СЕКЦІЯ: ПРОЦЕСИ ТА АПАРАТИ ХАРЧОВИХ ВИРОБНИЦТВ

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ВІБРАЦІЙНІ АСПЕКТИ КАВІТАЦІЙНИХ ПРОЦЕСІВ У ГІДРОДИНАМІЧНИХ АПАРАТАХ ПО ТИПУ ТРУБИ ВЕНТУРІ

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VIBRATION ASPECTS OF CAVITATION PROCESSES IN HYDRODYNAMIC DEVICES OF THE VENTURI TUBE TYPE

Static hydrodynamic devices based on the Venturi tube principle are actively used to create a controlled cavitation effect in food, chemical and water treatment technologies. Cavitation allows for the intensification of mass and heat transfer processes, but its side effect is the occurrence of high-frequency vibrations and possible destruction of equipment surfaces. That is why studying vibration characteristics is important for understanding the mechanisms of cavitation and assessing the service life of devices.

The work simulated the operation of hydrodynamic devices with conical and screw obstacles. The numerical experiment was performed in SolidWorks Flow Simulation using experimentally determined boundary conditions (inlet pressure 0.3–0.6 MPa, water temperature 20 °C, flow rate 20–40 l/min). Vibration characteristics were recorded using accelerometers installed at several control points of the structure.

It has been established that the vapour-gas phase appears at a pressure of about 0.35 MPa, and the zone of its highest concentration forms at the outlet of the diffuser. This area proved to be critical in terms of vibration load. The highest accelerations were observed at the diffuser outlet, which correlates with the phase of intense bubble collapse and the formation of microjets.

A comparative analysis showed that the design with a conical obstacle forms a more uniform distribution of the vapour-gas cloud, while in the screw model there are local areas of increased vibrations. When the inlet pressure is increased to 0.6 MPa, the cavitation process stabilises: the vapour-gas phase shifts to the central part of the flow, and the impact on the walls decreases.

The results obtained confirm the feasibility of using vibration analysis as an informative tool for assessing the development of cavitation processes. The use of vibration monitoring provides the possibility of timely diagnosis of operating modes and improvement of Venturi tube designs, taking into account the increase in their operational reliability.

Reference

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