Transition from Churn to Annular Flow for an Upward Gas-Liquid in Vertical Concentric Annulus

by

Anna Lis Laursen

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Approved:

Dr. B. Wayne Bequette, Thesis Adviser

Rensselaer Polytechnic Institute
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ABSTRACT

This thesis was a study into the characterization of two-phase flow using a Shadowgraphy visualization technique. This is the first time this technique has been used for characterizing the air-water flow emerging at the exit of a vertical concentric dual-pipe configuration. The flow conditions were in the transition regime between churn and annular flow, where the characteristics of interest were the mass flow rate and pressure drop as well as the inner and outer water film thicknesses.

The Shadowgraphy technique provided images based upon which quantitative flow data could be derived. Because most flow conditions which could be established using the present experimental setup had stability issues, this allowed only one continuous air flow rate condition to be characterized in detail. Although the flow in this case was stable, it did have some periodic pulsating behavior. The result was presented as superficial air and water velocities, which then was in a form which could be directly compared to superficial velocity plots published in the literature. Numerous experimental runs were conducted and the average superficial water velocity and superficial air velocity was determined to be 7.7 m/s and 20.7 m/s, respectively.

These superficial velocity plots provide a convenient separation of flow regimes and are the accepted framework for presenting experimental data as well as modeling predictions. The new result fell near the churn-annular flow transition, but did differ somewhat from previous results and model predictions. This thesis discusses possible reasons for this and considers factors such as differences in setup and measurement methodology. It should be noted that the Shadowgraphy is a direct method for measuring the flow rates.