Vibrational hydromechanics of rotating systems

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The report highlights the results of theoretical and experimental investigation of novel domain - mean dynamics of non-uniform in density hydrodynamic systems in rotating cavities, subject to vibrations [1, 2, 3, 4] of linear or circular polarization. The behavior of multiphase systems (liquid - gas, solid inclusions in liquid), as well as thermovibrational convection in single-phase system with density inhomogeneity caused by nonisothermal conditions, is under consideration. Theoretical analysis of thermovibrational convection is performed using the equations [1] obtained by method of averaging.

The performed studies show that rotation qualitatively changes the mean vibrational behavior of liquid due to the Coriolis force. This force, as is shown in the theory [1] of thermal vibrational convection in rotating systems, influences not only the mean streams in the rotating system, but also directly influences the oscillating motion of the liquid, thus significantly changing the mechanism of vibrational convection itself. The key role of rotation and very specific role of "elastic" Coriolis forces on thermovibrational convection of incompressible liquid is corroborated by theoretical and experimental studies.

The vibrational dynamics of multiphase systems under rotation in many aspects remains similar. The specific feature is the resonant excitation of intensive oscillations of liquid - the inertial waves. The liquid oscillations in turn result in generation of intensive mean flows - vibrational convection. The form of vibrational streams is essentially determined by the structure of inertial waves. So, excitation of an azimuth wave generates azimuth streams (outrunning or lagging, depending on frequency of the wave), three-dimensional standing waves (in the systems with deformable interface) generate regular spatial flows of high intensity. In case of light inclusions, which under the action of centrifuge force are positioned on the rotation axis, the excitation of resonant oscillations results in their intensive rotation in the frame of container. Under resonant conditions the influence of vibrations appears to be very strong, the speed of mean streaming can achieve the values comparable with the speed of container rotation. It makes the combined action of vibration and rotation an effective method of heat-mass transfer control.

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