Numerical Investigation of Jet Impingement on a Semi-cylindrical Concave Surface Covered by Porous Material

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ABSTRACT

Impingement heat transfer has been widely applied in industries. Examples are laser cooling, electronics cooling, annealing of metals or glass, and cooling of gas turbine blades. Combination of impingement with other techniques has also been attempted. The objective of the present study is to combine jet impingement technique with the use of porous material to enhance heat transfer for possible application to the leading edge cooling of gas turbine blades. In this study, impingement of a circular jet onto a semi-cylindrical concave surface with or without coverage of porous material is investigated numerically. When the surface is covered with porous material, a trapping hole for jet fluid is provided. Varying parameters include Reynolds number, nozzle-to-plate distance, and relative curvature. Results show that heat transfer performance becomes better for higher Reynolds number. When the nozzle-to-plate distance decreases, the stagnation zone Nusselt number increases. On the other hand, when that distance increases, the Nusselt number in the far field becomes better. The phenomenon is more obvious for higher Reynolds number. From the study of relative curvature effect, it is suggested that the nozzle diameter be larger than the trapping hole diameter for better heat transfer performance. The use of jet diameter smaller than that of the trapping hole will result in a remarkable decrease in Nusselt number.

Keywords : semi-cylindrical concave surface、impingement heat transfer、trapping hole、porous material、numerical modeling

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