HEAT TRANSFER ANALYSIS OF SLUG FLOW IN MICROCHANNELS WITH INTERFACE CAPTURING METHOD

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Demands for compact heat pumps are increasing; they are applied to cooling servers, storage batteries, hand-carry or wearable air-conditioners that are available for maintaining human health in times of disasters, etc. In order to downsize heat pumps, heat exchangers with microchannels need to be developed. Inner flows in microchannels of heat exchangers were mainly studied by experimental approaches. However, it is difficult to comprehend detail flow patterns in microchannels by experiments because of micro-scale flows. Flow patterns in microchannels were classified to slug flows; the flow patterns in microchannel are different from those in conventional macro-channels because surface-tension forces are dominant. In the case, heat transfers in thin liquid-films of slug flows are important for predicting overall heat transfer. Computational Fluid Dynamics is very useful to study the detail behaviour of the thin liquid-films.
In this study, gas-liquid flows in microchannels were simulated with OpenFOAM®. InterFoam solver with VOF method that is one of the interface-capturing methods was used to study the behaviour of the thin liquid-films. A simulated air-water slug flows were validated with experimental results[1][2]; the liquid-film thicknesses of slug flows agreed with measured ones. Furthermore, we used the simulated liquid-film thicknesses as an input parameters of an experimental correlations in the past study[2] for predicting heat transfer(water or R32 refrigerant were used as working fluids). As a result from validated heat transfer rates with our measurements and the past study[2], combined methods were more accurate than the original one.

References

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