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Original Article

# Research of the pressure characteristics of the centrifugal water drainage plant of the WCP 25-60G brand

**A. Makhmudov, O. M. Kurbonov, M. D. Safarova**

Department of Mining, Navoi State Mining Institute, P.M.B., Tashkent City, Navoiy, Uzbekistan

**ABSTRACT**

Water supply and sanitation refer to industries with intensive use of pumping equipment, the proportion of electricity consumed by pumps is more than 50% of total energy consumption. Therefore, the issue of increasing the energy efficiency of water supply consists, first of all, in the rational operation of pumping equipment. The total energy consumption to a large extent depends on the pumping equipment. The efficiency of the pumping station is often lower than the efficiency of the individual pumps installed on it. The reason for low-energy efficiency lies in the mismatch of the performance of the equipment, as well as in the improper management. To increase the efficiency of pumping plants, it is necessary to reduce the cost of operating pumping equipment, to increase its reliability and durability, this requires the correct choice of operating modes of the installation and parameters of the external network. Optimization of the operating modes of pumping units is possible due to the implementation of real measurements of the operating indicators of specific grades using measuring instruments directly at the facilities during operation. The article presents the results of experimental studies to determine the optimal operating conditions of a centrifugal pump brand WCP 25-60G.

**Keywords:** Centrifugal pumps, economical operation, energy efficiency, optimal operating mode of pumping equipment, pressure and flow, butterfly valves, pressure discharge characteristics of the pump, pressure and flow rate

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## INTRODUCTION

Hereby, investigation is aimed at solving categorical problems of the development and liberalization of the economy of action strategies in five priority areas of the development of the Republic of Uzbekistan in 2017–2021, which will allow to obtain scientific, scientific, and technical results and create technologies that are the basis for the innovative development of the domestic market of products and services, sustainable position of Uzbekistan in the international market.

Centrifugal pumps are powerful energy-intensive machines; therefore, their efficient and economical operation is a very important task. The efficiency of the pumping equipment is determined by the value of efficiency during operation.[1] In this regard, during operation, it is necessary to analyze the actual pressure and energy characteristics of the pumps and develop measures to improve them.

At present, the country pays great attention to energy conservation and energy efficiency. According to various estimates, up to 15% of the electricity generated in the country is consumed by pumping equipment. In some industries, this figure reaches 25% or more. The energy efficiency of pumping units largely depends on correctly selected operating modes for specific operating conditions.

However, unfortunately, today, the issues of choosing the optimal operating modes of pumping equipment depending on operating conditions have not been investigated completely. Research and determination of optimal operating conditions of pumping units under various operating conditions are an urgent scientific and practical problem, the solution of which leads to increased reliability and efficiency of pumping equipment.

### Purpose of the Work

The purpose of these studies is to increase the energy efficiency of a WCP 25-60G centrifugal pump by identifying

**Address for correspondence:** O. M. Kurbonov, Department of Mining, Navoi State Mining Institute, P.M.B . 210100, M. Torobiy street 129-house, 29-apartment, Navoiy, Uzbekistan. E-mail: agent7001.oq@gmail.com/oybek7001@mail.ru

and justifying the optimal parameters of operating modes for specific operating conditions, by obtaining experimental values of the dependence of the flow on the pressure of the unit.

## Discussion of the Issue

The problem of growing electricity shortages can be most effectively resolved through the development of energy conservation. Reducing energy losses are primarily achieved by increasing the efficiency of its use.[2]

Pumping equipment of various technological cycles is one of the most significant consumers of electricity in the industry.

The issues of increasing the reliability of operation of pumps are very relevant and require the manifestation of increased attention of both designing and operating organizations.

According to various estimates, up to 10% of the generated electricity is spent on the drive of pumping units. It should be noted that in the total estimate of the cost of servicing pumps, the amount of payment for electric power to the drive, for individual industries, reaches more than 50%; therefore, issues of increasing the efficiency of pumping equipment are relevant and promising.[3]

The implementation of energy-saving measures determines the need to improve the performance of centrifugal pumps, which are the most common type of pumping equipment.

The basis for increasing the efficiency of centrifugal pumps is to improve operating conditions depending on operating conditions, which significantly affect the efficiency of a centrifugal pump.

The main reasons for the inefficient operation of pumping equipment include:

- Operation of pumps with exceeded pressure and flow rates;
- Regulation of operating modes by means of a butterfly valve;
- Wear of structural elements of equipment leading to a change in operating modes.[4]

Since the operating parameters of the pump for a given system are determined by the position of the intersection point of the curves of the characteristics of the pump and the network, to change the operating parameters of the pump, you need to change the position of this point. Therefore, to change the pump operating mode, it is necessary to change the pump characteristic or the system characteristic.

In most cases, pumping units are selected with overestimated parameters, which are impractical from the point of view of efficiency. The volumes of water consumption in water supply systems vary significantly depending on the time of day, day of the week, and season, which are shown in Figure 1. At the same time, the station should provide water consumption both in normal mode and during peak loads.[5]

In the absence of regulation of pumping units, its effectiveness cannot be achieved for different ranges of water consumption. Another common reason leading to oversized pumps is the changing volume of water consumption. During operation of the pump with a greater than required pressure and a more powerful electric motor, the motor overloads. At which equipment is usually replaced with another one with an even higher pressure and a more powerful electric motor, however, this does not lead to positive effects, and the result will remain the same, this is explained by the graph, as shown in Figure 1.

With the required flow rate Q2 and the required pressure H1, a pump with a pressure H2 is usually selected, as can be seen from the figure, the operating point determined by the intersection of the pump characteristic and the system characteristic is shifted to the right from the optimal one and is outside the operating range. At the same time, the pump operation is characterized by a large flow rate Q1 and a higher power consumption, which leads to an overload of the electric motor (point 2).[6]

The selection of optimal operating modes of the pump installation is a complex task that determines the effectiveness of the main indicators of the installation as a whole.

## MATERIALS AND METHODS

The issues of energy-saving modes and methods of effective control of the modes of drainage plants were considered by many authors who studied the problems of optimization and improvement of operational parameters,[7,8] while many dependencies affecting the operating mode of pumping units,

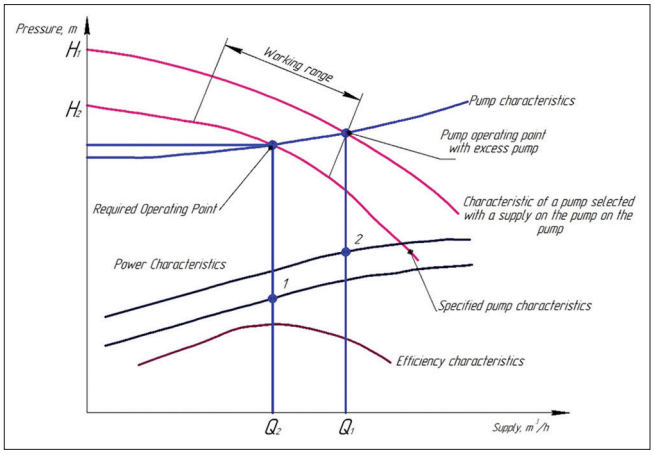


**Figure 1:** Choosing a high-pressure pump

such as changes in static and dynamic, were not investigated in fluid level, as well as external factors and fluid composition.

Thus, to study the main dependencies affecting the efficient operation of drainage plants, it becomes necessary to conduct experimental study of the operating modes of the installation.

The pressure characteristics of the centrifugal drainage plant of the WCP 25-60G brand were investigated at the test bench SSU-DN-5LR, which contains a pump installation, pressure and flow meters, control elements, and controllers.

The test bench allows you to:

- Remove the pressure-flow characteristics of the pump and pump station;
- Set and determine the pressure and flow rate of the fluid at various points in the hydraulic system.

Pressure is measured using analog pressure sensors with secondary devices – indicators and absolute pressure sensors are used in the stand. The liquid flow rate is measured in a volumetric manner and using a water meter with a differential transducer and digital display.

When studying the pressure characteristics of a centrifugal pump, the dependences of the pressure characteristics on the pump flow at various drive powers were studied.

## RESULTS AND DISCUSSION

An experimental study of the pressure characteristic of a centrifugal pump of the WCP 25-60G brand was performed for three operating modes at various drive capacities of the installation.

The results of experimental measurements are shown in Table 1.

According to the results of experimental studies of the operating modes of a centrifugal pumping unit, the dependences of the pressure (H) on the supply (Q) for various operating modes are established.

Figures 2-4 show the dependences of the change in the pump pressure (H) on the supply (Q).

It is realized from the graphs that a decrease in the discharge height, that is, pressure, leads to an increase in the pump performance. In the first mode, with a drive power of 46 watts, a decrease in pressure of 0.5 m, the pump flow increases by 4.5–5 l/min.

In the second and third modes, an increase in productivity is also observed due to a decrease in the pressure at low-power values on the unit drive.

**Table 1:** The results of experimental measurements

| Name | Mode I: Experience number | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 | 3 | 4 | 5 | 6 | 7 |
| Pressure pin1at the inlet to the pump H1, kPa. | −4 | 0 | 1 | | | | |
| Pressure pout1at the outlet to the pump H1, kPa. | 4 | 14 | 21 | | | | |
| Supply QH of pump H1, l/min. | 11,5 | 5,1 | 0 | | | | |
| Pump pressureH1, HH1m | 0,81 | 1,427 | 2 | | | | |
| Power at the pump drive (W) | 46 | 46 | 46 | | | | |
| Name | Mode II: Experience number | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Pressure pin1at the inlet to the pump H1, kPa. | −10 | −4 | 0 | 1 | 1 | | |
| Pressure pout1at the outlet to the pump H1, kPa. | 7 | 17 | 27 | 37 | 39 | | |
| Supply QH of pump H1, l/min. | 16,7 | 11,8 | 7,7 | 1,8 | 0 | | |
| Pump pressureH1, HH1m | 1,73 | 2,1 | 2,752 | 3,67 | 3,874 | | |
| Power at the pump drive (W) | 67 | 67 | 67 | 67 | 67 | | |
| Name | Mode III: Experience number | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Pressure pin1at the inlet to the pump H1, kPa. | −20 | −13 | −7 | −2 | 1 | 2 | |
| Pressure pout1at the outlet to the pump H1, kPa. | 13 | 23 | 33 | 43 | 53 | 55 | |
| Supply QH of pump H1, l/min. | 23,4 | 19,2 | 14,8 | 9,7 | 2,6 | 0 | |
| Pump pressureH1, HH1m | 3,364 | 3,67 | 4 | 4,587 | 5,3 | 5,4 | |
| Power at the pump drive (W) | 93 | 93 | 93 | 93 | 93 | 93 | |

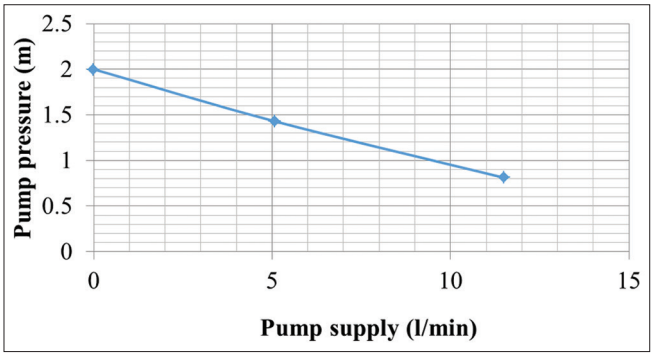


**Figure 2:** The dependence of the change in pressure size (H) on the supply (Q) of a centrifugal pump of the WCP 25-60G brand with a drive power of 46 watts

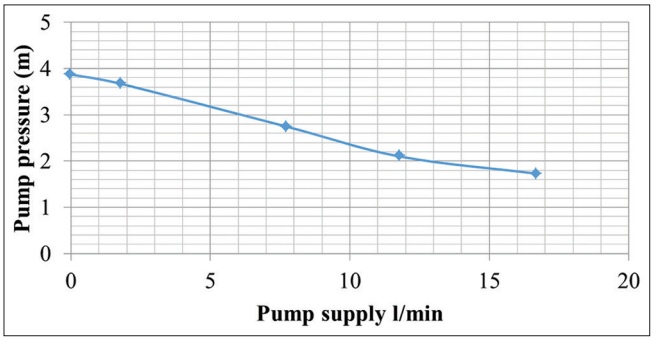


**Figure 3:** The dependence of the change in pressure (H) on the supply (Q) of a centrifugal pump of the WCP 25-60G brand with a drive power of 67 watts

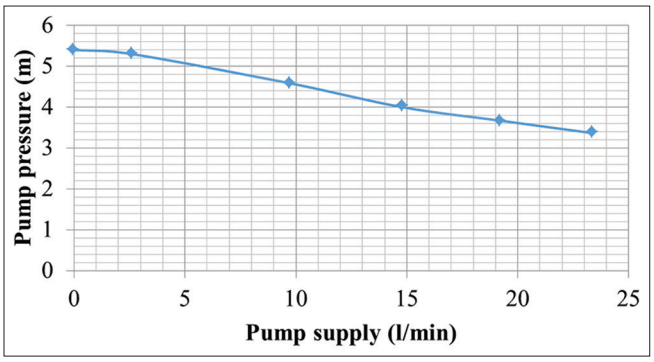


**Figure 4:** The dependence of the change in pressure (H) on the supply (Q) of a centrifugal pump of the WCP 25-60G brand with a drive power of 93 watts

During the operation of centrifugal pumping units, in most cases, to increase the supply, they increase the drive power, which negatively affect the efficiency of the installation as a whole. Based on the results of the studies, it was determined that an increase in the supply of a centrifugal pump is possible without increasing the power on the drive due to a change in the pressure characteristics.

## CONCLUSION

Having analyzed the results of experimental studies, we can conclude that increasing the efficiency of centrifugal drainage plants is possible by regulating the operating conditions depending on operating conditions.

The results of the studies prove that the change and regulation of one of the operating characteristics of the pumping unit lead to a change in another parameter. Thus, based on operating conditions, increasing or decreasing the pressure, you can get the desired flow, while not changing the drive power.

Thus, one of the optimal ways to increase the energy efficiency of the pump installation is probably the method of regulating the operating conditions of the installation without changing the power on the drive.

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