Experimental study of the two-phase natural circulation using visualization and ultrasonic techniques

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This work presents an experimental study on natural circulation [1], performed in the Natural Circulation Circuit (CCN) installed at the Experimental Thermo-Hydraulics Laboratory (LTE) of the Nuclear Engineering Institute (IEN/CNEN) (Fig. 1). This experimental circuit was designed based on the concepts of reduced scale and similarity. The behavior of the circuit is similar to the Passive Residual Heat Removal System of Advanced Pressurized Water Reactors (APWR). The circuit is composed of heater, heat exchanger and expansion tank, interconnected by pipes, representing hot and cold legs. One part of the hot leg is a boron-silicate glass tube where the flow can be visualized. Assuming that the reactor is operating in sub-critical state, the heater generates electric power which is similar to thermal power in the core, resulting from the decay of nuclear reactions. The heat exchange between primary and secondary fluid occurs in the heat exchanger. The expansion tank is installed on the cold leg. Data of flow and temperature are obtained by a data acquisition system. An ultrasonic technique was employed which comprises a pulse-technique for bubble velocity and size measurements as well as the Doppler technique for liquid flow and velocity measurements. An image acquisition system formed by a high-speed camera, software for image acquisition, personal computer and Ethernet network allowed for the identification of the flow patterns.

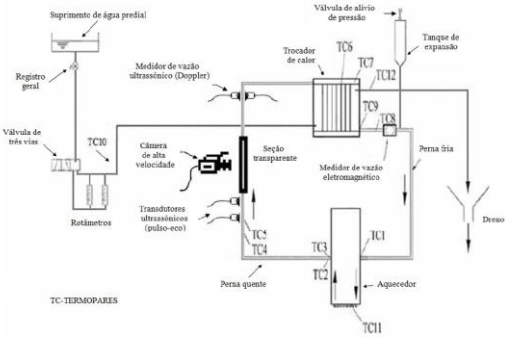

Figure 1. Schematic of the CCN.

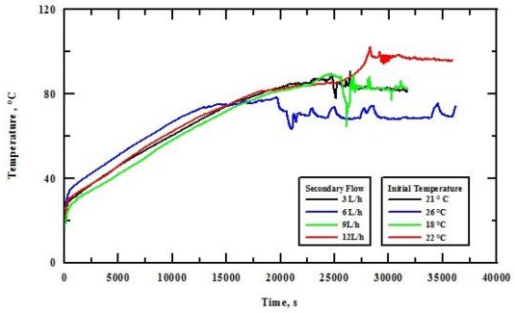

Figure 2. Example of hot leg temperatures evolution.

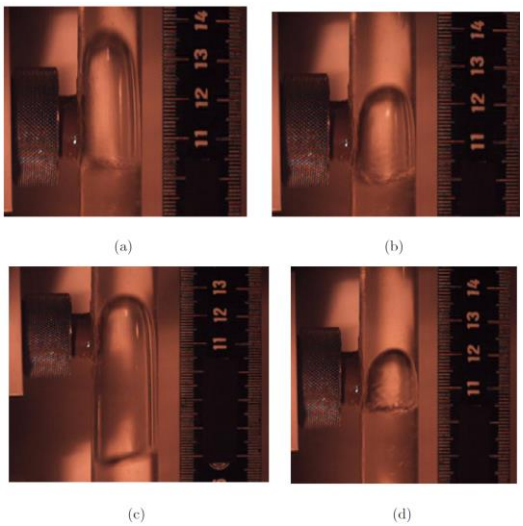

Figure 3. Bubble images as a function of time.

Figure 3: Two-phase flow regimes in natural circulation.

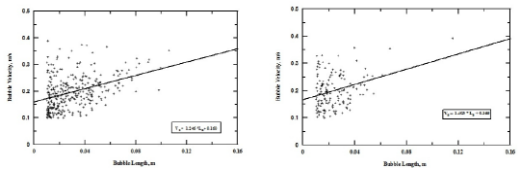

Figure 4. Correlation between bubble velocity and bubble length.

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Reference

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