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HYDRAULIC SHOCK-BASED WATER PUMP OPERATIONAL LIMIT AND ITS THEORETICAL CALCULATION

Z.T. Khayitov
Teacher of "Natural sciences" department of Samarkand state architectural and civil engineering institute

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Abstract:

As a result of modern scientific and technological progress, as well as the growing anthropogenic (direct human involvement) in nature the interdependence of natural factors is to some extent out of balance, which threatens the life course on earth as in the brochure. Therefore, the environmental protection problems are in many ways related to environmental research.

Keywords: Hydram, supply pipe, pressure valve, shock valve, running water, small single reservoir, tank, water accelerator.

INTRODUCTION:

Around the world, examples of the use of technologies that save energy and resources can be found in different parts of the world. At the same time, many of these technologies have been used for centuries and are passing from generation to generation. The life of mankind is inextricably linked to its natural environment, and sources confirming this are found at every step. The rapid global scientific and technological revolution not only has a positive impact on working conditions, improving the living standard of people, but also, in turn, the environmental changes caused by it have an impressive impact on humanity, on the native nature that preserves it.

The management of natural resources and the environment is not just a work, but a huge socio-economic and alarming problem. For the stability and healthy life of man, it is necessary that land, water, air, underground wealth and green land cover are the main factors of nature.

In addition to being a source of life for existing water and water resources, our priceless natural treasures serve as an enormous resource in the energy system. The use of water energy is much more convenient, and ecologically it still shows negative consequences, although this is well mastered by mankind. [6]

The use of hydram as an alternative energy-saving tool can create electricity at a any time. Hydraulic or hydraulic ram is a mechanical device adapted to lift water to a large (several tens of meters) height. No external bearing forces are required to operate this pump. At the same time, the pump passes through itself large volumes of water from a low height h and raises a small volume of water to a height above H. The cycle is constantly repeated. [3,4,5]

Although hydraulic shock was known to science in the XVIII century, the theory of this employee was developed by the first Russian scientist Nikolai Zhukovsky. His theory was first published in 1898. A general view of the hydram drawing is shown in Figure 1.

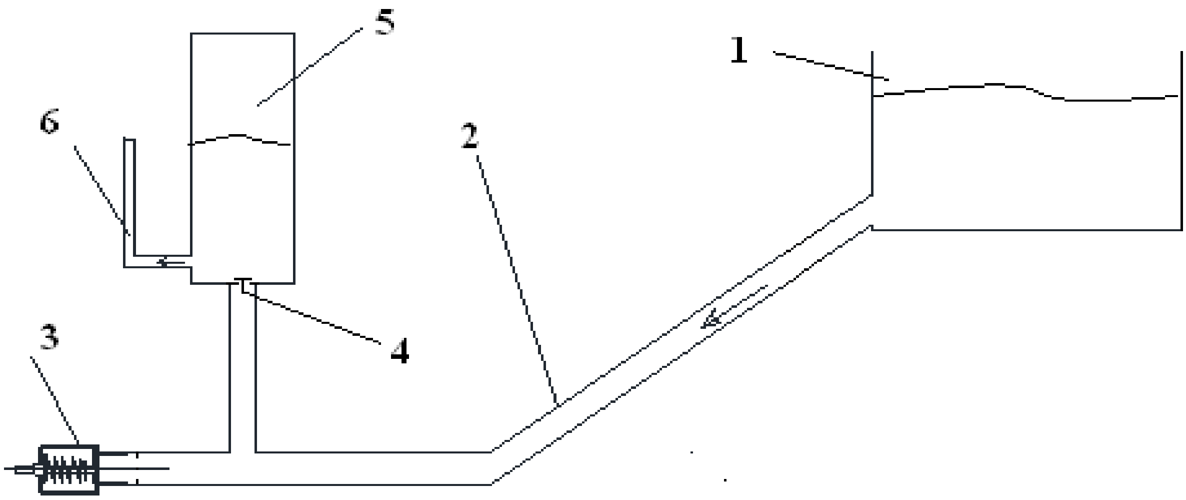

Fig. 1. Hydram water pump.
1- reservoir (reserve), 2- support pipepipe, 3-shock valve, 4- pressure valve, 5- air shield, 6-outlet pipepipe.

Zhukovsky's formula for the formation of hydraulic shock:

$$P_{\tilde{a}.\c{c}} = \tilde{n} \cdot \vartheta \cdot \rho \qquad (1)$$

$P_{\tilde{a}.\c{c}}$ - pressure under hydraulic shock. c- the sound speed in water, ϑ - flow rate, ρ - water density.

Hydram efficiency ratio:

$$\eta = \frac{H - h}{H} \cdot 100\% \qquad (2)$$

If we observe the working process of hydrams, [3;4;5;9] the efficiency magnitude in it decreases with increasing output height-H. At the same time, there is an increase in water wastage and a decrease in the water volume in the outlet pipe-6 (Fig. 1). The increase in water (resource) waste is explained by a decrease in the device efficiency.

Before we talk about the working principle of hydram, let's mention the water properties. On the water surface, it is formed in an environment where it is in contact with air, solids, or other, liquids. Surface gravity occurs under the influence of the mutual gravitational forces of molecules and compensates one by the molecular gravitational forces inside the liquid, while the non-compensating forces do not affect the outer molecules and their direction will be directed to the inner layers of the water.

The surface tension of water is 72 din/cm^2 at 18^{0}C, which is the highest value. Alcohol is 22, acetone is 24, and gasopipe is 29, only mercury maximum is 500 din/cm^2. The surface tension forces of sapipe waters are different from those of freshwater.

The liquid molecules are so close together that the gravitational forces between them are much larger. Since the interaction forces decrease rapidly with increasing distance, the gravitational forces between molecules from a distance cannot be ignored.

As the molecule moves from the liquid inside to the surface layer, it must work against the forces acting on the surface layer. This work is done by the molecule at the expense of its kinetic energy, and this work is spent on increasing the potential energy of the molecule. As the molecule passes from the surface layer to the inside of the liquid, the potential energy it has in the surface layer is converted into the kinetic energy of the molecule.

Thus, the molecules have additional potential energy in the surface layer of the liquid. The entire surface layer will have additional energy entering as a component of the internal energy of the liquid.

Since the equilibrium state corresponds to the minimum of the potential energy, the liquid surface left in its state comes to a shape with a minimum, i.e., a narrow shape. In tiny droplets of liquid, surface energy predominates. Therefore, such droplets shape is close to a spherical shape. In large droplets of liquids in this case the surface energy flattens under the influence of the gravitational forces of the earth, despite the increase. Large masses of liquid take the self-contained vessel form, and the free surface remains horizontal. Due to the presence of surface energy, the liquid tends to shrink its surface. The fluid behaves as if it has been inserted into an elastic elongated object that tends to contract. There is really nothing that limits the fluid from the outside. The surface layer is also composed of same liquid molecules, and the interaction nature of the molecules in the surface layer is the same as in the liquid. The fact is that the molecules in the surface layer have more energy than the molecules in the liquid. We can distinguish a part of the liquid surface bounded by a closed contour. This part tendency to contract leads to the fact that it acts on the parts adjacent to it with forces propagating along the entire contour. These forces are called surface tension forces. The force of the surface tension is directed perpendicular to the part of the contour affected by the motion applied to the liquid surface:

$$F = \sigma \cdot L \qquad (3)$$

here F – surface tension force, L- the fluid contour length, δ- surface tension coefficient (0,073 н/м).

The static pressure of the water column can be given by $P = \rho \cdot g \cdot h$: ρ-water density, g-(9,8m/s^2) free fall acceleration, h-water column height. Because when water enters under the air cap, the pressure valve closes and the water movement calms down for a while. The fluid state at this time switches to static mode. Equilibrium occurs when the compression pressure of the air under the air cap is equal to the water rise (static pressure at the outlet pipe height), as a result the pressures on both sides of the heterogeneous system in the air-water gap under the air cap are equal. This state is as calm as a fountain immersed in water. But a two-step boundary, which is not homogeneous and differs in density and phase aspects, can quickly absorb external influences. Because the waves propagating in the liquid cannot propagate in the air, longitudinal deformation is observed at certain intervals on the liquid surface. This stretching is an elastic back process. It is known that sound and mechanical waves propagate well in liquids, especially water. In the hydram, it is therefore more common to observe that all the shocks generated in the forging valve accumulate under the air cap.

The externally transmitted external effect is uniformly transmitted to all fluid points. According to Pascal's law, when observing the working principle of a hydram, the working process under the air cap was observed using a transparent material, when shock waves began to be received in the water, no curvature of the water surface, abrupt expansion of the surface and consequent sharp compression of air were observed. It can be seen that the water surface is not curved, but a flat rise is observed, just like the movement of an internal combustion engine piston.

It should be noted that in the hydrams (Fig. 1) the shock waves return from the percussion valve (3) and drive a certain amount of water under the air cap (5). Once the pressure valve (4) under the air cap receives this volume, an interruption in the water flow is observed. The water volume then obeys other, hydrostatic laws as it rises. In the meantime, the following can be deduced theoretically about the water lift height.

METHOD AND TECHNIQUE:

No thermal conductivity is observed in gases. Therefore the environment under the air cap is an isothermal process. From it caused by

$$P_1 \cdot V_1 = P_2 \cdot V_2 \qquad (4)$$

$$P_1 = \rho \cdot g \cdot h$$

$$P_2 = \rho \cdot g \cdot H$$

P_1 – supply pipe pressure, P_2 - outlet pipe pressure. h- water drop height, H- the rising height of the water

Due to the opposite sign of the pressures under the air cap:

$$P_1 \cdot V_1 = (P_2 - P_1) \cdot V_2 \qquad (5)$$

$$\frac{V_2}{V_1} = \frac{h}{H-h} \qquad (6)$$

$$\eta = \frac{h}{H-h} \cdot 100\% \qquad (7)$$

η-ФИК.

RESULTS:

So it is possible to consider the height of the water column rise under the air cap.

Water surface pressure [7,8]:

$$P = \frac{2 \cdot \delta}{R} = \rho \cdot g \cdot h^1 \qquad (8)$$

P- the pressure created by the water column under the air cap, δ- surface tension coefficient, R- the lower radius of the water column, h^1 - water surface column height

More surface column height:

$$h^1 = \frac{2 \cdot \delta}{R \cdot \rho \cdot g} \qquad (9)$$

The result obtained from this is that the height of the water rise in the outlet pipe in the hydram can be found by multiplying the normal atmospheric pressure by the water column height (9.8 m).

For example, if the air cap radius is 50 mm, the water rise in the outlet pipe is about 9 m.

However: Considering the attitude:

$$H \to \frac{1}{R}$$

Increasing the elevation height

$$m = \rho \cdot V = \rho \cdot h \cdot S$$

Leads to a decrease in the water volume being pumped

$$P = \frac{2 \cdot \delta}{R} \qquad (10)$$

The origin of:

$$P = \frac{2 \cdot \pi \cdot R \cdot \delta}{\pi \cdot R^2} = \frac{2 \cdot \delta}{R} \qquad (11)$$

can be seen here considering that R is the water level and the lower surface radius of the water column. If the air cap is taken in the cone form, not in the cylinder form, this relation can give rise to the following relation.
If

$$P = \frac{2 \cdot \pi \cdot R_{ñàòõ} \cdot \delta}{\pi \cdot (R_{îñòêè})^2} \qquad (12)$$

$$R_{îñòêè} = \frac{R_{ñàòõ}}{n} \qquad (13)$$

is entered, it can be seen that it is

$$P = \frac{2 \cdot \delta \cdot n^2}{R} \qquad (14)$$

This in turn leads to an increase in η as well.

CONCLUSION:

Hence, the difference between the water level under the air cap and the bottom surfaces is important for the performance of hydraulic water pumps.

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