Channel Structure Influence on the Thermal-Hydraulic Performance of Zigzag PCHE

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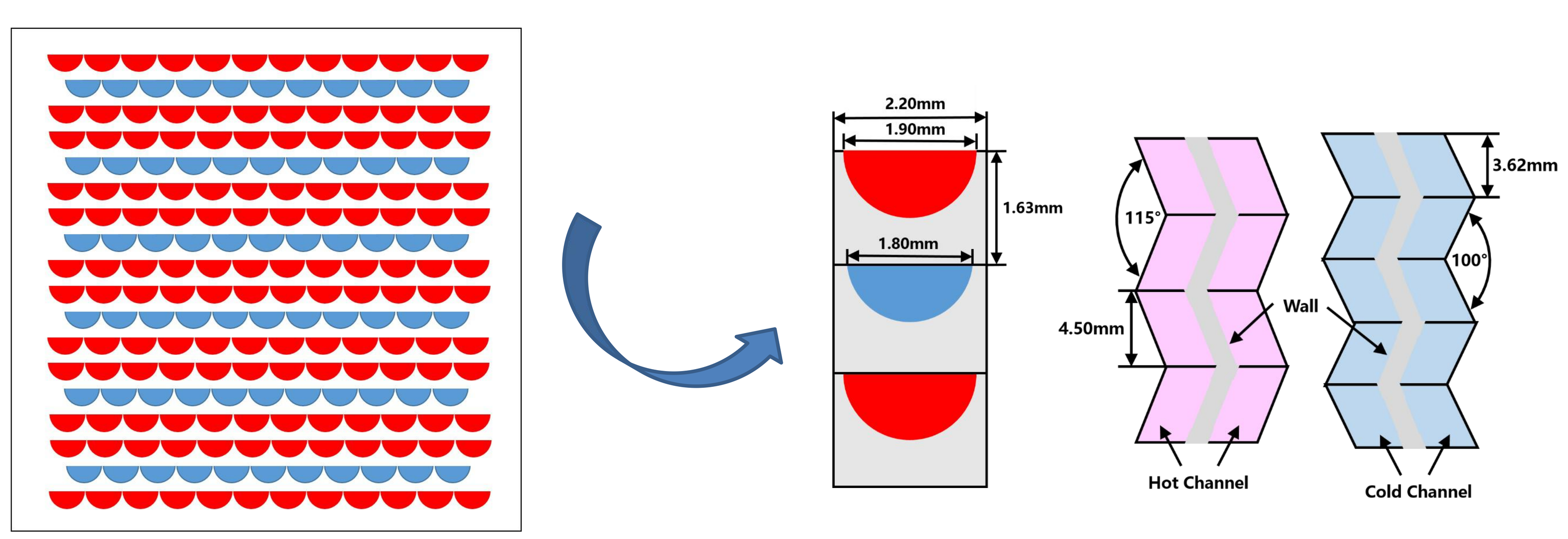
Introduction

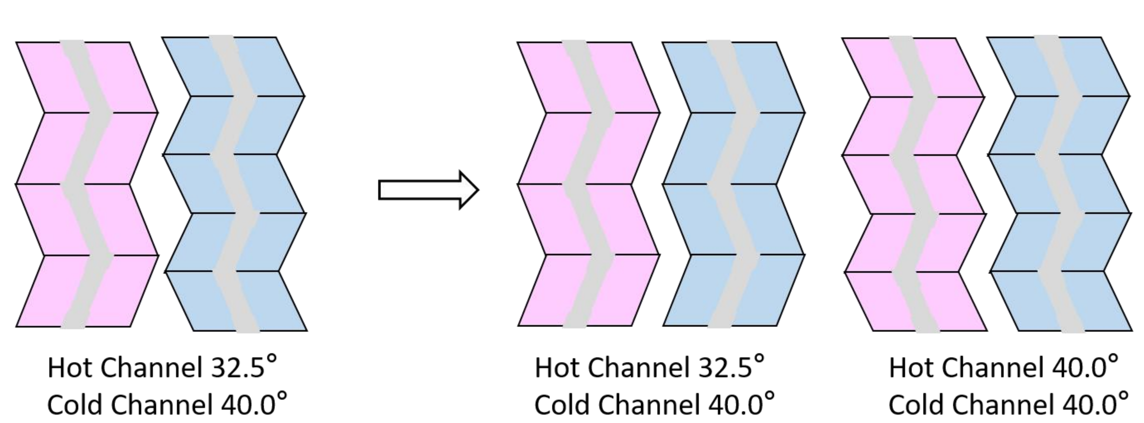
Printed Circuit Heat Exchanger (PCHE) is a very promising flat plate heat exchanger. Based on the PCHE model of Tokyo Institute of Technology, CFD method was used to measure the two fin angles which were 32.5° and 40.0° of the zigzag channels, the simulation shows a good agreement with the experiment results in local heat transfer, Nusselt number and friction factor.

The channel structure influence on the thermal-hydraulic performance of PCHE was studied, including 1.0-6.0mm channel width, 5°-60° fin angle, and six types of fin length, which were 27mm×2, 18mm×3, 9mm×6, 6mm×9, 3mm×18 and 2mm×27.

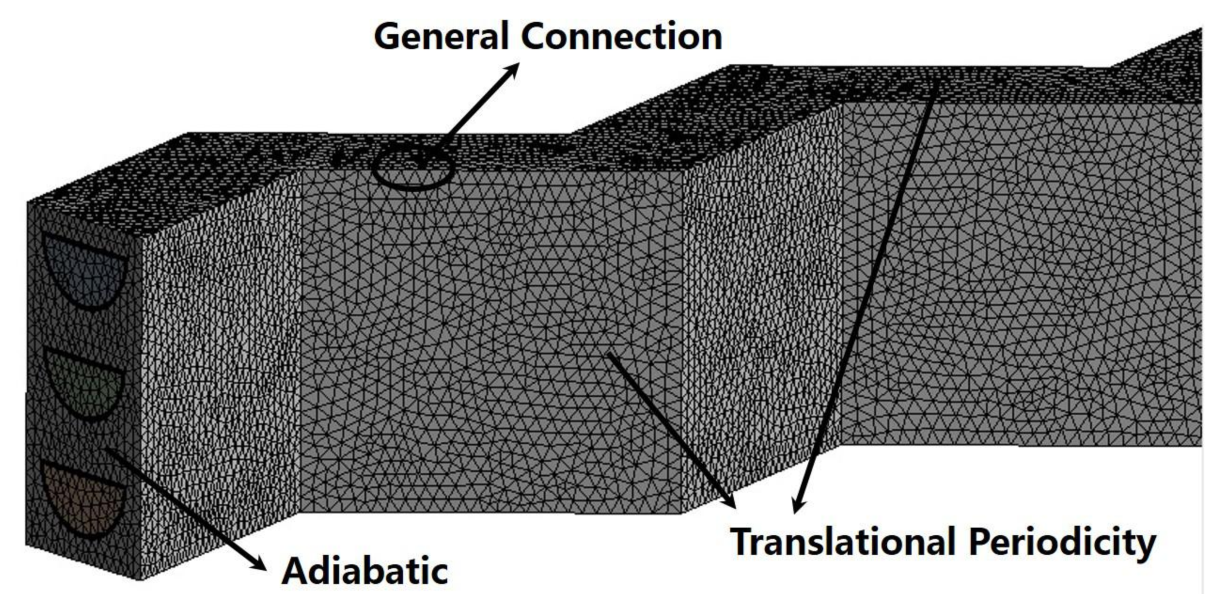
Model Establishment

The experiment model of TIT (Tokyo Institute of Technology) was used in this paper. The PCHE volume is 71×76×896mm3, including 144 hot channels and 66 cold channels. The diameter of the hot and cold channel is 1.90mm and 1.80mm, respectively.

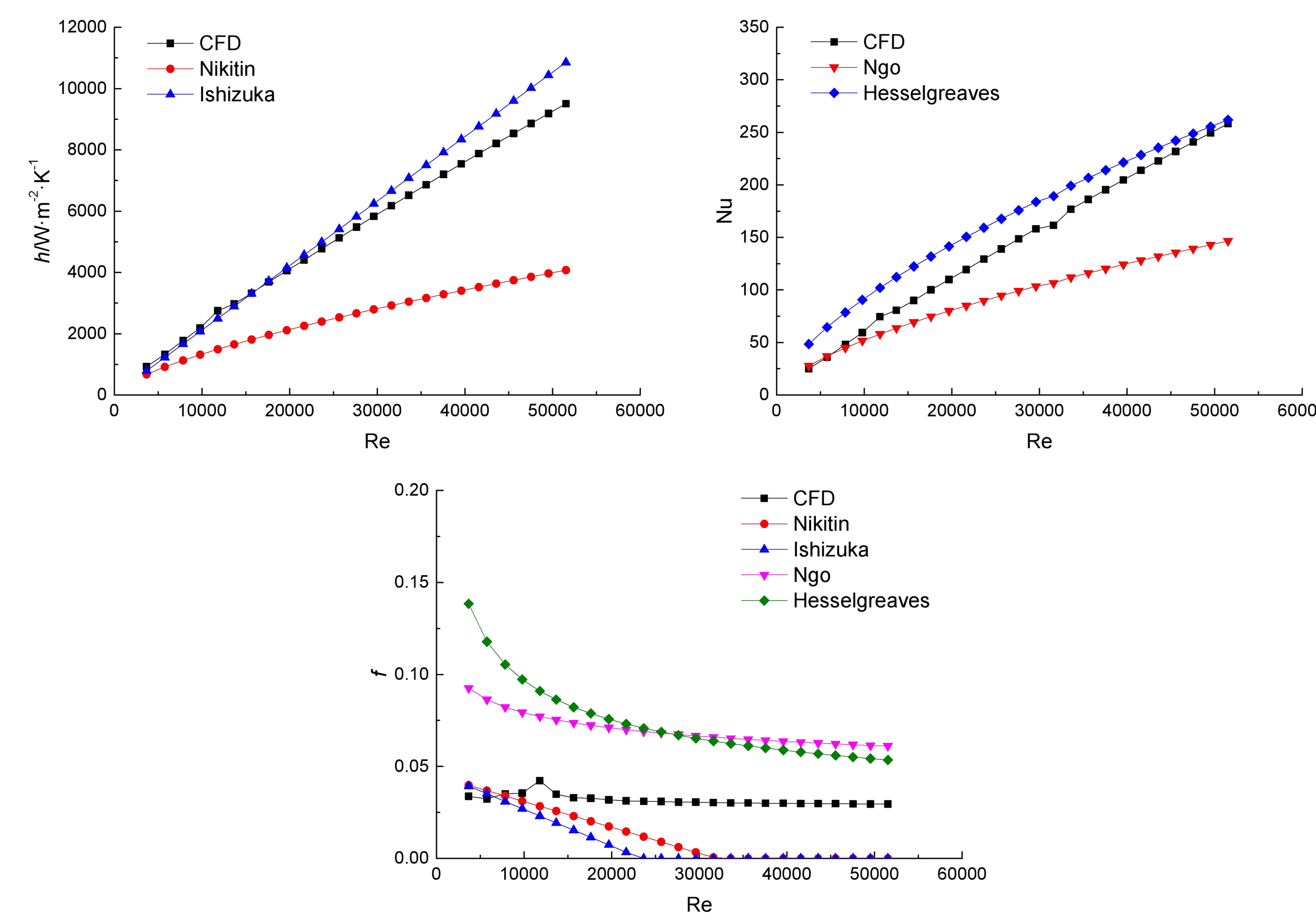




The top and bottom, left and right surfaces of PCHE are set as translational periodicity boundary condition and the front and rear surfaces are set as adiabatic boundary conditions. For the boundary layer between PCHE and SCO2 fluid, general connection was used. The first-order high-precision convergence mode was adopted and the convergence precision is 10-4.

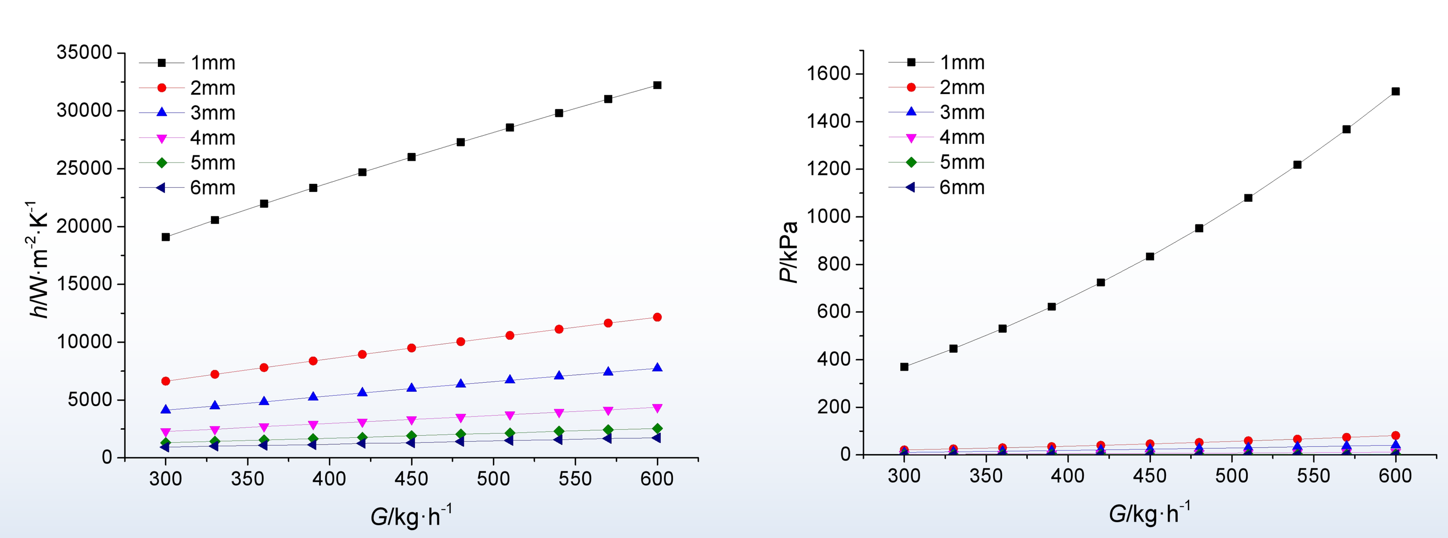


Comparison of Simulation and Experiments

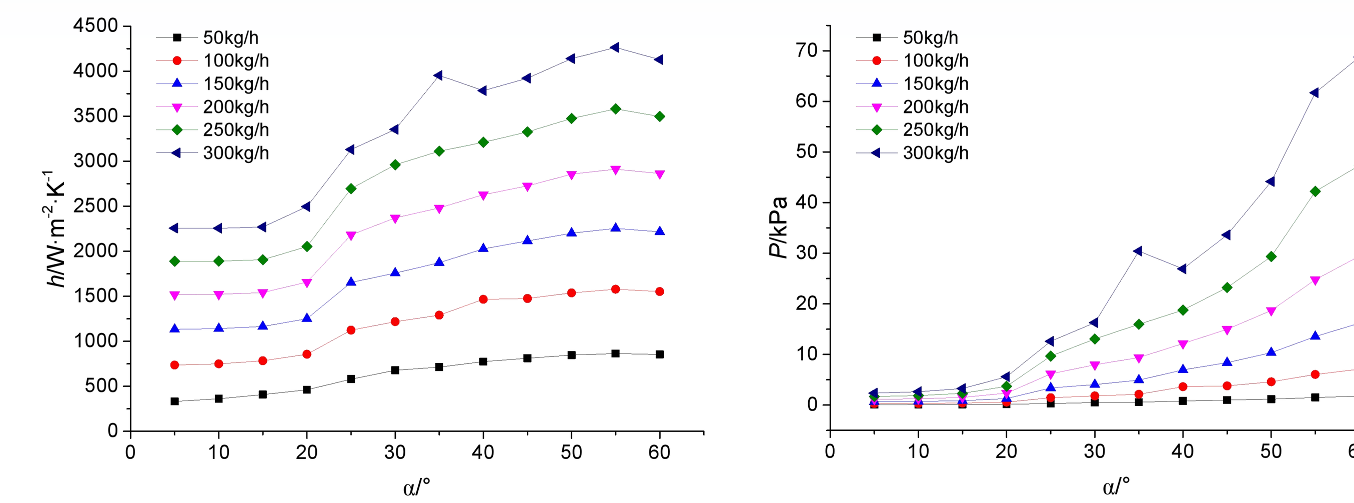


By comparing the CFD results with the experimental data, it is concluded that the relative deviation are acceptable. The accuracy of the CFD method in studying the thermal-hydraulic performance of the PCHE is proved.

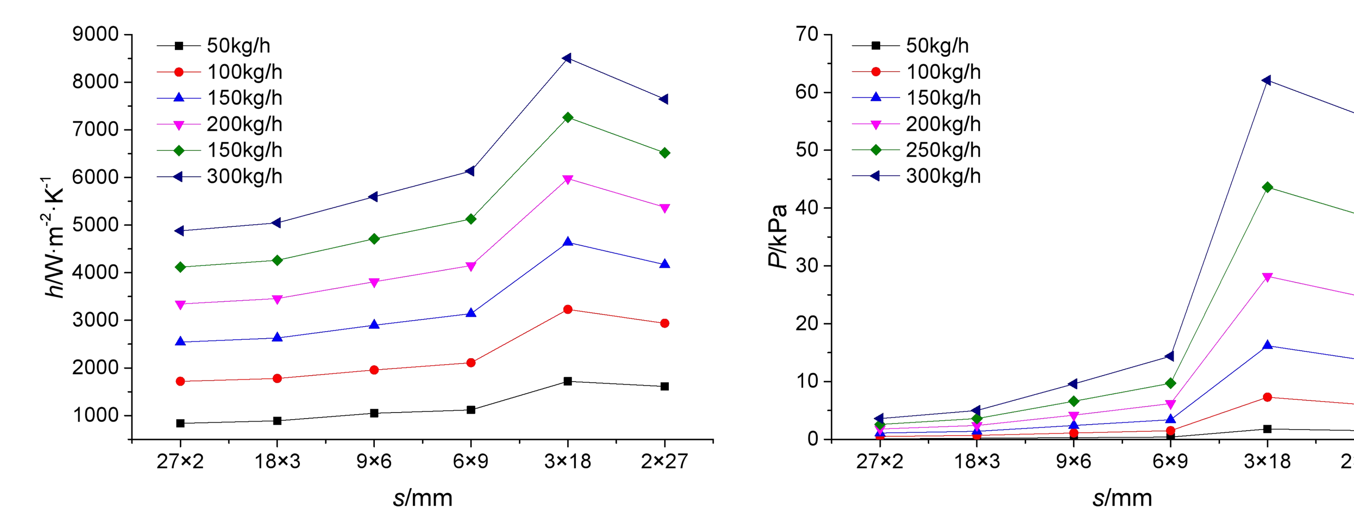
Channel Width Influence on PCHE Heat Transfer and Pressure Drop



Fin Angle Influence on PCHE Heat Transfer and Pressure Drop



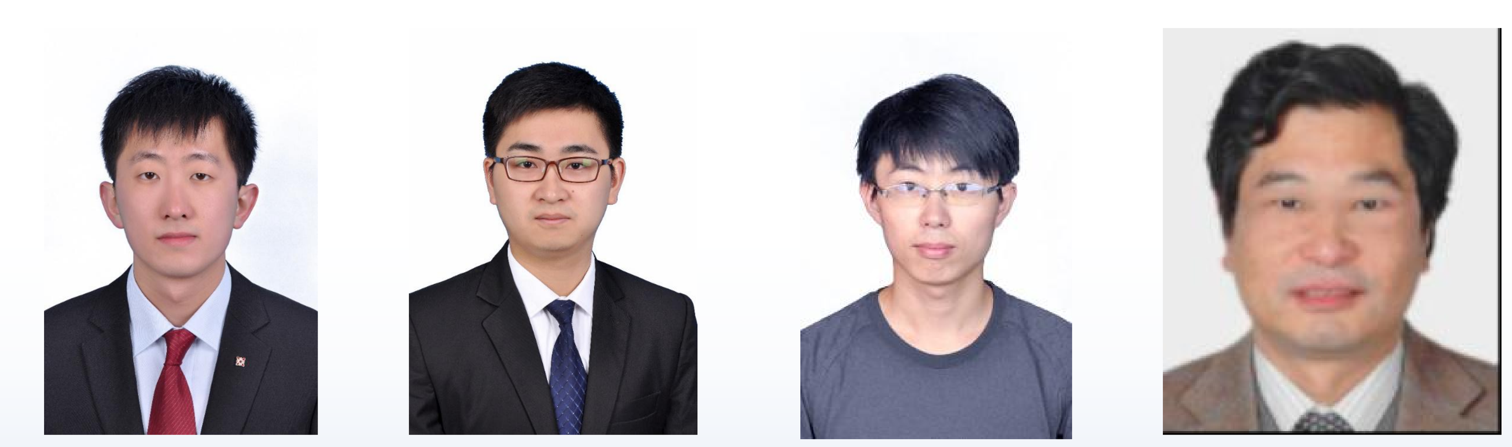
Fin Length Influence on PCHE Heat Transfer and Pressure Drop



Conclusions

- The increase of channel width decreases the heat transfer and the pressure drop simultaneously. Small channel width has the best heat transfer effectiveness and 1.0-2.0mm channel width is recommended.
- The increase of fin angle increases the heat transfer and the pressure drop simultaneously. The 20°-45° fin angle is favorable for it combines the good heat transfer effectiveness and small pressure drop.
- The heat transfer and pressure drop increases with the decrease of fin length to a certain value, and then the trend becomes opposite. 3mm is recommended for its optimal heat transfer performance and limited pressure drop.

Authors



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