CHARACTERISTICS OF TWO PHASE NATURAL CIRCULATION AT NEAR ATMOSPHERIC PRESSURE IN A FIGURE OF EIGHT LOOP

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ABSTRACT

To provide information on the fundamental behaviour of two phase natural circulation cooling in a CANDU-primary heat transport geometry, an experimental study using steam and water was carried out in a low pressure, simple figure of eight loop. The experimental facility was constructed to represent the basic geometrical features of the CANDU-PHTS, but simple and flexible to allow for possible changes in the loop to study the effect of different components, and parameters on the phenomenon, and to have maximum visual observation.

The experiments were carried out over a range of heater power input of 1.2 kW to 4.0 kW per heated section, primary side pressure of 100 kPa to 500 kPa, and primary side coolant inventory of 100% to 60%. Over the range of the experiments, three large amplitude flow oscillation modes were observed. They are the 180° out-of-phase flow oscillation, the in-phase flow oscillation, and the intermittent flow. It was observed that the heaters eventually dry out under the in-phase flow oscillation and the intermittent flow modes. Stable flow was not observed at all conditions, in the current experiments.

Because of the non-linear nature of the observed oscillation characteristics, and the limitation of the previously developed linear model [1], a non-linear thermalhydraulic stability code is currently being developed. This non-linear model is to be used together with the linear analysis to obtain the limit cycle behaviour of the linearly indicated unstable conditions. The model is formulated from the drift-flux conservation equations, and the equations are discretized by integration over each node of interest. Provisions are provided in the differencing scheme to allow the equations to be solved by either fully implicit, or fully explicit, or by Crank-Nicholson method.

This paper will discuss in detail the experimental results obtained in the low-pressure figure of eight loop, and the current status of the development of the non-linear stability code.

[1] F.B.P. Tran, W.J. Garland, "Modelling of Two Phase Instabilities Under Natural Circulation Conditions in a Figure of Eight Loop", 12th CNS Simulation Symposium on Reactor Dynamics and Plant Control, Hamilton, Ontario, 1986.