

Methods to Increase the Hydraulic Blow-Based Pump Efficiency

A.T. Musurmonov¹, U. Usarov² and Z.T. Hayitov³

¹Doctor of Technical Science (SVMI).

²Prof., Candidate of Mechanical Sciences, (SSACI).

³Researcher (SSACI).



Abstract – Although three centuries have passed since the discovery of the hydrotaran, almost no changes have been made to its working principle and construction. The article is based on the results of previous research, scientific ideas and views on improving the performance of hydrotherapins. It is reasonable to say that the automatic operation of the hydraulic tank is due to the fact that the surface tension coefficient of the water under the air cap varies as a result of the constant, compression deformation of the mixed gases under the air cap.

Keywords – Hydraulic, Hydraulic, Surface Tension, Supply Pipe, Outlet Pipe, Pressure, Air Cap.

I. INTRODUCTION

Hydrotaran operates at the expense of fully renewable energy. However, its use has decreased due to the high water wastage. The hydraulic can automatically run for years without interruption. Low operating costs, low maintenance required, no environmental impact during operation. In this regard, one of the important tasks is to reduce water wastage and increase efficiency.

II. THE MAIN PART

The idea of raising water upwards only at the expense of the potential energy of water without spending any additional energy was put forward in 1775 by the English scientist Joseph Whitehast.

In 1797, the French scientist H.Mongolfe, the inventor of the aerostat, and in this period the English scientist M.Bulton, and in 1809 American inventors Semi and Hallett received a patent for a device that lifts the water upwards at the expense of the initial potential energy of water without external, other additional energy. This device was later renamed the hydraulic shock absorber. [2; 3; 7]

Although the phenomenon of hydraulic shock was known to science in the 18th century, the theory of this phenomenon was first developed by the Russian scientist Nikolai Zhukovsky. About this, in 1898, his theory was first published. A general schematic view of the hydrotherapist is shown in Figure 1.

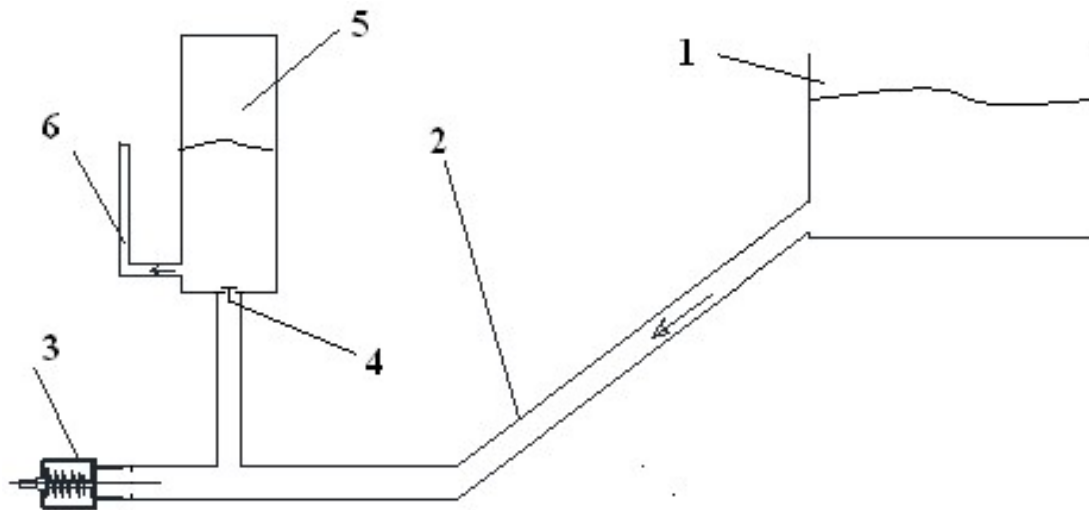


Figure 1. Hydraulic water pump. 1-reservoir (reserve), 2-supply pipe, 3-valve, 4-pressure valve, 5-air cap, 6-outlet pipe.

The principle of general operation has not changed, if we look at the discovery of hydrotherans and so far with improved options [5]. It would be wrong to say that the

automatic operation of a hydrotherapist is only a product of hydrotreating, and this idea cannot be fully justified.

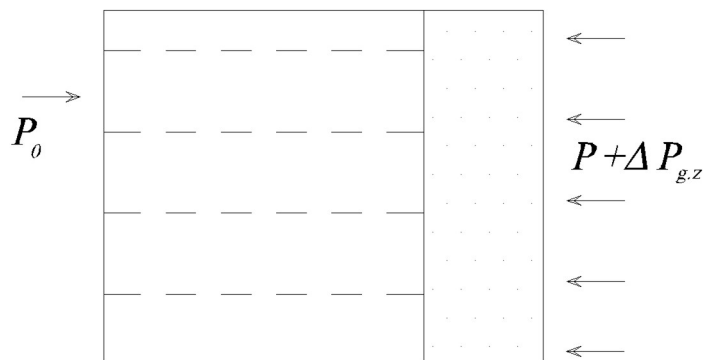


Figure 2. Occurrence of reverse hydraulic shock (at the percussion valve). P_0 - initial flow (in the supply line), $P_{\tilde{a},\zeta}$ -hydraulic shock pressure, ΔP -deformation (elongation) change.

Jukovsky's formula for the formation of hydraulic shock:

$$P_{\tilde{a},\zeta} = \tilde{n} \cdot \mathcal{G} \cdot \rho \quad (1)$$

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

Hydrotaran efficiency:

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

If we observe the process of operation of hydrotrans, [2; 5] the magnitude of the useful work coefficient decreases

with increasing output height- H . At the same time, there is an increase in water wastage, which leads to a decrease in the volume of water in the outlet pipe-6 (Fig. 1). The increase in water (resource) waste is explained by the decrease in the efficiency of the device.

The content of the experiment is as follows: (Fig. 1) Water in the reservoir-1, moving through the supply pipe-2 with ($\mathcal{G}$) speed and (P) pressure, the tap at the end of the pipe-3, when it reaches the closed position, the water the velocity of the first particles disappears and their kinetic energies are converted into the deformation work of the pipe walls and the

fluid. In this case, the fluid has to increase the pressure due to compression, even if it is small, and this compression creates a large amount of $P_{a,c}$ shock pressure (Figure 2). Then, according to $P_{a,c}$ the additional pressure created, the walls of the pipe are stretched, and the liquid is compressed. The first particles are followed by neighboring particles, and their velocities disappear. The resulting pressure increase limit is compressed by the shock wave-3, the reservoir-1, the velocity of the shock wave propagation towards the direction-c. The area that changes to $P_{a,c}$ pressure is called the shock wave. When the shock wave reaches the supply vessel, the liquid is stopped and compressed all over the pipe, and the pipe walls are stretched. The increase in pressure will be distributed throughout the pipe. Under the influence of $P_{a,c}$ this fluid pressure difference, air begins to flow from the pipe through the pressure valve-4 to the cap-5, and its direction is reversed, leaving the recirculated flow behind. With the recovery of the P_o -pressure, the fluid and the pipe return to their original state. The liquid mass tends to break away from the percussion valve 3. As a result, when the percussion valve-3 is fully closed, a negative shock wave moving at c-velocity in the vessel is generated, which reduces the pressure to $P_{a,c}$,

narrows the pipe walls, and expands the liquid under the air cap-5. In the experiment, the cycle is repeated. So, what is the reason for this?

Once the volume of water under the influence of the shock wave $P_{a,c}$ generated against the flow velocity enters under the air cap, this volume of water becomes a participant in a new system other than the system that was previously there. This is because of the shock wave in the water collects under the air cap and is extinguished here. In short, there is no direct involvement of the hydraulic blower in the rise of water in the hydraulic tank (extinguishers are an example in the fight against the hydraulic shock).

The derivation of the formula for the efficiency of the hydrotherapist in formula (2), the direct involvement of the formula in the formula (1) is not observed. (2) The formula is derived from the isothermal compression process of the universal gas law.

The rising of the water is done by another system. This can be explained as follows: To determine this, we consider the boundary of the water and air layer under the air cap of the hydrotherapist. Figure 3.

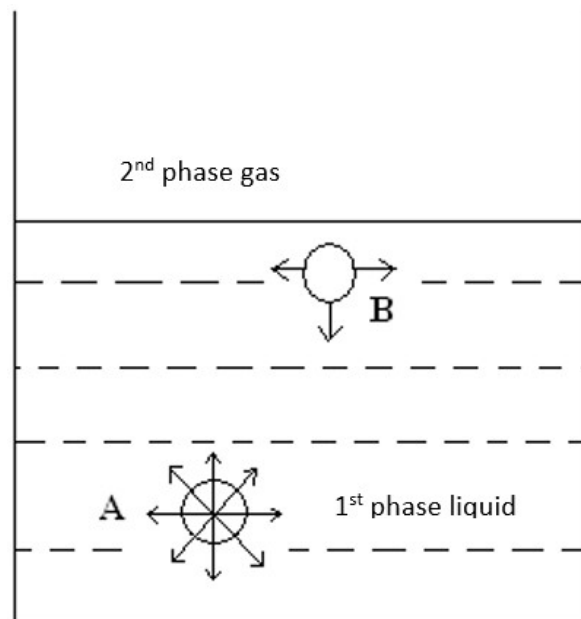


Figure 3. Water and air boundary phase.

If the intermolecular interactions at the phase boundary are different (Figure 3), the system will consist of different phases [2]. In a system consisting of a liquid phase 1 and a

gas phase 2, the intermolecular interaction force F_{1-1} in the liquid is greater than the intermolecular interaction force F_{2-2} . $F_{1-1} > F_{2-2}$ because the molecule A inside the liquid

is surrounded by all the other molecules, the forces of interaction are mutually equal. The V molecule on the interfacial surface is affected by liquid molecules on the one hand and gas molecules on the other. As long as $F_{1-1} > F_{2-2}$, the resulting force P directed to the depth (bottom) of the liquid appears. This force is often called pressure.

$$P = F_{1-1} - F_{2-2} \quad (1)$$

The greater the difference between the intermolecular interactions in the boundary phases (surfaces), the greater the internal pressure.

The molecule on the surface of the liquid is affected by 2 different forces (Fig. 3): the forces in the gas phase and the forces in the liquid phase. Because the intermolecular distance in the gas phase is large, their gravitational force is less than the gravitational force of the molecules in the liquid. Therefore, the molecule on the surface of the liquid moves into the liquid as much as possible. This is why any liquid tends to shrink its surface. This in turn creates internal pressure. It is this internal pressure that is the force in the hydrotherapist (Fig. 1) that prevents the volume of the hydraulic wave from reaching below the air cap-5 [1; 3].

In general, because there are molecules on the surface of any liquid where the intermolecular gravitational forces are unbalanced, in the outer layer, (interfacial) surface energy is generated. This energy constantly tends to decrease.

In order to gain the surface of the liquid, its surface (under the air cap) must overcome free energy. That is, it is necessary to spend work from the outside (at the expense of hydraulics).

If a system consists of several macroscopic parts that are separated from each other by a boundary surface, it becomes a heterogeneous system. On such surfaces, some parameters change with the jump as well as the coefficient of surface tension (surface tension can be strictly constant in the absence of a heterogeneous layer on the water) [2, 5].

Hence, due to the fact that the pressure of the hydraulic tank under the closed system air cap is higher than that of the

small surface, the coefficient of surface tension on the surface of this part of the water decreases. This, in turn, becomes the area of the hydrotherapist under the air cap that receives the shock waves generated in the entire system. Here the shock waves are completely extinguished, and a short stop occurs, covering the water in the wave volume. The forging valve-4 under the air cap is in the closed position at this time. The air cap-5, supply pipe-2, is disconnected from the associated system. This suggests that the direct involvement of shock waves in the rise of water in the hydrotherapist is not observed (Fig. 1).

Therefore, taking into account the above, the following two methods can be used to increase the efficiency of the hydraulic tank:

1. In view of the above, it is only necessary to reduce the coefficient of surface tension of the water under the air cap using a surfactant. However, if the surfactant is distributed over the entire volume of water, it leads to a decrease in the viscosity of the water [2; 3; 4]. This leads to a decrease in natural cavitation. As a result, there is a decrease in productivity in hydraulics. For this purpose, it is only advisable to add a water-insoluble and non-sedimentary surfactant under the air cap of the hydrotherapist. It is recommended to use paraffin or some oils as such surfactant.
2. Surface tension force:

$$F = \sigma \cdot L \quad (4)$$

F – is surface tension force, σ - is surface tension coefficient, L - is the length limit of the surface, Given that $L = 2 \cdot R$, we obtain the following.

$$\sigma = \frac{F}{2 \cdot R} \quad (5)$$

from (5), it is necessary to increase the surface area to reduce the surface tension coefficient. Based on the above considerations, it is advisable to make the air cap of the Hydrotaran conical.

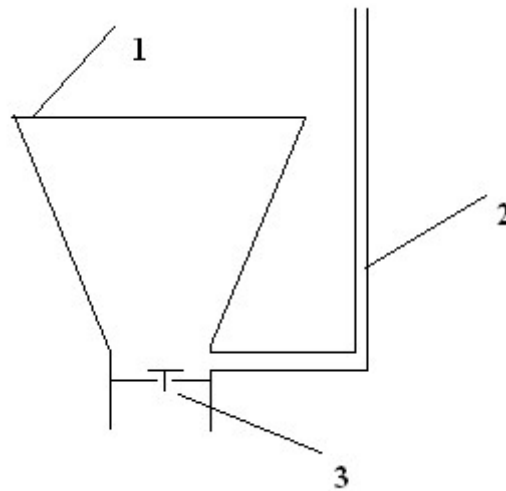


Figure 4. Hydraulic conical air cap. 1- conical air cap; 2 - outlet pipe; 3 - pressure valve.

By increasing the air-water boundary surface under the air cap, the surface tension coefficient is reduced and an increase in the amount of water covered under the air cap is achieved. As a result, according to the law of conservation of energy, the initial energy consumed in the hydrotherapist can lead to an increase in the efficiency of the relatively large water consumption.

III. CONCLUSION

It is reasonable to say that the automatic operation of the hydraulic tank is due to the fact that the surface tension coefficient of the water under the air cap changes as a result of constant, compression deformation of the mixed gases under the air cap.

It can be said that the accumulation of hydraulic waves (as a volume) under the air hood in the hydraulic tank is due to the variation of the surface tension coefficient. In short, the above methods can increase the efficiency of the hydraulic tank.

REFERENCES

- [1] Colloid chemistry. N.I.Fayzullaev, N.Q.Muxamadiev. Sano-Standard Publishing House. Tashkent-2016. (Pages 23-24, 28-29, 69, 23-102, 182-232.)
- [2] Fluid and gas mechanics. X Khudoynazarov., A Abdirashidov. State Enterprise "Zarafshon" publishing house. Samarkand-2017. (Page 32)
- [3] Problems in physical and colloid chemistry. T.Kholdarova, J.Haydarov "Tafakkur Bostoni" Tashkent-2015. (Pp. 239-283.)
- [4] Water chemistry and microbiology. M.Xodjiddinova, A.Rizaev. Yangi Nashr Publishing House. Tashkent-2010. (Pp. 86-89.)
- [5] International patent database on the Internet. Special sites for hydrotaran.www.patent.su, www.caspatents.com.