Paper ID: 15618
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MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

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WAVE INSTABILITY OF A ROTATING LIQUID COLUMN

Abstract

The wave processes on the surfaces of the velocity tangential discontinuity are studied in the rotating systems. The discontinuity on the boundary of the Taylor–Proudman column is considered, the latter being formed by a light spherical body rotating with the velocity different from that of the medium. The body is free and under the centrifugal force action is situated near the rotation axis of a liquid-filled cavity. In the basis of generation of the light body differential rotation is the vibrational mechanism described theoretically in [1, 2]. The body motion is excited as a result of its circular oscillations in the cavity frame of reference. The oscillations, in their turn, are induced either by the cavity vibrations in the direction perpendicular to the rotation axis, or by an external static force field. In the latter case, at the cavity rotation around the horizontal axis the gravity field is rotating in the cavity frame. Depending on the vibrational action frequency the excitation of both outstripping and lagging body rotation is possible.

The development of the wave instability on the liquid column boundary (Taylor–Proudman column) is found at a certain intensity of the sphere differential rotation. It manifests itself in the azimuthal wave excitation, the crests of which are elongated parallel to the rotation axis. The study of the phase velocity, the wave number and the wave instability threshold is carried.

The waves of the similar kind have been earlier found on the interface of two immiscible liquids of different density at rotation and simultaneous action of an external force [3]. In the basis of the light liquid column differential rotation is also the vibrational mechanism of the average shear stress generation on the media interface. The further study of this phenomenon is led. The comparative analysis is done of the results obtained in the experiments with the solid in liquid and the results obtained for the rotating two-liquid system.

References

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