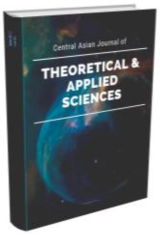

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Article

The Importance of Construction on the Performance of a Hydraulic Ram Water Pump

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Abstract: The article discusses the operation of the hydraulic shock water pump and the reasons for its efficiency in simple language and elementary methods. Although the hydraulic shock water pump is considered a long-standing invention, it continues to be studied by scientists around the world. This article also clearly shows that it is possible to increase efficiency through methods that reduce various losses in hydraulic devices. It discusses how the characteristics of hydraulic shock effects depend on the design.

Keywords: Hydraulic ram, hydraulic ram/water hammer, air chamber, surface tension, surface, pressure, valve, pipe.

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Introduction

A hydraulic ram pump is a mechanical device designed to lift water to a higher elevation (several tens of meters). A key characteristic of this pump is that it operates without the need for any external power source. Instead, it utilizes the momentum of a large volume of water flowing from a lower height (h) to lift a smaller volume of that water to a much higher height (H). This process occurs in a cyclical, repeating fashion.

The Joukowsky Formula (1) in the Context of Hydraulic Shock

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

$P_{\tilde{a}.\c{c}}$ pressure due to hydraulic shock and the speed of sound in water ϑ - water flow velocity ρ water density

Formula for Hydraulic Ram Pump Efficiency (2)

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

If we observe the process of operation of hydrotharans, [1] the magnitude of the useful coefficient of work in it (2)-the formula is an increase in water waste in combination with an increase in the output height-H, and also occurs a decrease in the volume of water in the output pipe. The increase in water (resource) waste is explained by a decrease in the operational productivity of the device.

The working process of the hydrozarbal water pump depends on the characteristics of the water.

On the surface of water, physical phenomena occur in its air, solid objects or other, adjacent (touching) environments with liquids. While the molecules on the surface of air and water do not react to the forces their direction will be directed to the inner layers of water. Fluid surface drag is caused by the interaction forces of molecules, and the molecular friction forces inside the fluid are pulled inward. [4]

Due to the presence of surface energy, the liquid tends to shrink its surface. The fluid behaves as if it is inserted into an elastic stretched object that seeks to contract[4]. In reality, there is no such thing as limiting fluid from the outside. The surface layer is also composed of molecules of that liquid, and the character of the interaction of molecules in the surface layer is the same as in the liquid. The fact is that in the surface layer, molecules have more energy than in molecules inside the liquid. [5]

We mentally separate a part of the surface of the liquid bounded by a closed contour. This part's quest for contraction leads to the fact that it acts on the parts adjacent to it with forces spread across the entire contour. These forces are called surface tension forces.

This can be observed under the air cap of the hydraulic Taran, and it is as follows: the air cap is oriented perpendicular to the part of the contour affected by itself along the urinal, through which the surface tensile force of water is transferred to the surface of the liquid:

$$F = \delta \bullet L, \qquad (3)$$

where F is the surface tension force, L is the length of the fluid contour, the coefficient of fluid-surface tension is the static pressure of the output pipe height (water column).

When the hydraulic Taran is working, the pressure valve closes when the water enters under the air cap, and the water movement calms down for a while. The fluid state at this time, goes into static mode. An equilibrium state occurs when the air under the air cap is equalized by the compressive pressure of the rising water (the static pressure of the output pipe height), resulting in the equalization of pressures (air and water pressure) on both sides of the heterogeneous system in the air-to-water range under the air cap [6]. This position is calm, like a menbranch lowered into the water. But the two-line limit, which is not homogeneous, with different densities and phase aspects, is able to rapidly accept the effect that will be External, being (according to Formula 3) elastic. Because waves propagating in a liquid cannot propagate in air (gases), as a result of which stretching deformation is observed on the surface of the liquid, within a certain range. This stretch is elastic and is a reversible process. It is known that sound and mechanical waves propagate well in a liquid, in particular in water. The accumulation of all the shocks produced by the hydrotaranda shock valve under the air cap is therefore more observed, and the hydrozarba pressure is quenched there (1)-formula.

As stated in Pascal's law, the transmitted external influence is transmitted uniformly to all points of the liquid. When observing the principle of operation of the hydrotaran, the process of work under the air cap was observed using a transparent material, when shock waves began to be received in the water, there was no curvature on the surface of the water under the air cap, a sharp board on the surface of the air cap and, as a result, a sharp compression of the air The surface of the water is not curved in shape, just as the internal combustion engine porsheni kharakati can be seen to observe a flat rise.

Mechanical waves from hydraulic Taran form a shock valve. In a shock valve, a mechanical wave propagates at a speed of 1400 m\s in water , 4000m\s in a metal pipe.

In the hydrotaran, the shock waves return through the shock valve and drive a certain volume of water under the air cap. After the pressure valve under the air cap has received this volume, an elongation is observed in the water stream. Further processes i.e., water is subject to other, now hydrostatic, laws as it moves upward.

About the upward movement of water, the following can be induced by a theoretical path.

Thermal conductivity in gases is not observed, so the environment under the air cap is an isothermal process. From this

$$P_1 \cdot V_1 = P_2 \cdot V_2 \tag{4}$$

$$P_1 = \rho \cdot g \cdot h, \; P_2 = \rho \cdot g \cdot H$$

(4) is the P1 supply pipe pressure in the formula, P2 is the output pipe pressure. H-drop height of water? H-elevation of water

(4) - if the pressure FAQ is brought, the pressure under the air cap is due to the opposite qashi signal:

$$P_2 \cdot V_2 = (P_2 - P_1) \cdot V_1 \tag{5}$$

(5) - comes to state

$$\frac{V_2}{V_1} = \frac{H-h}{H}$$

$$V_1 > V_2, \quad \frac{V_2}{V_1} = \eta.$$

$$\eta = \frac{H-h}{H} 100\%$$

It is derived from the fact that. V_1 is the volume of water in the supply pipe, V_2 is the volume of water in the output pipe. η-FIK follows the (2) - Formula.

From this, the height of the rise of the water column under the air cap can also be considered.

Water surface pressure formula :

$$P_{\text{сирт}} = \frac{2 \cdot \delta}{R}$$

$P_{\text{сирт}}$-- water surface pressure under the air cap, heat-surface tension coefficient, R-radius of the water surface

$$P_{\text{устун}} = \rho \cdot g \cdot h_{\text{устун}}$$

$P_{\text{устун}}$- the pressure generated by the rising water column in the outlet pipe. ϱ is the density of water, g is the acceleration of free fall, $h_{\text{устунча}}$ - column height.

$$P_{\text{сирт}} = P_{\text{устун}}$$

It can be seen that. [5]

At this point, the performance of hydraulic Taran was limited by the general formula through the (2)-formula, with gabarites of increased performance of hydrotharan. Gabarites in turn explained the expansion of the air cap level, which in turn caused the rise of water in the exit pipe. In fact, in any hydrotaran, that is, no matter what the diameter of the supply pipe, the output heights of the water, respectively, do not differ according to the same. That is, the choice of the lifting height of water in the outlet pipe for any hydraulic Taran is made by the surface of the level of its air cap. This in turn is explained by the increase in η.

In accordance with the above, it can be said that the upward movement of water in the hydraulic Taran output pipe is not the main hydraulic shock effect, but due to the compression of the air.

This means that in the operation of the hydraulic Taran, the pressure under the air cap will be equal to the sum of the pressures of the water column in the outer atmosphere and the outlet pipe. From this we can conclude that the gas pressure equal to the atmospheric pressure above the water in the output pipe is Hyder.

Initially the water enters and balances the water inlet outlet from the supply pipe before the Hydrotharan can operate. This

$$P_{\text{к}} = \rho \cdot g \cdot H \tag{6}$$

(6) in r_k is the supply pipeline pressure. H-supply chase height.

$$P_{\text{ч}} = \rho \cdot g \cdot h \tag{7}$$

(7) where R_ch is the output pipe pressure, h is the lift height of the water in the output pipe. Originally

From H=h

$$P_к = P_ч \qquad (8)$$

(8)-treats.

The relationship between the water surface and the outlet pipe also occurs when the pressure valve under the air cap is closed.

In them, it is advisable to take into account the need for the performance of work in relation to the weight of its entire water when lifting water in the compressed air and outlet pipe, as well as the weight strength of the water in the discharge taking into account the break in the water

$$\frac{F_1}{S_1} = \frac{F_2}{S_2} \qquad (9)$$

(9) - the violence of considering the relationship is born. F_1 is the pressure force acting on the surface, s_1 is the water surface, F_2 is the weight of the water, S_2 is the output pipe surface.

(9) - from Proparsionality

$$\frac{h}{S_2} = \frac{H}{S_1} \qquad (10)$$

(10)-is obtained.

$$h = h_x + H \qquad (11)$$

(11)-yes h_x is a jump in the browning force in the actual cooling ballast.

$$h_x + H = \frac{H}{S_1} \cdot S_2$$

$$h_x = \frac{H \cdot S_2}{S_1} - H$$

$$h_x = H \cdot (\frac{S_2}{S_1} - 1)$$

$$h_x = H \cdot \left(\frac{R_2}{R_1} - 1\right) \qquad (12)$$

(12)-in the formula r_2 is the radius of the air cap, R_1 is the radius of the output pipe.

Technological part: as a result of the shock valve being hit and stopped under pressure, the mechanical wave moves under a speed of 4000 m\s in the pipe, spreading at a speed of 1400 m\s in the water. A mechanical wave propagating through the pipe vibrates the surface of the water under the air cap and spreads over the surface. Since the source of this is the circular edge parts of the air cap, the direction of the wave is the longitudinal wave, which is directed inward. When a mechanical wave propagates on the surface of water, the water particles on the entire surface of the water also form a vibration in its place in the form of a circle or an ellipse. And the reason for this is the impossibility of foxes from the water to the air. The vibration is active on the surface of the water and continues to subside as it drops below the surface. The characteristic circular motion of water particles on the surface thinns the air at the surface Boundary, resulting in a decrease in the moment of impact of the pressure acting on the level from the bottom pressure valve roof [4]. The flow rate of water flowing from the supply pipe at a certain height in the hydraulic Taran drives the shock valve at a certain speed. The amount of wave speed generated by the sharp stop of this movement directly affects the amount of mechanical wave speed generated on the surface of the water under the air cap. When the amount of mechanical wave speed on the surface of water is equal to the average speed of air molecules under pressure, under the air cap, there is a thinning of air at the water limit. During the compression of the water in the shock valve at a certain speed, the friction in it, and finally, in accordance with the wave speed generated in the water from the hit of the shock valve, determines the rising height of the water in the output pipe of the hydrotaran. As a result of the adjustment of the shock Valve, the compression of the Water leads to an increase in the speed in it. This speed leads to an increase in the rate of vibration at the boundary surface of water and air, respectively. This speed determines the output height of the water.

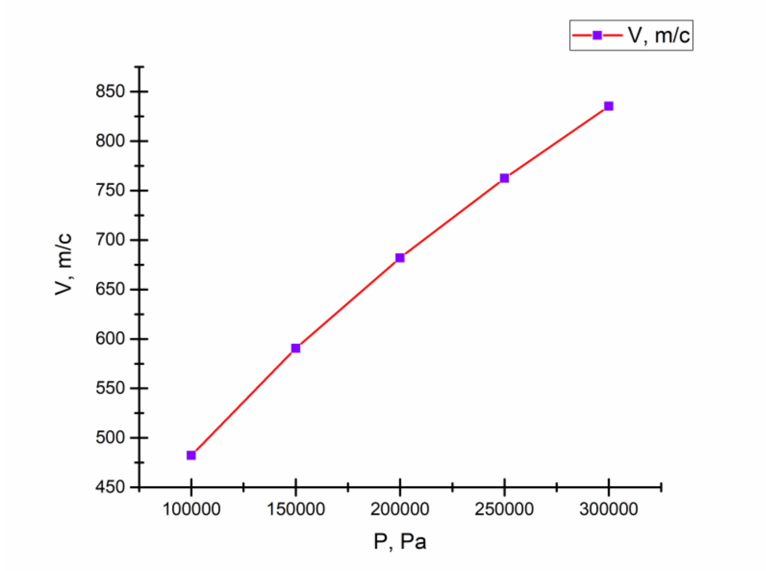

Figure 1. Is a pressure dependence graph of the average velocity of molecules in mixing gases.

During the instant effect, high-pressure water in the supply pipe will have time to penetrate under the air cap. The amount of incoming water depends on the amplitude of the circular motion wave of the molecules forming on the surface of the water. It is the pressure of the air that resists the formation of amplitude. Therefore, in the process of operation of hydraulic Taran, it is required to adjust the shock valve for quick operation as the water lifting height increases. This adjustment leads to an increase in the amount of water at the expense of the number of small water servings in large quantities.

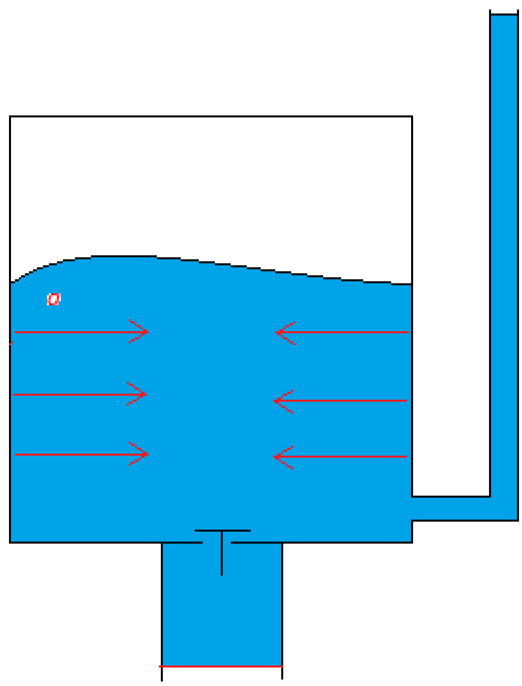

Figure 1. Cylinder-shaped air cap.

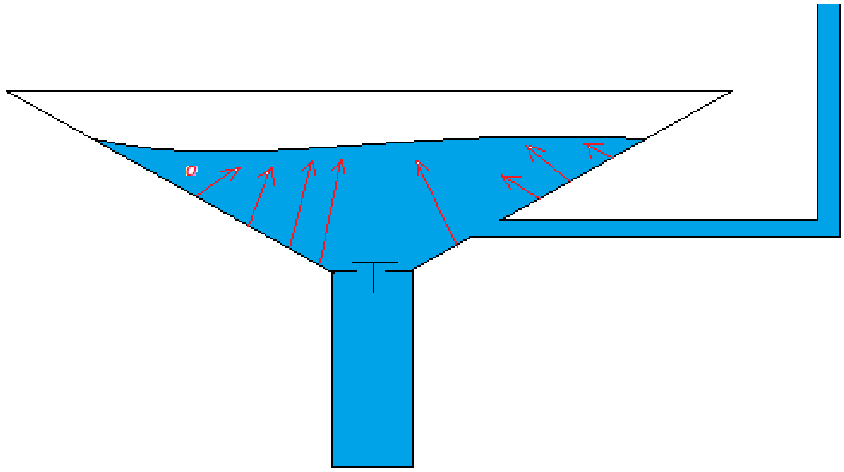

Figure 2. Cone-shaped air cap.

Figure 1 the dispersion of mechanical waves on the lower side of the cylinder-shaped air cap is directed towards the inner side of the water inside the air cap. The α angle between the side of the air sac and the surface, considered a source of mechanical wave propagating at the boundary of water and air, is 〖90〗^0. The source of the wave is located scattered relative to the surface.

Figure 2 the spread of mechanical waves on the lower side of the cone-shaped air cap is directed towards the water level. The α angle between the side of the air cap and the surface is less than 〖90〗^0. The spread of mechanical waves in a cone-shaped air cap to the water level increases the chances of mechanical waves in a cylinder-shaped air cap being able to spread to the water level. It depends on the angle α, which constitutes the air cap side tone relative to the water level.

If the angle α is greatly reduced the water level under the air cap decreases, a sharp decrease in the water level causes the water in the outlet pipe to slide out with a high break when the hydraulic Taran is running. The lifting height is limited. The thickness of the water under the air cap is significant for the full power operation of the hydraulic Taran.

Therefore, the α angle between the side of the cone-shaped air cap and the water level in it is taken in the Triangle 〖30-40^ ^ 0.

The intensity of the wave propagating at the water level under the air cap of a conical shape and the chance to awaken it is considered relatively high in the form of a slime. [6]

Conclusion.

Hydraulic Taranda hydrozarba serves water to enter under the air cap. The atmospheric pressure to raise the water to the top is due to the pressure generated by the compression of the water under the air cap.

The larger the surface of the water under the air cap, the higher the elevation of the water in the outlet pipe increases, so that the height (thickness) of the water under the air cap decreases. It is necessary that the minimum value of this height is not less than 70-80 mm, at a thickness lower than this, interruptions and siltation of water at the exit pipe of the hydraulic Taran occur, as well as stresses. Therefore, the high volume of the air cap leads to an increase in the weight of the water in it. This weight resists the entry of water under the air cap through the pressure valve in the supply pipe.

The volume of the air cap of the hydraulic Taran, taken in accordance with the diameter of its supply pipe, ensures its reliable operation. Based on the corresponding measurement studies,the conical-shaped air intake and supply pipe diameter d_Ø=40 mm, V_(x.q) = recommended to take in 8 liters of proparsionality.

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