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Author: Dr. Nikolai Kozlov
PSHPU, Russian Federation

Mrs. Darya Shuvalova
PSHPU, Russian Federation

INFLUENCE OF TRANSVERSAL VIBRATION ON THE DYNAMICS OF TWO IMMISCIBLE LIQUIDS AT ROTATION

Abstract

Influence of vibration on the behavior of an interface between two immiscible liquids of different density at rotation in a horizontal cylindrical cavity is experimentally investigated. The liquids are centrifuged, the vibration is transverse to the rotation axis. At rotation of the system in the gravitational field the column of internal liquid makes inertial oscillations. Such motion of the light column is explained by the action of the gravity vector, which rotates in the cavity frame. Inertial oscillations generate a differential rotation of the interface. The vibration influences the dynamics of two-liquid system in resonant regions where interface oscillations of large amplitude are excited, and an intensive differential rotation is generated. The resonance is determined by the ratio of vibration frequency to rotation frequency $n \equiv \Omega_{\text{vib}}/\Omega_{\text{rot}}$, at $n > 1$ the interface rotates faster than the cavity, at $n < 1$ – slower than the cavity. The vibration and the gravity act independently, the superposition principle is valid. Also, in the resonance regions the interface deformation is observed. The deformation is caused by emergence of a two-dimensional inertial azimuthal wave in the form of crests parallel to the rotation axis. The phase velocity of the wave in the laboratory reference system doesn't depend on such parameters as cavity rotation speed and vibration amplitude, and can differ from the cavity rotation speed several times. The influence of relative density of liquids, relative volume, and viscosity ratio on the resonant values of n is investigated. The average flows arising under the influence of the vibration force generated due to nonlinear effects in the Stokes boundary layers near the liquid–liquid interface and on the cavity walls are discussed. The results of research are of interest in the use of vibration as a method for controlling multiphase systems with the interface.

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