ABSTRACT

Airlift pump is a simple method for lifting water and solid particles from the bottom of a reservoir by injecting the compressed air. This method is widely used in mining, fisheries, wastewater management, chemical industry, and irrigation field. Besides having advantages such as simple structure and manufacture and also without using lubricants, the airlift pump also has disadvantages such as low efficiency and unstable discharge flow rate. Research and development of the airlift pump has been carried out by researchers to improve its performance. In this study, the airlift pump was combined with an orifice type bubble generator (BG) to supply bubbles into the riser pipe and it was called the airlift pump-BG. The riser pipe, with 56 mm inner diameter and 2.55 m total length, was made of transparent acrylic for flow visualization. The lower and upper test sections were located at a distance of 120 cm and 170 cm, respectively, above the bubble generator. Water and atmospheric air were as the testing fluid, and sand was as solid particles. The height of the water column in the riser pipe, corresponds to the submergence ratio (SR), was changed from 0.50 to 0.74. The volumetric flow rate of water supplied to the bubble generator was kept constant at 7 m^3/h and the sucked atmospheric air was regulated from 0.03 to 3 m^3/h. Two bubble generator units were placed in the suction head with 45^o intake angle to form swirl flow. High speed camera and differential pressure methods were used to take video of the flow pattern and pressure in the riser pipe, respectively. The data was processed using image and signal processing techniques. The results show that the trend of the airlift pump performance operating in two and three phases was very similar, namely the higher the SR, the lower the critical point. At the same supplied air flow rate, the higher the SR, the greater the water and particle discharges in the separator. The developed model for the performance of the two-phase airlift pump-BG has the highest mean absolute percentage error (MAPE) of 11.97%, while the three-phase flow has the highest MAPE of 15.61%. The observed flow patterns are bubble flow patterns with sub-regimes were clustered bubble, homogeneous bubble and cap bubble, and slug flow patterns with sub regimes were bubbly-stable slug, bubbly-unstable slug, and slug-churn. The bubble flow pattern was indicated by the peak energy wavelet at a8 and the wavelet energy d4 approaches d5, while the slug flow pattern was characterized by the wavelet peak energy at d7 and/or d8. The mechanism for the movement of water and particles in the riser pipe was grouped into three steps, namely non-circulated, locally circulated, and fully transported depending on the amplitude of the pressure differential signal. The chaotic level increases with increasing SR and air flow rate. Flow pattern grouping with ANN input using energy wavelet provides a better approach than using input from statistical parameters of time domain.

Keywords: *Airlift pump-BG, image and signal processing, pump performance, and identification of flow structures.*