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Hydraulic Calculations of the Working Process of Fluid Pumps

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Abstract: *The article discusses the issue of improving the operation of jet pumps (hydraulic elevators). The problem is solved by modeling the jet pumps to determine the effective values of the operating parameters.*

Keywords: *jet pump, nozzles, hydraulic elevator, injection coefficient, working camera, relative pressure, relative consumption.*

Introduction: Along with the development of the economy of our republic, the need for water is increasing day by day. As a result, the issue of reconstruction of water volume management facilities, construction of new ones, improvement of existing facilities with extensive use of resource-saving technologies remains an important issue on the agenda.[1]

Most of the land that is being developed today is intended for pumping irrigation. This in itself leads to additional costs. At the same time, liquid transmission devices based on resource-efficient technologies are currently being used in a number of technical fields. Among them, flow water elevators create a vacuum with the help of a working flow during operation, water rises to a certain height due to the pressure difference, such devices are called hydraulic elevators or flow pumps [2].

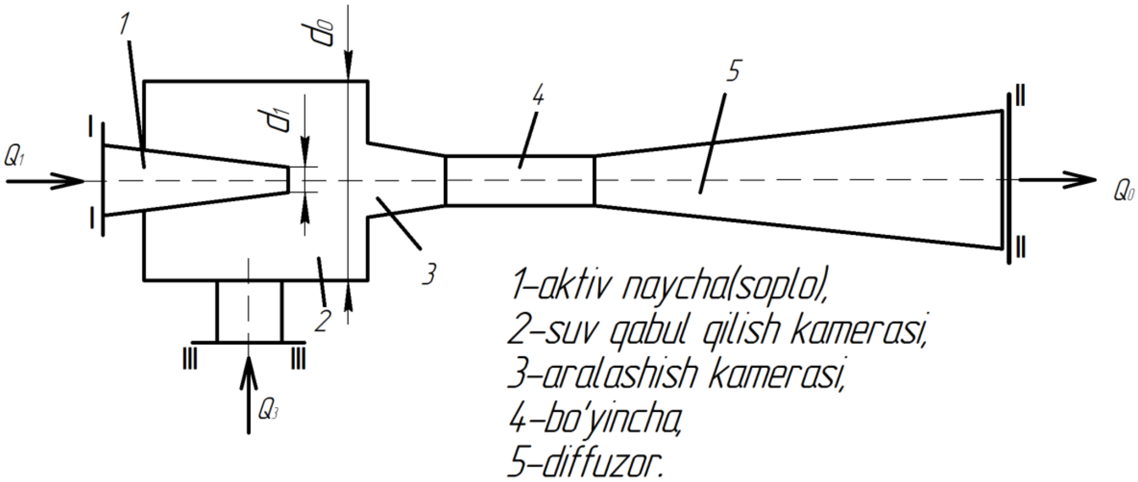

Figure 1. Scheme of the water lift device.

Physical model. It is important to choose the right size of hydraulic elevators. The use of flow water risers is complicated, the useful work coefficient is low, but there is no need for energy sources that require separate devices when using the simple structure. When using flow water risers, it is necessary to choose its parameters correctly. In this device, the working pressure height is calculated by the difference in the pressure heights at the inlet and outlet parts of the working chamber, which can be found using Bernoulli's equation:

$$H_i = \frac{P_1}{\rho g} + \frac{v_1^2}{2g} - \frac{P_2}{\rho g} - \frac{v_2^2}{2g} \qquad (1)$$

From the required pressure head, the resulting pressure head in the jet riser is found:

$$H_{tq} = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} - \frac{P_3}{\rho g} - \frac{v_3^2}{2g} \quad (2)$$

The working water flow consumption in the device was determined using the length equation as follows:

$$Q_1 = v_1 w_1 = v_1 \frac{\pi d_1^2}{4} \quad (3)$$

Current water consumption:

$$Q_3 = v_3 w_3 = v_3 \frac{\pi d_3^2}{4} \quad (4)$$

The useful work coefficient of the water riser:

$$\eta = \frac{H_{tq} Q_3}{\Delta H_i Q_1} \quad (5)$$

In flow risers, energy loss due to hydraulic resistance is high.

When determining the optimal values of the above-mentioned parameters, based on the modeling requirements, we express the main parameters of the process without units of measurement based on the theory of similarities [3].

Relative pressure altitude:

$$H = \frac{H_{tq}}{H_{tq} + H_i} \quad (6)$$

Relative water consumption or injection coefficient:

$$q = \frac{Q_3}{Q_1} \quad (7)$$

Then we write the following expression for the useful work coefficient:

$$\eta = \frac{qH}{(1-H)} \quad (8)$$

We express the geometric dimensions of the working chamber of the water lifter as follows:

$$D = \frac{d_0^2 - d_1^2}{d_1^2} \quad (9)$$

Here, -working chamber diameter,d_0

d_1- the diameter of the outlet slot of the tube (nozzle).

Analysis of results. The performance of a submersible pump depends on the movement of the flow in the chamber. Design parameters of the jet pump are determined depending on the flight length of the jet flowing from the nozzle.

In the literature, the following formula is proposed to determine the flight length of the current in relation to the injection coefficient.

$$L = \frac{0.37 + q}{4.4a} d_1 \quad (10)$$

here, - injection coefficient;$q = \frac{Q_3}{Q_1}$

✓ correction factor[3].$a = 0.07 \div 0.09$

Using the above formulas, it is possible to determine the hydraulic parameters of the flow riser. By choosing these parameters correctly, it is possible to increase the water transfer using a riser without using additional energy.[4]

Summary. Based on the obtained results, the effective value of the geometric parameters of the jet pump was determined. Flow pumps are selected based on the effective values, thereby reducing the energy consumption and increasing the efficiency [7-10]. In a hydrolift, the flight length is important, so the control of the flight length depending on the injection ratio and nozzle diameter is shown.

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