INTISARI

Sistem pendingin pasif berbasis aliran sirkulasi alami banyak diterapkan di bidang *thermal engineering*. Namun, aliran sirkulasi alami masih memiliki banyak kelemahan salah satunya adalah instabilitas aliran yang dapat menurunkan kinerja sistem pendingin pasif dan menjadi lebih sulit untuk dikendalikan. Tujuan dari penelitian ini adalah untuk menganalisis instabilitas aliran sirkulasi alami. Eksperimen dilakukan menggunakan untai FASSIP-03 NT dengan panjang total lintasan 21000 mm dan diameter nominal 1 inci. perbedaan ketinggian antara *heating tank section* dan *cooling tank section* sebesar 3050 mm. Air dipilih sebagai fluida kerja baik di dalam untai maupun di dalam *heating tank section* dan *cooling tank section*. Metode penelitian dilakukan dengan memvariasikan $\boldsymbol{T}_{\mathbf{HTS}}$ mulai dari 40°C hingga 75°C dengan kenaikan temperatur sebesar 5°C. Hasil eksperimen menunjukkan bahwa pada kondisi tunak, laju pemindahan kalor berada pada rentang 545,51 W hingga 1642,08 W, sementara nilai bilangan Reynolds berkisar antara 990,68 hingga 3917,2. Nilai bilangan Rayleigh sebesar 10^9 untuk semua variasi $\boldsymbol{T}_{\mathbf{HTS}}$. Analisis menggunakan metode Power Spectral Density (PSD) menunjukkan bahwa ketika $\boldsymbol{T}_{\mathbf{HTS}}$ dinaikkan, amplitudo sinyal debit aliran meningkat, namun frekuensinya menurun. Selain itu, hasil analisis menggunakan Discrete Wavelet Transform (DWT) menunjukkan bahwa energi wavelet didominasi pada level D6 (skala besar dan frekuensi rendah) dengan nilai energi wavelet paling tinggi yang artinya osilasi sinyal lebih seragam dan lebih minim *noise*. Dari hasil analisis dapat disimpulkan bahwa ketika nilai $\boldsymbol{T}_{\mathbf{HTS}}$ ditingkatkan, laju aliran meningkat dan instabilitas aliran semakin menurun.

Kata kunci: *discrete wavelet transform*, instabilitas aliran, *power spectral density*, sirkulasi alami.

ABSTRACT

Passive cooling systems based on natural circulation flow are widely applied in thermal engineering. However, natural circulation flow still has many disadvantages, one of which is flow instability, which can reduce the performance of passive cooling systems and make them more challenging to control. This study aims to analyze the instability of natural circulation flow. Experiments were conducted using the FASSIP-03 NT loop with a total loop length of 21000 mm and a nominal diameter of 1 inch. The height difference between the heating and cooling tank sections is 3050 mm. Water was selected as the working fluid inside the loop and the heating and cooling tank sections. The research method was carried out by varying the $\boldsymbol{T}_{\mathbf{HTS}}$ from 40°C to 75°C with a temperature increase of 5°C. The experimental results show that at steady state, the heat transfer rate ranges from 545.51 W to 1642.08 W, while the Reynolds number values range from 990.68 to 3917.2. The Rayleigh number value was 10^9 for all $\boldsymbol{T}_{\mathbf{HTS}}$ variations. Analysis using the Power Spectral Density (PSD) method showed that when the $\boldsymbol{T}_{\mathbf{HTS}}$ was increased, the amplitude of the volumetric flow rate signal increased, but the frequency decreased. In addition, the results of the analysis using Discrete Wavelet Transform (DWT) show that the wavelet energy is dominated at the D6 level (large scale and low frequency) with the highest wavelet energy value, which means that the signal oscillation is more uniform and less noise. From the analysis, it can be concluded that when the $\boldsymbol{T}_{\mathbf{HTS}}$ value is increased, the flow rate increases, and the flow instability decreases.

Keywords: discrete wavelet transform, flow instability, natural circulation, power spectral density.