INTISARI

Perkembangan teknologi energi yang efisien dan terbarukan meningkatkan urgensi penelitian untuk institusi akademik seperti Universitas Gadjah Mada dalam bidang energi alternatif, khususnya pada pemanfaatan *microchannel* untuk transportasi hidrogen yang lebih efisien dan efektif. Penelitian ini melakukan studi eksperimental dan numerik karakteristik aliran dua fase hidrogen dan akuades pada *microchannel* dengan perubahan luas penampang *sudden contraction*. Tujuan penelitian ini adalah menganalisis pola aliran, karakteristik aliran, serta penurunan tekanan akibat variasi kecepatan superfisial fluida dan perubahan geometri saluran, sekaligus memvalidasi hasil numerik dari hasil eksperimen menggunakan *software* ANSYS Fluent. Aliran fluida dialirkan pada *microchannel* berdimensi D_H = 0,8 mm pada bagian *upstream* dan D_H = 0,5 mm pada bagian *downstream*. Variasi kecepatan superfisial gas dilakukan pada rentang 0,67 – 6,67 m/s, sedangkan kecepatan superfisial cair pada rentang 0,1 – 1 m/s, untuk mengkaji pengaruh kecepatan superfisial fluida terhadap pola aliran, karakteristik aliran, dan *pressure drop*. Visualisasi pola aliran menggunakan *high-speed camera* mengidentifikasi empat pola aliran yaitu *bubbly flow, slug flow, slug-annular flow,* dan *annular flow*. Selain itu, analisis dengan metode *Power Spectral Density* (PSD) dilakukan dengan menggunakan sinyal listrik yang diperoleh dari *differential pressure transducer* (DPT) untuk mengklasifikasikan pola aliran secara lebih objektif ketimbang berdasarkan visualisasi *high-speed camera*. Hasil eksperimen dan simulasi menunjukkan bahwa peningkatan kecepatan superfisial fluida cenderung meningkatkan panjang dan kecepatan *slug*, serta memperbesar penurunan tekanan. Namun demikian, perubahan geometri *sudden contraction* berkontribusi paling besar terhadap *pressure drop* karena menyebabkan fenomena *spiking*. Temuan ini diharapkan dapat memberikan pemahaman yang lebih mendalam mengenai karakteristik aliran dua fase pada *microchannel* untuk aplikasi transportasi hidrogen atau *microfluidic device* lainnya.

Kata kunci : Aliran dua fase, *microchannel*, hidrogen, *sudden contraction*, pola aliran, *pressure drop*

ABSTRACT

The advancement of efficient and renewable energy technologies has increased the urgency of research in alternative energy, particularly within academic institutions such as Universitas Gadjah Mada. One area of interest is the utilization of microchannels for more efficient and effective hydrogen transport. This study presents an experimental and numerical study of two-phase flow characteristics of hydrogen and distilled water in a microchannel with sudden contraction. The objective of this research is to analyze flow patterns, flow characteristics, and pressure drop resulting from variations in fluid superficial velocities and channel geometry, as well as to numerical result from experimental results using ANSYS Fluent. Fluid flow was introduced into a microchannel with hydraulic diameters of D_H = 0,8 mm in the upstream section and D_H = 0,5 mm in the downstream section. Gas superficial velocity was varied within the range of 0,67 – 6,67 m/s while liquid superficial velocity was varied within the range of 0,1 – 1 m/s, in order to examine their effects towards flow patterns, flow characteristics, and pressure drop. Flow visualization using high-speed camera identified four flow regimes which are bubbly flow, slug flow, slug-annular flow, and annular flow. In addition, Power Spectral Density (PSD) analysis was performed using electrical signals obtained from Differential Pressure Transducer (DPT) to classify flow regimes more objectively compared to visual alone. Both experimental and simulation results agree that increasing fluid superficial velocity tends to increase slug length and slug velocity, as well as the overall pressure drop. However, the sudden contraction geometry contributes most significantly to the pressure drop due to the occurrence of pressure spiking. These findings are expected to provide deeper understanding into two-phase flow behavior in microchannels for hydrogen transport applications and/or other microfluidic devices.

Keywords : Two-phase flow, microchannel, hydrogen, sudden contraction, flow pattern, pressure drop