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Enhancement of Cooling Performance of Block Heat Source Module in a Rectangular Channel by Installing Baffle onto Channel Wall

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Summary

A lot of researchers have dealt with the heat transfer enhancement of block heat sources mounted on the channel walls by using baffle. On the other hand, the heat generating components are allocated inside the channel or cabinet in many engineering applications. This study aims firstly to investigate the characteristics of conjugate heat transfer of conduction-forced convection in a rectangular channel containing a block heat source module. The module is comprised of a board and five block heat sources mounted discretely on the up surface of the board. Furthermore, efforts are carried out to explore the enhancement of cooling performance of the module by installing a baffle onto the channel walls.

The governing equations and interface matching conditions describing the heat transfer from a block heat source module to the steady laminar forced air stream in the rectangular channel are solved by a numerical scheme derived from the SIMPLER algorithm. The numerical computation has been carefully validated. Moreover, the results for the limiting case with block heat sources mounted on the channel walls are compared to the relevant literatures. Excellent agreement is found between the present predictions and the results of previous articles.

In this study the influences of module position, baffle height and baffle position on the flow structure, temperature distribution and heat transfer behaviors are examined rigorously for the system at various Reynolds number. Results show that the spacing between the module and channel walls can affect significantly the heat transfer characteristics of block heat sources. Comparing the results for cases with and without the installation of baffle, the maximum enhancement of the average Nusselt numbers of blocks is about 84.66%. The reduction in hot temperature of blocks by the baffle can be up to 49.46%. To attain the minimum hot spot temperature, the optimum installing position of baffle should be moved toward upstream when the baffle height is increased. In addition, the enhancement of heat transfer characteristics by the baffle is more effective for the case with larger Reynolds number.