НАУЧНЫЙ ИМПУЛЬС
ЦЕНТР НАУЧНОЙ ПОДДЕРЖКИ

МЕЖДУНАРОДНЫЙ СОВРЕМЕННЫЙ НАУЧНО-ПРАКТИЧЕСКИЙ ЖУРНАЛ

НОВОСТИ ОБРАЗОВАНИЯ: ИССЛЕДОВАНИЕ В XXI ВЕКЕ

Последние взгляды	Последние данные	Последние исследование

И НОВОЕ ОБРАЗОВАНИЕ

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Журнал «Новости образования: исследование в XXI веке» освещает сферу духовно-просветительского мышления человека, общественно-политическую жизнь человека, институты гражданского общества, глобальные проблемы, проблемы образования, новые технологии, производимые сегодня, реформирование системы образования и публикуются научные статьи, посвященные открытому научно-популярному анализу.

DETERMINATION OF HYDRAULIC SHOCK PARAMETERS IN LARGE PUMP PIPING

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Annotation: *In the article in the section of hydraulic calculations of transient processes, we note that as a result of mathematical modeling, it is possible to set parameters corresponding to the operating modes of pumping stations. The results obtained can be used to justify the design of the water pipeline road elements, as well as in technical and economic calculations, for example, to justify the parameters of pumping stations at the next stages of their design and development. In addition, the identified parameters are preliminary information for the study of transient processes in the electrical system, including hydroelectric power plants.*

Key words: *pumping stations, transients, excitation control, synchronous motors.*

Pressure pulsations at the operating frequencies of pumping units, vibrations, transients (switching, turning on, turning off pumps), hydraulic shocks that inevitably occur during the operation of hydraulic systems enhance the mechanisms of their degradation, greatly accelerate the rate of internal corrosion processes, contribute to the accumulation of fatigue characteristics of the material in places of stress concentration (welds, scuffs, etc.) and are the main background for the occurrence of emergencies. More than 70% of all accidents and incidents occur due to hydrodynamic processes [1].

The occurrence and high-speed propagation of waves of increased pressure, several times higher than the operating pressure, often has the character of a hydraulic shock. As a result of the occurrence of hydraulic shock, as a rule, ruptures occur in the most weakened places of the pipeline system, which, due to wear, is unable to withstand dynamic shock loads.

The propagation velocity of hydraulic shock waves in steel pipelines is about 1000 m/s, and a change in the flow velocity by 1 m/s causes a pressure change of about 9.0 atm.

The need to take into account the destructive force of hydraulic shock in pipelines transporting liquids (oil, oil products, water, etc.) is expressed in the fact that on such pipelines (unlike gas pipelines) valves are never installed that quickly block the pipeline section , but on the contrary, valve valves are used, which give a slow overlap of the section and ensure a safe stop of the fluid flow. Moreover, in some cases, special devices are used to protect the pipeline from the effects of water hammer. For example, in an oil pipeline, on the suction lines of pumping stations, hydraulic shock absorbers are installed in case the station suddenly turns off and the pressure in front of it starts to rise. The principle of operation of hydraulic shock absorbers is to divert part of the liquid from the pipeline into a special tank to reduce pressure when it increases [2]. It has been established that in real (complex) hydraulic systems, the specificity of transient processes is determined by the multiple superposition of reflected pressure waves from structural inhomogeneities of the system and the transformation during their passage along the length of pipelines.

Water hammer in pumps can be caused by various reasons, but the shocks observed when the pump is operating in cavitation mode deserve special attention. The shock in this case is due to the fact that when the pump chamber is not filled with liquid, due to its cavitation, the hydraulic system discharge line (with the pump outlet line) is connected, a reverse flow of liquid occurs into this chamber, accompanied by pressure shock processes in it. Since in this case (due to high pressure drops between the discharge line and the working chamber) high liquid reverse flow rates are possible, shock surges of pressure in the pump chambers can reach values that can disable the pump [3].

In addition, a wave of increased shock pressure that occurs during hydraulic shock in the pump can cause significant pressure surges, and cause noise and failure of various hydraulic equipment.

Transient processes are influenced by a large number of factors, for example, the presence of air dissolved in the liquid in the pipes, the deformation compliance of the pipe walls, and other phenomena. In particular, it was found that the nature of non-stationary processes in pipeline systems is fundamentally affected by cavitation discontinuities in the liquid, which can occur at any point in the system when the pressure drops below the saturated vapor pressure of the liquid. Recently, due to frequent power outages, cases of water hammer have become more frequent, so the need for protection against them is becoming more acute.

The determination of the nature of the transient process and the values of the mode parameters can be carried out on the basis of the equations:

- for pressure:

$$y(x,t) = A\left(\frac{x}{L}-1\right)+\frac{2Ag}{\pi}\exp(-mt)\sum_{n=1}^{\infty}\frac{1}{n}\left(\cos q_n t+\frac{m}{q_n}\sin q_n t\right)\sin\frac{n\pi}{L}x \qquad (1)$$

- to change the fluid velocity:

$$v(x,t) = \left[\frac{Ag}{2mL}(\exp(-2mt)-1\right]+\frac{2Ag}{L}\exp(-mt)\sum_{n=1}^{\infty}\sin q_n t\cos\frac{n\pi}{L}x \qquad (2)$$

where $y = H/H_0$ - is the reduced head, ν - is the flow velocity in the pipeline, x - is the coordinate measured along the pipe axis, g - is the acceleration of gravity, H, H_0 – is the effective head of the installation and the head in the initial mode, t - is the time, $m = \lambda v_{cp}/2d$, v_{cp} - is the average velocity of the fluid movement, approximately equal to the initial one ($v_{cp} = v_0$), λ - is the coefficient of friction resistance, determined by the Blasius formula, $\lambda = \frac{1}{\sqrt[4]{100\,\mathrm{Re}}}$ Re - is the Reynolds number, d - is the diameter of the pipeline, L - is the length of the pipeline, $q_n = \sqrt{(\frac{n\pi}{L})^2 - m^2}$, $A = H_p + h_p$ – pressure drop at the valve during its rapid closing, H_p - working pressure at the valve, h_p - pressure equal to atmospheric pressure.

Let us consider the possibility of a water hammer in the irrigation pumping stations of Uzbekistan, in which, as a rule, long pipelines are installed. In particular, we will study this issue on the example of a pumping station [1].

Let 8 units with a capacity of 10500 kW each be installed at the irrigation station, with a flow rate of 10 $м^3$/s, a head of H_0 = 40 m, a pressure pipeline diameter of 3.96 m, a length of L = 1100 m, and a feed rate of ν_0 = 1.8 м/s. It is possible to determine the possibility of the occurrence of an impact, its parameters and the nature of the transient process during an impact, in various sections of the pipeline. We will solve the problem on the basis of the MATLAB software package and formulas (1-2) for n=3. The calculation results are shown in Figs. 1 and 2.

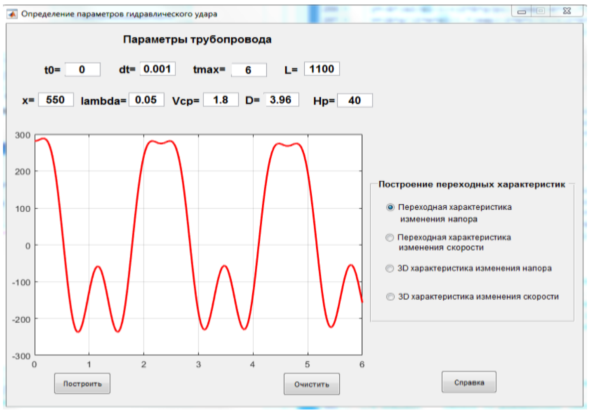

Fig.1. Transient response of pressure change as a result of water hammer

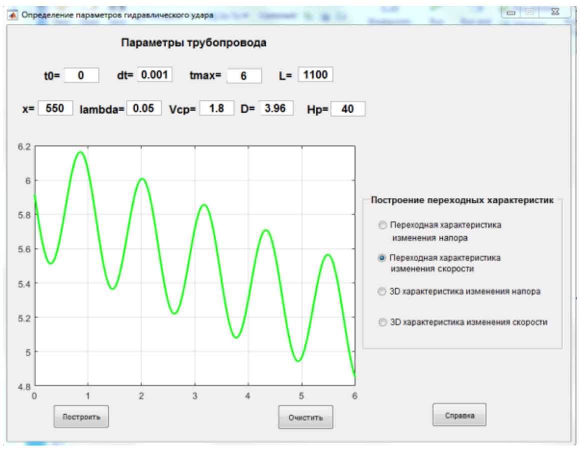

Fig.2. Transient response of fluid velocity change due to water hammer

Concluding the section on hydraulic calculations of transients, we note that, as a result of mathematical modeling, it is possible to set the parameters corresponding to the operating modes of pumping stations. The results obtained can be used to justify the design of the elements of the water supply path, as well as in technical and economic calculations, for example, when justifying the parameters of pumping stations at subsequent stages of their design and development.

In addition, the identified parameters are the initial information for the study of transient processes in the electrical system containing hydropower plants.

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