AEC-NASA TECH BRIEF

Propagation of Density Disturbances in Air–Water Flow

A study has been conducted to investigate the behavior of density waves propagating vertically in an atmospheric pressure air–water system. The technique was based on the correlation between density change and electric resistivity.

A forced circulation air–water loop was used for determining the behavior of void perturbations. The primary airflow, secondary air flow, and liquid velocity were varied in the experimental tests. A square wave pattern was imposed on the solenoid valve controlling the secondary air flow, resulting in a regular sequence of density disturbances. These disturbances were measured at five axial and five radial locations by an improved version of an existing electrical resistivity probe. It was shown that decreasing the curvature of the probe tip, and increasing the liquid velocity of the system decreased the error in probe measurements from 35% to less than 7%.

Two air–water mixers were used to produce the primary air–water flow and secondary perturbations. Twenty runs were made in which the steady-state air flow, the perturbation air flow, and the liquid velocity were varied independently.

A plot of the computer results showed qualitative agreement with the kinematic wave theory. Thus, this void fraction response technique was used to calculate the propagation velocity and the decay or build-up of the disturbances.

A comparison of the experimental propagation velocity with predictions from the kinematic wave theory shows fairly good agreement, but there was a tendency at low mixture velocities for the experimental velocity to exceed the theoretical velocity; for large mixture velocities, the reverse was true. Also, at low mixture velocities, the propagation velocity was greater than the gas velocity; at higher mixture velocities, the correlation was reversed. This does not agree with assumptions that the flow parameter, C_0, and the weighted average drift velocity, V_d, remain essentially constant for a given flow regime, but are probably due to turbulent diffusion.

A comparison of the experimental decay rate with predictions from the kinematic wave theory shows a perturbation decay rate higher than predicted. This was probably due to axial turbulent diffusion, not considered by the wave theory. A diffusion equation for two-phase flow was solved, and diffusion coefficients were calculated from the experimental results. These coefficients tended to increase with increasing downstream void fraction and increasing mixture velocity. The radial diffusivity profile decreased strongly near the wall.

Notes:

1. Detailed information is available in "Propagation of Density Disturbances in Air-Water Flow", ANL-7053, Argonne National Laboratory, June, 1965, by George P. Nassos. This report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151; Price—$3.00 (microfiche $0.65).
2. This information may be of interest to industries working with heat transfer systems and fluid power and control systems.
3. Inquiries concerning this report may be directed to:

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   Reference: B69-10043

Source: George P. Nassos
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(continued overleaf)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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