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NASA TECH BRIEF

Large-Amplitude Inviscid Fluid Motion in an Accelerating Container

A study was made to characterize the dynamic behavior of the liquid–vapor interface of an inviscid fluid in an accelerating cylindrical container and the flow of the liquid from one end of the container to the other. In particular, a combined analytical–numerical method was developed for determining certain large-amplitude motions. This large-amplitude analysis, which does not involve any linearizations in the equations of motion, is a natural extension of a previous study of symmetric fluid motion to the asymmetric case. As in the previous study, surface tension is included as a smoothing term, and the constant contact angle condition is imposed. The method applies to all but surface tension dominated motions. Problems where the surface is initially in motion can also be treated by this method.

The method is based on the expansion of the velocity potential in a series of harmonic functions with time dependent coefficients. The time dependent coefficients are determined numerically by an orthonormalizing computation in order to satisfy the required boundary conditions. Different sets of harmonic functions depending on the container geometry and various orthogonalizing computations have been used in the analysis. It was found that a wide variety of large amplitude oscillatory or sloshing motions could be computed over extended time periods. It was also found that large amplitude reorientation motions could be computed over relatively long periods of time, but that an instability developed in the computation in this type of motion. To eliminate the instability in the computation, which manifests itself in surface splashing, a technique of velocity extrapolation was used to predict the motion beyond the point at which the instability developed.

Note:

Details of this analytical study may be obtained from:

Technology Utilization Officer
Manned Spacecraft Center
Houston, Texas 77058
Reference: B68-10170

Patent status:

No patent action is contemplated by NASA.

Source: L. M. Perko
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Category 02