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ПОРІВНЯННЯ ПІДХОДІВ ОЦІНЮВАННЯ ЕНЕРГОСПОЖИВАННЯ ГІДРОДИНАМІЧНИХ АПАРАТІВ ПО ТИПУ ТРУБИ ВЕНТУРІ

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COMPARATIVE ANALYSIS OF ENERGY CONSUMPTION ESTIMATION METHODS FOR VENTURI-TYPE HYDRODYNAMIC APPARATUS

Based on the literature sources, several approaches can be distinguished for determining and analyzing the energy consumption of the hydrodynamic apparatus of the Venturi pipe type. One of these methods is based on determining the hydraulic resistance coefficient (ξ). Researchers use both experimental methods and numerical modelling (CFD), which allows for a comprehensive assessment of the impact of design parameters and flow regimes on hydraulic losses. In [1] and [3], emphasis is placed on the geometry of the Venturi pipe, particularly the length of the throat, the angle of the diffuser, and the diameter ratio. The results of CFD calculations show that optimizing these parameters can significantly reduce pressure losses. At the same time, an excessive increase in the expansion angle can lead to the formation of a recirculation zone and, consequently, an increase in ξ. Studies [2] indicate that the development of cavitation significantly affects the hydraulic resistance coefficient. When cavitation conditions are reached (low throat pressure), ξ increases, negatively impacting the energy characteristics of the system. At the same time, these phenomena can be utilized in a targeted manner, for example, to intensify processes in a cavitation apparatus.

The comparative analysis presented in [3] demonstrates a high correlation between the results of experiments and CFD modeling. This indicates the reliability of numerical methods for predicting ξ and confirms the feasibility of their use at the equipment design stage. The behavior of the resistance coefficient in two-phase flow was considered in [4]. The results show that the value of ξ in such cases varies significantly depending on the volume concentration of phases, their distribution, and the mode of motion (bubbling, foaming, jetting, etc.). This requires taking into account additional empirical correlations in the calculations. Therefore, further research should focus on the quantitative analysis of energy consumption of systems with Venturi tubes, in particular by calculating specific energy consumption, pressure efficiency, and the impact of different operating modes on overall energy performance. It is also promising to develop criteria for energy optimisation of the design for various technological applications.

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