliligi va samaradorligini ta'minlash uchun batafsil tahlilni talab qiladi. Tadqiqot nasoslarning joriy ish rejimlarini tahlil qilish, mavjud haydovchi tizimlaridagi muammolar va kamchiliklarni aniqlash va ularni yaxshilash bo'yicha tavsiyalar ishlab chiqishni o'z ichiga oladi. Xususan, yangi texnologiyalar va materiallarni joriy etish, shuningdek, nasoslarning ish rejimlarini o'zgaruvchan gidrologik sharoitlarga moslashtirish imkoniyati ko'rib chiqilmoqda. Bundan tashqari, maqolada iqlim sharoiti o'zgarganda nasos stantsiyalarining turli xil stsenariylarini modellashtirish natijalari keltirilgan. Tavsiya etilgan optimallashtirish choralari nasoslarning tarkibiy elementlarini yaxshilash, ularning energiya samaradorligi va ishonchliligini oshirish, shuningdek, ish rejimlarini avtomatik boshqarish va tartibga solish tizimlarini joriy etishni o'z ichiga oladi. Tadqiqotning asosiy maqsadi o'zgaruvchan iqlim sharoitida Angren ko'mir konining nasos stantsiyalarining barqarorligi va samaradorligini oshirish bo'yicha tavsiyalar ishlab chiqishdir. Taqdim etilgan natijalar va xulosalar nasos qurilmalarini ishlatish va texnik xizmat ko'rsatish bo'yicha mutaxassislar, shuningdek, gidravlik tizimlar sohasida yangi texnologiyalarni ishlab chiquvchilar uchun foydali bo'lishi mumkin.)*

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Tayanch so‘zlar: *Nasos stansiyalari yuritmalari, Angren ko'mir koni, iqlim o'zgarishi ta'siri, ish rejimlari, yer osti suvlarining o'zgarishi, drenaj suvlari, ishonchlilik, samaradorlik.*

Аннотация: *В данной статье приводятся результаты комплексного анализа функционирования приводов насосных станций южной части Ангренского угольного разреза АО «Узбекуголь». Рассматриваются режимы работы и конструкции насосов различных типов, включая ЦНСГ 850-240, Д320-50, Д1200-125 и ГР170-30. Исследование охватывает эксплуатационные характеристики этих насосов, а также их адаптацию к специфическим условиям угольного разреза. Особое внимание уделено влиянию климатических изменений на режимы работы насосных установок. Изменения в количестве и интенсивности осадков, а также колебания уровня грунтовых и дренажных вод оказывают значительное воздействие на эксплуатационные условия насосных станций. Эти факторы требуют детального анализа для обеспечения надежности и эффективности насосных установок в условиях изменяющегося климата. Исследование включает в себя анализ текущих режимов работы насосов, выявление проблем и недостатков в существующих системах привода, а также разработку рекомендаций по их улучшению. В частности, рассматривается возможность внедрения новых технологий и материалов, а также адаптация режимов работы насосов к изменяющимся гидрологическим условиям. Кроме того, в статье приводятся результаты моделирования различных сценариев работы насосных станций при изменении климатических условий. Предложенные меры по оптимизации включают улучшение конструктивных элементов насосов, повышение их энергоэффективности и надежности, а также внедрение систем автоматического контроля и регулирования режимов работы. Основная цель исследования заключается в разработке рекомендаций по повышению устойчивости и эффективности работы насосных станций Ангренского угольного разреза в условиях изменяющегося климата. Представленные результаты и выводы могут быть полезны для специалистов в области эксплуатации и обслуживания насосных установок, а также для разработчиков новых технологий в сфере гидравлических систем.*

Ключевые слова: *Приводы насосных станций, Ангренский угольный разрез, Влияние изменения климата, Режимы работы, Колебания грунтовых вод, Дренажные воды, Надежность, эффективность.*

Introduction

The Angren coal deposit, located in the Tashkent region of the Republic of Uzbekistan, 110 km south-east of Tashkent city, plays an important role in the energy and industrial infrastructure of the region. This deposit is connected to Tashkent by road and rail, which provides convenient transportation of extracted resources. The deposit is located in the densely populated valley of the Akhangaran River, which is bounded from the northwest and southeast by the ridges of the Tien Shan mountain system. The heights of the valley range from 850 to 1300 meters, which creates specific conditions for the operation of the coal mine. Akhangaran is a typically mountainous river, which in the flood period has a flow rate of up to 450 m3/h, and in the autumn-winter period the flow rate reaches 2 m/s. To regulate the flow of flood waters above the current section, a dam was built on the river, from where the water is diverted by a tunnel along the stationary side of the section. The climate of the area is sharply continental and dry, with a long summer period and low rainfall [1]. The region is characterized by high seismic activity and belongs to the eight-point zone on the Richter scale. A coal mine, mine No. 9 of the Sredazugol production association and an underground coal gasification station operate at the field.

In addition to coal, minerals are mined here: clay deposits used as an additive in cement production, limestones for cement production and kaolin clays for building materials enterprises in the republics of Central Asia and Kazakhstan. Angrenskaya GRES with a capacity of 393 MW and Novoangrenskaya GRES with a design capacity of 2,100 MW operate based on Angren coal [2].

Coal mining is carried out both underground and open-pit. The development of a coal deposit requires the performance of significant amounts of stripping work, while the area of the quarry exceeds 5 km2. Natural precipitation, such as rain and snow, as well as groundwater, flows into the working areas of the coal mine. To ensure smooth operation, it is necessary to effectively remove these waters from work sites.

In such difficult conditions, pumping stations providing pumping of groundwater, drainage and flood waters are of crucial importance. By properly managing these installations, energy consumption can be significantly reduced, resulting in lower operating costs and increased overall efficiency. The efficiency of pumping stations directly affects the production processes and the safety of field operation. This article analyzes and optimizes the drives of pumping stations in the southern part of the Angren coal mine of Uzbekugol JSC, including consideration of the operating modes and designs of pumps CPSH 850-240, D320-50, D1200-125 and GR170-30. Special attention is paid to the impact of climate change on the operation of pumping units, as well as the development of recommendations for their

optimization to improve reliability and efficiency in a changing climate.

Research Methods and the Received Results

Precipitation and groundwater accumulate over time and form reservoirs in the quarry area. These accumulations of water must be regularly removed to ensure the smooth and safe operation of production processes. For this purpose, various types of pumps are used, each of which is designed to perform specific tasks for pumping and moving water, depending on operating conditions and water volumes. During the operation of the pumping stations of the Angren coal mine, changes in the height of the water rise, as well as in the length of the pipeline, often occur. These changes can be caused by various factors, such as periodic changes in the groundwater level, an increase or decrease in the water level in reservoirs. Changes in the lifting height require appropriate adjustments to the parameters of pumping units, such as flow and pressure, as well as modifications to pipelines taking into account new operating conditions, the height of the water rise and the volume of pumped water.

In the Angren coal mine, the southern (22nd section) and northern pumping stations (26th section) play a key role in the wastewater disposal process. The Angren coal mine is also divided into pickets (PCs), providing more detailed management and control of wastewater disposal. In the southern pumping station, located on the 22nd site, there are seven pumping units located in various pickets: PK-1, PK-5, PK-6 and PK-11. Since the work is carried out at different levels of the section, it is not possible to use gravity flow to drain water. Instead, pumping units are used, which ensure reliable and efficient drainage regardless of the water level. These installations are designed for efficient pumping of water, which is critical to maintaining safe and stable working conditions at the mine. All pumping units are located on floating platforms, which allows for a constant suction flow. The dimensions of these floating platforms depend on the weight and design of the pumping units, ensuring stable operation of the pumps in various water level conditions. The pump outlets are connected to the discharge line through a flexible connector, which allows changing the water level in the tanks to change the platform level (Fig. 1).

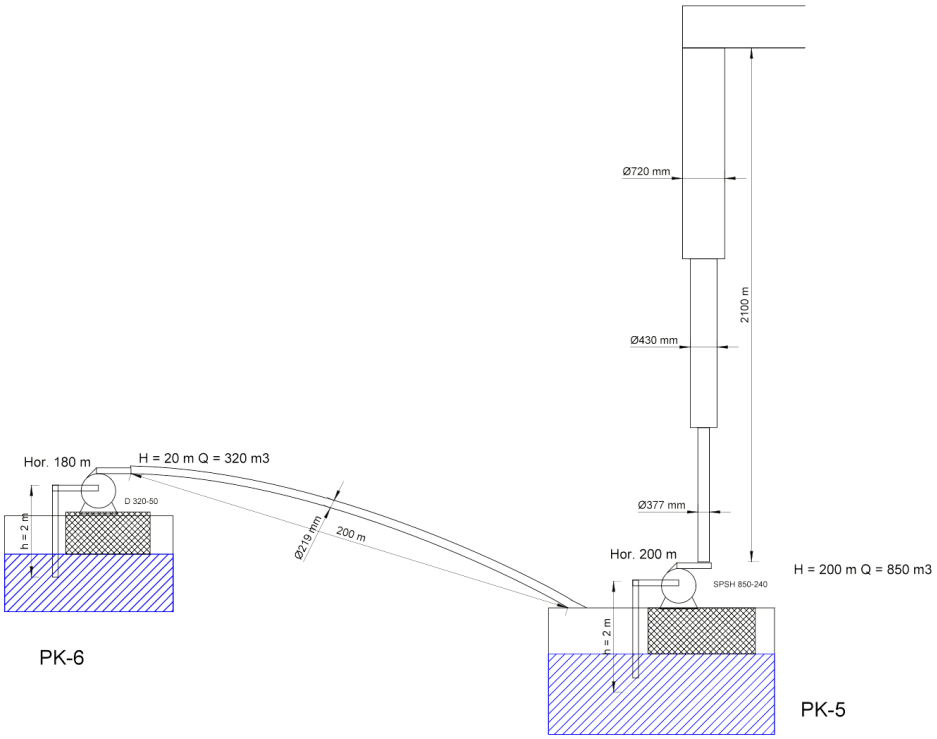


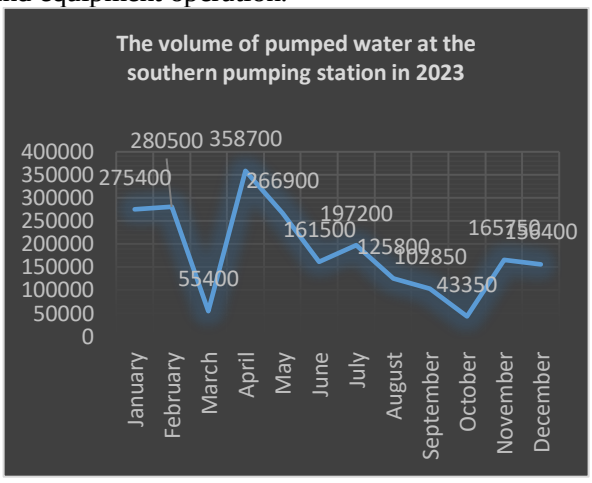
Fig. 1. Scheme of pumping units 22-sections located on pickets 5-6

The D320-50 pumping unit located in PK-6 plays a particularly important role. This pump, located at a horizon of 119 meters, pumps water into a reservoir located in PK-5 through a pipeline 200 meters long and 219 mm in diameter. The pumping unit in PK-6 provides a continuous supply of water to the reservoir, which is a key element of the drainage system at this site. The main reservoir in PK-5 is equipped with a pumping unit CPSH 850-240, which is located at a horizon of 200 m and pumps water from the quarry into the hydraulic dump through a pipeline with a length of 2,100 meters and a diameter of 377, 430 and 720 mm. The change in the diameter of the pipeline is due to the need to regulate pressure and control flow turbulence, which contributes to improving the efficiency of the drainage system.

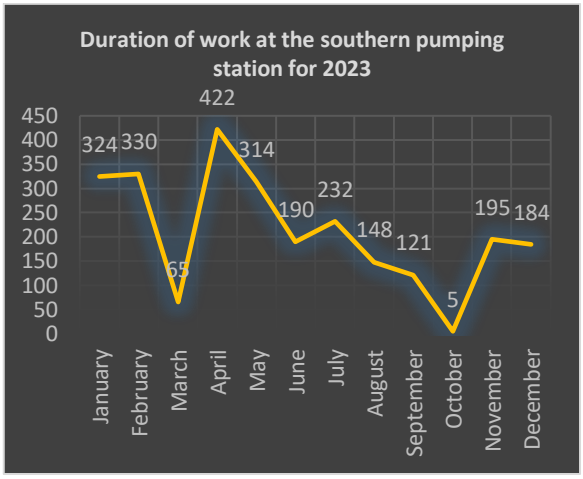
Thus, the coordinated operation of pumping stations at the 22nd and 26th sections, as well as their

relationship with various pickets of the Angren coal mine, ensures reliable and efficient wastewater disposal. This helps to maintain stable and safe working conditions throughout the coal mine, which is extremely important for uninterrupted coal mining and equipment operation.

In the graph below (see Fig. 2a, 1b), shows the amount of water pumped out by month from the southern part of the quarry and the operating time of the main pumping unit during 2023.



a)



b)

Fig. 2. The schedule of operation of the southern pumping station for 2023: a – the volume of pumped water, b – the duration of operation of the pumping unit

The main work on wastewater disposal is performed by the pumping unit CPSH 850-240. The CPSH 850-240 pump is designed for pumping water with a temperature from 1 to 45 °C. It is capable of treating water with a mechanical impurity content of no more than 0.2% by weight, a solid particle size of no more than 0.2 mm and a microhardness of no more than 1.46 GPa [3]. The parameters of the CPSH 850-240 pumping unit are shown below (Table 1).

Table 1

The technical parameters of the CPSH 850-240 pumping unit

Pump	Productivity Q, cubic meters	pressure H, m	brand M	η, %	D, m	diameter of the suction pipe	diameter of the discharge pipe, mm
ЦНС 850-240	850	240	А4-450Х-4	72	5**	300	250

The main structural elements of the pump are the housing and the rotor, which consists of three impellers. The housing includes suction and discharge line covers, guide devices, as well as front and rear brackets. The housings of the guide devices, suction and discharge covers are connected by coupling bolts. Each section of the pump consists of a guide device, a ring with O-rings and an impeller. The joints of the housings of the guide devices are sealed with rubber rings made of oil- and gasoline-resistant rubber [4]. Thanks to the modular design of the pump housing, it is possible to change the pressure by installing a different number of impellers and guide devices with housings, while only the length of the shaft and coupling pins change. The pump rotor consists of a shaft on which impellers, rings, shaft jacket, remote sleeve, adjusting rings and an unloading disc are mounted. All elements on the shaft are fixed with a rotor nut. The rotor supports are two radial spherical bearings mounted in the front and rear brackets on a sliding fit, which allows the rotor to move axially by the amount of the "run-up" of the rotor. The bearing chambers are sealed with cuffs installed in the bearing covers. The bracket is covered from the outside with a lid in which the rotor displacement control device is mounted. The shaft exits from the bearing housing and chambers are sealed with an oil seal [5].

The operation of the pump is based on the interaction of the blades of the rotating impeller and the pumped liquid. The rotating impeller gives the fluid between the blades a circular motion. Under the action of centrifugal force, the liquid moves from the center of the wheel to the external outlet, and the vacated space is filled with liquid coming from the suction pipe due to the created vacuum. After exiting the impeller of the first section, the liquid enters the channels of the guide device and then into the second

impeller, which is under pressure created in the first section. Then the liquid enters the third impeller with increased pressure created in the second section, and so on. The liquid coming out of the last impeller enters the discharge cover through the guide device and then into the discharge pipeline. During the operation of the pump, due to the pressure of water on the unequal side surfaces of the impellers, an axial force arises, tending to shift the pump rotor towards suction [6].

To balance the axial force, an unloading device is provided in the pump, consisting of an unloading disc, a ring and an unloading sleeve and a remote sleeve. The liquid from the last stage passes through the annular gap between the unloading sleeve and the remote sleeve and presses on the unloading disc with a force equal to the sum of the forces acting on the impellers, but directed towards injection. The pump rotor is balanced automatically. The liquid coming out of the discharge chamber cools the oil seal from the discharge side. The oil seal on the suction side is washed with liquid coming under pressure from the suction pipeline. The liquid passing through the shaft jacket through the stuffing box prevents air from being sucked into the pump and simultaneously cools the stuffing box [7]. Most of the liquid passes through the gap between the shaft jacket and the hydraulic seal sleeve into the suction cavity, part passes between the shaft jacket and the oil seal on the suction side, cooling it, the rest goes out through the fitting. The tightening of the stuffing box must ensure that the pumped liquid seeps out between the shaft and the stuffing box in an amount of 5-15 l/h. A smaller amount indicates excessive tightening of the oil seal, which increases friction losses and accelerates wear of the shaft jacket and rotor nut. The pump rotor is driven by an electric motor connected to the pump through an elastic sleeve-finger coupling consisting of two half couplings (pump and electric motor) and fingers with rubber bushings. The direction of rotation of the pump rotor is clockwise when viewed from the side of the electric motor. The technical characteristics of the electric motor of the CPSH 850-240 pumping unit are given below (Table 2).

Table 2

Technical parameters of the A4-450X-4 electric motor

Power P, kW	Turnovers N, rpm	Voltage U, Volts	Weight M, kg	Dimensions mm
800	1500	6000	2690	1700x1420x1410

Despite the high performance of the CPSH 850-240 pumping unit, there are a number of problems that must be taken into account during its operation:

1. The pump is subject to cavitation in the absence of sufficient inlet support, which can lead to its rapid wear and damage. This requires special attention to ensuring the necessary conditions at the inlet to prevent cavitation damage.
2. The pump requires regular maintenance, including checking and replacing oil seals, which can increase operating costs and require the participation of qualified personnel to carry out maintenance work.
3. Despite the ability to work with water containing mechanical impurities, exceeding the permissible values can accelerate the wear of the pump's working elements, which requires careful quality control of the pumped water.
4. The complex design and high performance of the pump may require significant installation and initial setup costs, which may be burdensome for some enterprises.
5. CPSH 850-240 pumps have significant dimensions and weight, which requires appropriate conditions for their installation and operation. A mobile lifting device.

Thus, despite its advantages, the CPSH 850-240 pumping unit requires a careful approach to operation and regular maintenance to ensure its reliable and efficient operation.

In addition to the problems associated with pumping plants, there are significant problems with pipelines. The operation of excavators and bulldozers often leads to damage to pipelines, causing cracks. Another reason for cracks is impurities and unstable water flow, which contribute to pipe corrosion. Pressure drops also have a negative impact, contributing to the appearance of cracks and reducing the reliability of the entire drainage system.

The PK-1 tanks are equipped with pumping units GR 170-30, D 630-90 and D 320-50, which pump water into a tank located in PK-11. All reservoirs are located on the horizon of 240-255 meters. The PK-11 has a high-voltage pump D 1250-125, located at a horizon of 210 meters. This pump pumps water through a 450-meter-long pipeline with a diameter of 377 mm into a reservoir located in PK-19, which is located on the northern part of the quarry (site 26). The efficient operation of these pumping units and their proper coordination play a key role in ensuring reliable drainage from various parts of the quarry. Pumping units located in the PK-1, PK-11 and PK-19 reservoirs create a multi-level water pumping system, ensuring constant monitoring of the water level and preventing possible flooding of the working areas (Fig. 2).

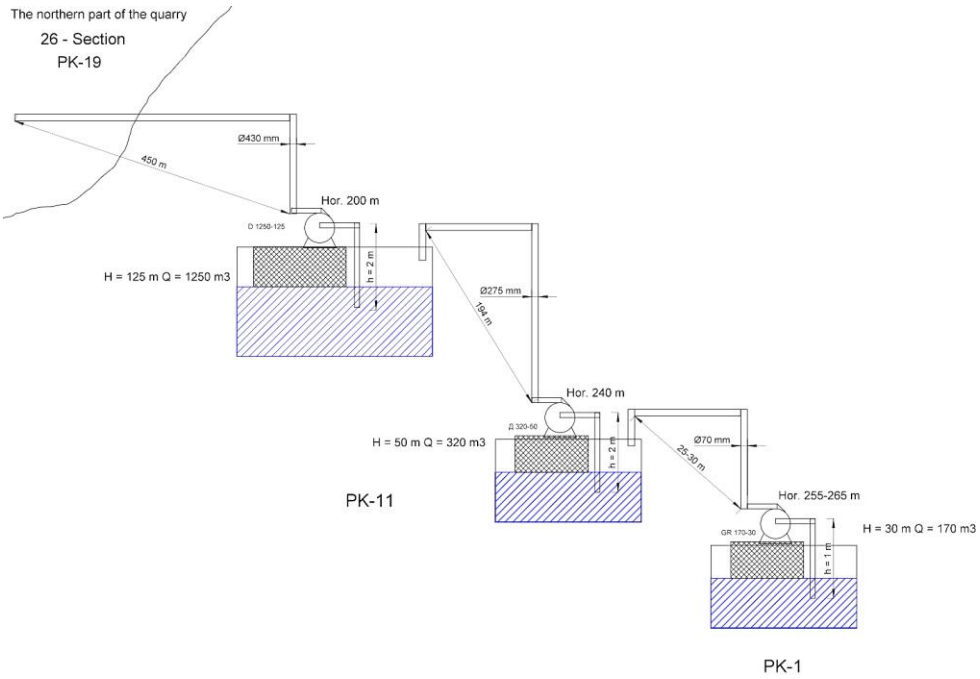
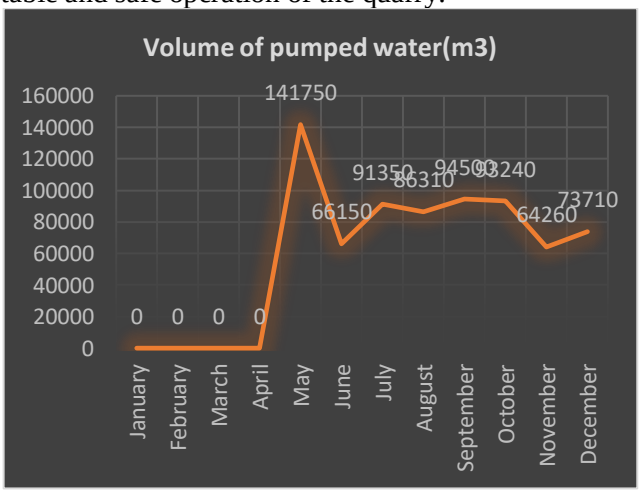


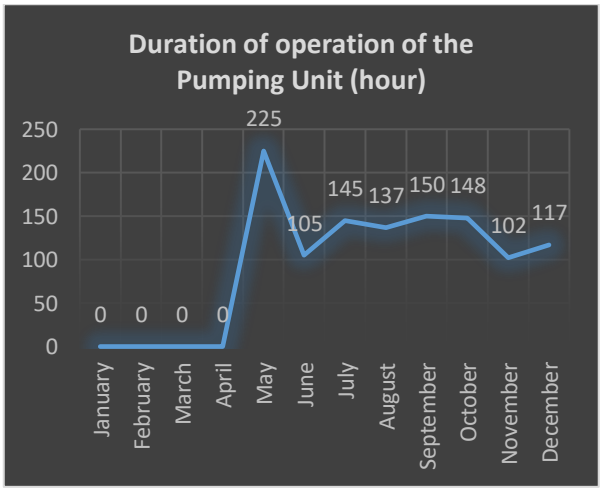
Fig. 2. The layout of pumping units on pickets 1,11 22-sites

Special attention is paid to the high-voltage pump D 1250-125 v PK-11, which has high power and reliability, which makes it possible to efficiently pump large volumes of water over long distances. This pump plays an important role in maintaining optimal working conditions in the northern part of the quarry. Thus, the pumping system at various pickets of the Angren coal mine, including GR 170-30, D 630-90, D 320-50 and D 1250-125, provides efficient and reliable drainage, which is a prerequisite for stable and safe operation of the quarry.

The pumping unit D 630-90 is located at a horizon of 240 meters and pumps water through a pipeline with a length of 194 meters and a diameter of 275 mm to the pumping unit D 1250-125. In 2023, the pumping unit D 630-90 pumped more than 711270 m3 of water (Fig. 4 a, b). This installation plays a key role in the wastewater disposal system, maintaining the safety and efficiency of work at the coal mine.



a



b

Fig. 3. The report on the operation of the pumping unit D 630-90 for 2023: a – the volume of pumped water, b – the duration of operation of the pumping unit

The pumping unit D 630-90 has the following characteristics, shown in the table (Table 3) (see Fig. 4):

Table 3

Characteristics of the pumping unit D 630-90

Pump	productivity Q, cubic meters	pressure H, m	Electric Motor power P, kW	N, rpm	η, %	Cavite. stock, m
Д 630-90	630	90	250	1500	77	5,5

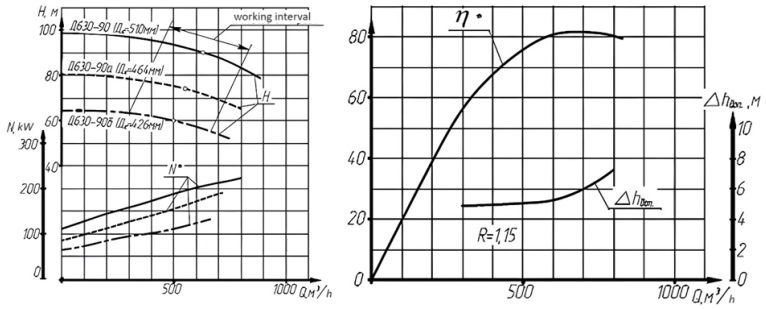


Fig. 4. Operating characteristics of the pumping unit D 630-90

Despite its high performance and reliability, the D 630-90 pumping unit has a number of disadvantages that must be taken into account in order to optimize its operation and increase the efficiency of the wastewater disposal system:

1. One of the significant disadvantages of the pumping unit D 630-90 is its high energy consumption. The 250 kW engine power requires significant energy costs, which increases operating costs.

2. The pumping unit D 630-90 is subject to wear due to constant interaction with abrasive particles in the water. This leads to the need for frequent maintenance and replacement of worn parts, which increases operating costs and can cause downtime.

3. If there is insufficient pressure at the pump inlet, there is a risk of cavitation, which can lead to damage to the impellers and other pump components. This requires strict control of the operating conditions and maintenance of optimal operating parameters.

4. Due to its size and weight, the D 630-90 pumping unit is not mobile, which limits its use in conditions requiring frequent movement of pumping equipment.

5. The pump D 630-90 is sensitive to the quality of the pumped water. The presence of mechanical impurities and aggressive chemicals can accelerate the wear of pump components, which requires additional measures for pre-treatment of water.

6. The operation of the pump is accompanied by vibrations and noise, which can create adverse conditions for the environment and maintenance personnel. The need to install vibration dampers and noise-absorbing devices increases the overall cost of installation and operation.

7. The process of installing and dismantling the pumping unit D 630-90 requires significant labor and time, which can complicate its operation in conditions of frequent changes in the configuration of the drainage system.

These disadvantages emphasize the need for an integrated approach to the operation and maintenance of the D 630-90 pumping unit, including regular monitoring of its condition, optimization of working conditions and the introduction of modern technologies to increase the efficiency and durability of equipment.

Low-voltage vertical pumps of the GR 170-30 brand are often used at excavators' workplaces, where there is a need to remove water. This is due to their compact size and mobility, which makes them an ideal choice for such conditions. During coal mining, especially in open fields, significant amounts of water are formed, which can end up at the excavator workplace. To effectively remove these waters and maintain safe working conditions, GR 170-30 pumping units are used. Due to its mobility and ease of use, GR 170-30 pumping units are easily transported and installed in the right place. This allows you to quickly respond to emerging water situations in the field and ensure the smooth operation of excavators and other equipment. Thus, the use of GR 170-30 pumping units at excavator workplaces in coal mining conditions ensures effective water removal, maintaining safe and productive working conditions (Table 4).

Table 4

The technical parameters of the CPSH 850-240 pumping unit

Pump	productivity Q, cubic meters	pressure H, m	Electric Motor power P, kW	N, rpm	η, %	Cavite. stock, m
ГР 170-30	170	30	55	1500	72	2,5

Conclusion

In conclusion, it should be noted that pumping units play a key role in the wastewater disposal system at the Angren coal deposit. Despite their importance, pumps such as CPSH 850-240 and D 630-90 have their own problems and limitations that must be taken into account during operation.

For example, high energy consumption and susceptibility to wear make pumps, especially the pumping unit D 630-90, costly to maintain and operate. Problems with cavitation and the quality of the pumped water can also affect the reliability and durability of the equipment. Moreover, the complex design and large dimensions of the pumps can create difficulties during installation and maintenance.

However, with proper management and maintenance, these pumping units can effectively solve the tasks of pumping water from the field, ensuring the smooth operation of production processes. The introduction of modern technologies and optimization methods can help improve the efficiency and reliability of pumping systems, which in turn contributes to the stability and safety of coal mining at the Angren field.

Thus, pumping units are an integral part of the infrastructure of the Angren coal deposit, and their proper functioning plays an important role in ensuring the successful operation of the enterprise.

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