MASTER**Boiling Heat Transfer and Stability Problems****Final Report****for Period November 1, 1976 - March 31, 1979**

by

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Abstract

Substantial progress has been made in two areas relating to the boiling heat transfer: the stability of a vapor-liquid system and the dynamics of bubbles. For the stability problem, a simplified formulation retaining the essential feature of the interfacial mass transfer has been established for the complex interfacial stability problem with mass and heat transfer. The simplified version was first applied to the linear Rayleigh-Taylor and Kelvin-Helmholtz stability problems. General agreement with results from previous more comprehensive treatment is obtained. Then the simplified formulation is utilized to study the nonlinear Rayleigh-Taylor stability problem. It is found that the combined effects of finite amplitude and the heat and mass transfer can stabilize the system in a regime which is linearly unstable. A single non-dimensional parameter can be found to characterize the stability criterion for certain configuration relevant to the problem of boiling heat transfer. For the problem of bubble dynamics, the investigation of the nonlinear coupling between the subharmonic spherical oscillation and the nonspherical oscillation has been carried out.

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Significant progress has been made for the research program on boiling heat transfer and interfacial stability problems.

To overcome the difficulty and obtain some basic understanding of this complex, nonlinear problem, we have first succeeded in developing a simplified version of the general formulation, which retains the essential features of the interfacial mass and heat transfer, while greatly reduces the complications due to the coupling of dynamic equations and heat equations in the fluid regions. This simplified version has been applied to the linear Rayleigh-Taylor and Kelvin-Helmholtz stability problems. For the Rayleigh-Taylor case, general agreement has been obtained in comparison with the previous more comprehensive study. Again the criterion of the stability is essentially the same as that of the classical Rayleigh-Taylor stability, but the growth rate of the instability is reduced when the vapor is hotter than the liquid. [1,2]

The simplified formulation is then applied to the nonlinear Rayleigh-Taylor stability problem. It was found that when the heat flux of the liquid-vapor system is large enough, the combined effects of the finite amplitude and the heat and mass transfer can stabilize the system in a regime which is linearly unstable. A single non-dimensional parameter can be found to characterize the stability criterion for certain configurations relevant to the problem of boiling heat transfer. [3,4,5]

The insight gained from the nonlinear stability analysis based on the simplified formulation is valuable for the investigation of the nonlinear Rayleigh-Taylor stability based on the general formulation. This more comprehensive study has begun and started to show promise when it was cut short by the termination of the contract.

The study of boiling heat transfer is invariably related to the problems of bubble dynamics. In the field of bubble dynamics, an outstanding problem is the dynamics of nonspherical bubbles. An investigation on various aspects of nonlinear oscillation of nonspherical bubbles was carried out. The study focuses especially on the coupling between the subharmonic spherical oscillation and the nonspherical oscillation due to nonlinear interaction. [6,7]

Some of the results were presented to the Annual Meetings of the Division of Fluid Dynamics of the American Physical Society, the meeting of the Acoustical Society of America, and the International Symposium on Nonlinear Acoustics in Paris.

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