INTISARI

Pola aliran dua fasa *stratified* banyak dijumpai pada industri minyak bumi, pembangkit listrik tenaga panas bumi, industri proses kimia, dan reaktor nuklir. Pada sistem perpipaannya, pola aliran cenderung dijaga pada kondisi pola aliran *stratified,* karena mempunyai sistem keamanan yang baik. Salah satu masalah utama dalam aliran dua fasa adalah penentuan *liquid hold-up* dan penurunan tekanan.

Pada penelitian ini dilakukan pengamatan visual, pengukuran *liquid hold-up,* dan pengukuran perbedaan tekanan. Pipa uji berupa pipa *horizontal* menggunakan material *acrylic* transparan dengan diameter dalam 26 mm dan panjang 9 m. Material ini dipilih supaya pola aliran *stratified* dapat diamati secara visual menggunakan kamera video kecepatan tinggi. Air dan udara sebagai fluida kerja dicampur melalui *mixer* dengan jenis *simple T* dilengkapi dengan plat pemisah untuk mempercepat aliran *stratified* yang berkembang penuh. Seksi uji juga dilengkapi dengan *correction box* supaya tidak ada indeks bias. Pengukuran *liquid hold-up* dilakukan dengan sensor *Constant Electric Current Method* (CECM) dilanjutkan dengan dilakukan analisis data berupa berupa *Probability Distribution Function* (PDF) dan *Power Spectral Density* (PSD). PDF digunakan untuk mengetahui karakteristik distribusi *liquid hold-up* sedangkan PSD digunakan untuk menggambarkan sinyal dalam membaca frekuensi gelombang. Pengukuran beda tekanan pada seksi uji diukur dengan menggunakan *Validyne pressure transducer* dengan posisi *pressure tap* berjarak 170 D hingga 295 D dari mixer. Pengambilan data perbedaan tekanan dilakukan pada 500 Hz. Penelitian dilakukan pada tekanan atmosfir dan kondisi adiabatis dengan variabel pada penelitian ini meliputi kecepatan superfisial air (J_L) dari 0,02 m/s sampai 0,1 m/s dan kecepatan superfisial udara (J_G) dari 3,83 m/s sampai 16 m/s.

Hasil penelitian menunjukkan bahwa pola aliran yang berhasil diamati meliputi pola aliran *stratified smooth, stratified wavy 2D, stratified wavy 3D, stratified wavy roll, stratified wavy pseudo-slug,* transisi *annular,* dan *annular.* Pada J_G dan J_L rendah, pola aliran berupa *stratified smooth,* ditandai dengan tidak adanya fluktuasi gelombang pada penampakan visual, sinyal CECM, dan sinyal tekanan. *Stratified wavy 2D* ditunjukkan oleh kenaikan amplitudo dan fluktuasi *liquid hold*-up beserta gradien tekanan. Kenaikan J_G dan J_L membuat aliran menjadi *stratified wavy 3D* kemudian *stratified wavy roll* dan *stratified wavy pseudo-slug* dilanjutkan dengan aliran transisi *annular* dan *annular.* Ketika nilai J_G dan J_L meningkat maka amplitudo dan fluktuasi *liquid hold-up* akan mengalami kenaikan.

Kata kunci: Aliran air udara, pipa *horizontal,* aliran *stratified, liquid hold-up,* gradien tekanan

ABSTRACT

Stratified two-phase flow pattern was common in the petroleum industry, geothermal power plants, chemical process industries, and nuclear reactors. In piping systems, flow patterns tend to be maintained under stratified flow pattern conditions because this flow has a good safety system. One of the main problems in the two phase flow was the determination of liquid hold-up and pressure drop.

In this study, visual observation, liquid hold-up measurement, and pressure difference measurement were performed. Transparent acrylic horizontal pipe with internal diameter of 26 mm and length 9 m was used as test pipe. This material was chosen so that the stratified flow pattern could be observed visually using a high speed video camera. Water and air as working fluids were mixed through a simple T-type mixer equipped with separator plate to accelerate a fully developed stratified flow. Test section was also equipped with correction box so that there was no refractive index. Measurement of liquid hold-up used sensor of Constant Electric Current Method (CECM) then the data analyzed in the form of Probability Distribution Function (PDF) and Power Spectral Density (PSD). The PDF was used to find out the liquid hold-up distribution characteristics whereas the PSD was used to describe the signal in reading the frequency of the wave. The measurement of pressure difference in the test section was measured using Validyne pressure transducer with pressure tap and the position is 170 D up to 295 D from the mixer. The frequency to take the pressure difference was 500 Hz. The study was conducted at atmospheric pressure and adiabatic conditions with the variables in this study including the superficial velocity of water (J_L) from 0.02 m / s to 0.1 m / s and the superficial air velocity (J_G) from 3.83 m / s to 16 m / s.

The results showed that the observed flow patterns were stratified smooth, stratified wavy 2D, stratified wavy 3D, stratified wavy roll, stratified wavy pseudo-slug, annular transitions, and annular. In low J_G and J_L, stratified smooth flow patterns are indicated by the absence of wave fluctuations in visual sightings, CECM signals, and pressure signals. Stratified wavy 2D showed by the increase in amplitude and liquid hold-up fluctuations along with pressure gradient. The J_G and J_L increments made the flow to be stratified wavy 3D then stratified wavy roll and stratified wavy pseudo-slug subsequent annular and annular transition streams. As J_G and J_L values increased, the amplitude and liquid hold-up fluctuations would also increase.

***Keywords**: air-water two-phase flow, horizontal pipe, stratified flow, liquid hold-up, pressure drop*