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A Neural Network based Framework to investigate Two-phase Flow in Plate Heat Exchangers

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Extended Abstract

Gas-liquid two-phase flow systems are frequently encountered in various industrial applications. Proton-Exchange-Membrane (PEM) electrolysis is a promising technology for hydrogen production, during which oxygen is produced at the anode. In the anode cooling circuit, gas-liquid two-phase flows influence both the pressure drop and heat transfer. The use of CFD to investigate these flows in a channel is computationally expensive, necessitating the development of a neural network capable of reducing the cost while maintaining sufficient prediction accuracy.

This study proposes a framework that leverages image-based analysis and neural networks to detect and predict gas-phase behavior. An experimental facility was built to generate gas-liquid flows inside a transparent plate heat exchanger channel. The mixture Reynolds number and homogeneous gas fraction were varied, and flow recordings were obtained for each configuration. First, raw images are acquired via a high-speed camera. A set of raw images representing potential gas objects was selected, and the contours of these gas objects were manually annotated to create a robust training dataset. Subsequently, a convolutional neural network (CNN) was developed and trained based on this annotated dataset. At this stage of the framework, the neural network can predict the gas contours for all the experimental configurations studied. A second CNN will then be developed to predict the gas-phase distribution by considering the history of the flow and the operational parameters, thus enabling a clearer understanding of flow patterns. Finally, 3D shape reconstruction is employed to facilitate comprehensive flow prediction. This approach underscores a viable strategy for advancing gas-liquid flow analysis and optimizing performance in relevant industrial processes.

Keywords: two-phase gas liquid flow analysis, Neural network, Image analysis