

ABSTRAK

Penelitian ini bertujuan untuk menganalisis pengaruh debit air terhadap karakteristik aliran berlawanan arah (*counter-current flow/CCF*) pada geometri 1/30 hot leg dengan konfigurasi bukaan katup udara kiri. Penelitian dilakukan menggunakan simulator yang merepresentasikan sistem *Pressurized Water Reactor* (PWR) untuk mengamati fenomena *Counter-Current Flow Limitation* (CCFL) atau *onset flooding*. Variasi debit air yang digunakan yaitu 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, dan 32 gph, sedangkan debit udara dinaikkan secara bertahap hingga terjadi kondisi flooding. Parameter yang diamati meliputi permulaan flooding, *water level*, perbedaan tekanan, serta visualisasi struktur aliran menggunakan kamera dan sistem akuisisi data.

Hasil penelitian menunjukkan bahwa peningkatan debit air memperkuat interaksi antara fase cair dan fase gas sehingga fenomena flooding terjadi lebih cepat. Selain itu, peningkatan debit air menyebabkan kenaikan *water level* akibat bertambahnya akumulasi cairan di dalam sistem. Variasi debit air juga meningkatkan nilai perbedaan tekanan karena hambatan aliran dan interaksi dua fase yang semakin besar. Pengamatan visual memperlihatkan perubahan pola aliran dari *stratified flow* menjadi *wavy flow*, kemudian berkembang menjadi *onset flooding* hingga flooding penuh seiring meningkatnya interaksi antara udara dan air. Hasil penelitian ini diharapkan dapat memberikan pemahaman yang lebih baik mengenai karakteristik CCFL pada geometri *hot leg* serta menjadi referensi dalam pengembangan sistem keselamatan reaktor nuklir, khususnya untuk mitigasi risiko *Loss of Coolant Accident* (LOCA).

Kata kunci: Counter-Current Flow (CCF), Counter-Current Flow Limitation (CCFL), flooding, hot leg, debit air, aliran dua fase.

ABSTRACT

This study aims to investigate the effect of water flow rate on the characteristics of counter-current flow (CCF) in a 1/30 hot leg geometry using a left air valve opening configuration. The experiment was conducted using a simulator representing a Pressurized Water Reactor (PWR) system to observe the phenomenon of Counter-Current Flow Limitation (CCFL) or onset flooding. The water flow rates were varied at 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, and 32 gph, while the air flow rate was gradually increased until flooding occurred. The observed parameters included the onset of flooding, water level, pressure difference, and flow pattern visualization using a camera and a data acquisition system.

The results indicate that increasing the water flow rate intensifies the interaction between the liquid and gas phases, causing flooding to occur at an earlier stage. A higher water flow rate also increases the water level due to greater liquid accumulation within the system. In addition, the pressure difference increases with the water flow rate because of greater flow resistance and stronger two-phase interactions. Visual observations show that the flow pattern changes from stratified flow to wavy flow, followed by onset flooding, and finally develops into full flooding as the interaction between air and water becomes stronger. These findings provide a better understanding of CCFL characteristics in a hot leg geometry and may serve as a reference for improving the safety analysis of nuclear reactor systems, particularly in mitigating the risk of a Loss of Coolant Accident (LOCA).

Keywords: Counter-Current Flow (CCF), Counter-Current Flow Limitation (CCFL), flooding, hot leg, water flow rate, two-phase flow.