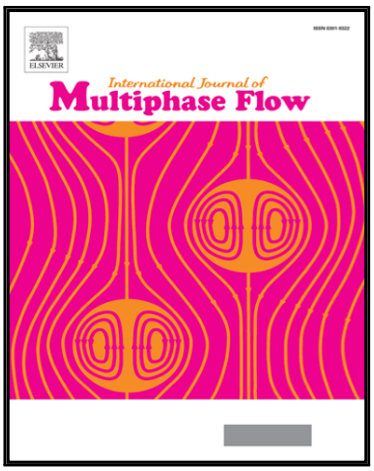

Using statistical learning to close two-fluid multiphase flow equations for bubbly flows in vertical channels

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Using statistical learning to close two-fluid multiphase flow equations for bubbly flows in vertical channels

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Abstract

Data generated by direct numerical simulations (DNS) of bubbly up-flow in a periodic vertical channel is used to generate closure relationships for a simplified two-fluid model for the average flow. Nearly spherical bubbles, initially placed in a fully developed parabolic flow, are driven relatively quickly to the walls, where they increase drag and slowly reduce the flow rate. Once the flow rate has been decreased enough, some of the bubbles move back into the channel interior and the void fraction there approaches the value needed to balance the weight of the mixture and the imposed pressure gradient. A database is generated by averaging the DNS results over planes parallel to the walls, and a Model Averaging Neural Network (MANN) is used to find the relationships between unknown closure terms in a simple model equations for the average flow and the resolved variables. The closure relations are then tested, by following the evolution of different initial conditions, and it is found that the model predictions are in reasonably good agreement with DNS results.

Keywords: Bubble dynamics; Gas/liquid flow; DNS; Two fluid models; Closure terms; Model averaging neural networks; Statistical learning;

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