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Calculation of Vacuum During Hydraulic Shock Taking into Account Dissolved Gas

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ABSTRACT

The article presents the results of theoretical and experimental studies of vacuum during hydraulic shock, taking into account the dissolved gas in the pressure pipeline of a pumping station. At the same time, quite satisfactory agreement between the results of vacuum calculations using the proposed method and experimental data was obtained, which also confirms the hypothesis that it is necessary to take into account the process of dissolved gas release when calculating pressure pipelines for hydraulic shock with a break in the continuity of the flow.

KEYWORDS: *pumping station, water hammer, vacuum, pressure pipeline, dissolved gas, discontinuity of flow.*

Introduction

The study of hydraulic shock with an interruption in the continuous flow that happens in the pressure conduit of irrigation pumping stations, resulting in emergency circumstances, is of current relevance and is intimately related with the defense of pressure systems against hydraulic shock.

The primary cause of hydraulic shock is a change in the operation mode of the regulating bodies placed on the pressure pipelines of pumping stations.

An abrupt power interruption of the pump motors is the primary cause of crises in the pressure pipelines of pumping stations. The most dangerous type of hydraulic shock in such a situation is one where the flow is broken [1,2,3].

The extreme pressure values in the typical pressure conduit sections must be identified when calculating pressure pipes for hydraulic shock with a break in the continuity of the flow. We have incorporated hyperbolic wave equations to address this issue [4, 5, 6, and 7].

A genuine liquid is modeled as a two-phase system with a tiny amount of dissolved gas (air) in the chosen mathematical model of an unstable hydraulic process in pressure pipes [1, 7, and 8].

The investigation revealed that the dissolved gas present in the actual liquid exerts its impact on non-stationary hydraulic processes in the pressure pipelines of pumping stations. [1, 2, 3].

In studies [3, 8], it is demonstrated that water contains roughly 2% (more specifically, 1.6% of the dissolved gas) at a temperature of 20^0C and atmospheric pressure. The findings of experiments on the impact of dissolved gas on hydraulic shock with a break in flow continuity are presented in this study.

Methodology

The essence of estimating the pressure pipes of pumping stations for hydraulic shock with a break in

flow continuity is that the maximum and minimum (vacuum) pressures are calculated in the initial phase of variations in hydrodynamic pressures.

The calculation of their key characteristics is critical for estimating pressure pipes for hydraulic shock with an interruption in the continuity of the flow. The value of the absolute minimum pressure (vacuum) must be computed when constructing the major parameters of the strength indicators of pressure pipes in the initial phase of hydraulic shock with an interruption in the continuity of the flow.

The findings of investigations on the estimation of vacuum in the initial phase of hydraulic shock with a break in the continuity of the flow, taking into consideration the influence of dissolved gas at low geodetic heads, are presented in this work (10-20m). The suggested method and experiment were used to calculate the vacuum values during hydraulic shock with an interruption in the continuity of the flow.

The calculated and experimental (experimental) vacuum values were compared to R.E. Trozyan's computed and experimental data [2].

A genuine liquid is represented as a multiphase system or mixture in the chosen mathematical model of an unstable hydraulic process in pressure pipes, consisting of a liquid phase with a tiny admixture of undissolved and dissolved gas (air) and solid suspensions. [1,2].

The findings of experiments on the influence of dissolved gas on negative hydraulic shock with a break in the flow continuity are presented in this study.

The essence of estimating the pressure pipes of pumping stations for hydraulic shock with a break in flow continuity is that the maximum and minimum (vacuum) pressures are calculated in the initial phase of variations in hydrodynamic pressures.

The calculation of their key characteristics is critical for estimating pressure pipes for hydraulic shock with an interruption in the continuity of the flow.

Results and Discussions

The value of the absolute minimum pressure must be computed when constructing the major parameters of the strength indicators of pressure pipes in the initial phase of hydraulic shock with an interruption in the continuity of the flow.

The results of investigations on the estimation of vacuum in the initial phase of hydraulic shock with a break in the continuity of the flow, taking into consideration the impact of dissolved gas at low geodesic heads [1,3,4,5,7,8] are presented in this study.

The suggested approach and experimental results were used to measure vacuum levels during hydraulic shock with an interruption in the continuity of the flow. [1,7,8].

The calculated and experimental (experimental) vacuum values were compared with the calculated and experimental data of R.E. Trozyan [7,8]. (Fig .1).

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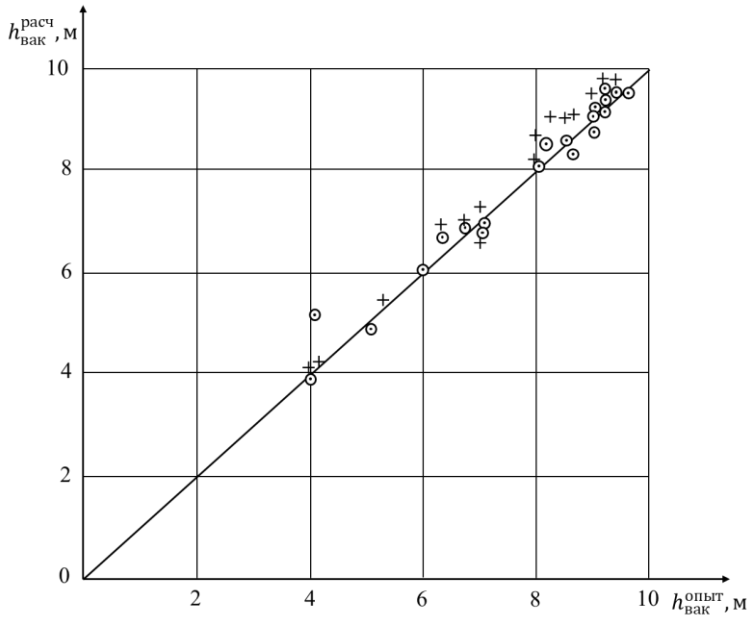

Figure 1. Comparison of the results with experimental data at N_G = 10…20 m: ○ - calculations according to the proposed method (according to the author);

+ - calculations according to R.E.Trozyan's formula.

Simultaneously, quite satisfactory agreement between the results of vacuum calculations and experimental data was obtained, confirming the hypothesis that when calculating pressure pipelines for hydraulic shock with a break in the continuity of the flow, the process of evolution of dissolved gas must be taken into account.

4. Conclusion

1. A very excellent agreement was found between the results of vacuum calculations during hydraulic shock, taking into consideration the dissolved gas, and experimental data, confirming the correctness of D.V.Shterenlikht's hypothesis.
2. The investigations further support the notion that when estimating pressure pipes for hydraulic shock with a break in the flow continuity, the process of dissolved gas release must be considered.

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