（様式６号）「課程博士用」

学 位 論 文 の 要 旨

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学位論文題目

Heat Transfer Mechanism and Thermal Performance of a Channel with Baffles having Open Wings

（和訳　開口翼のある障壁を持つ流路の熱伝達機構と伝熱特性　）

For more than a century, heat exchangers have been widely used in cooling/heating systems in many commercial applications such as solar air heating, refrigeration, gas turbines, vehicle manufacturing, chemical engineering, and power plant industries. The major challenge in producing a heat exchanger is to intensify its heat transfer rate with a minimum friction loss penalty. Several heat transfer augmentation techniques have been applied and developed. One of the most widely used techniques is employing transverse baffles/ribs to alter flow structures by generating a recirculation and reattachment. The former separates the fluid from heat transfer surfaces while the latter facilitates the contact between fluid and heat transfer surfaces and thus the heat transfer rate. The thesis seeks ways to minimize the recirculation and intensify the flow reattachment by forming wings on the baffles.

In the first part of this thesis, heat transfer augmentation of newly designed perforated V-type baffles with semi-circular wings (SCW-PVBs) was examined. For a better understanding of the reasons behind the heat transfer by the baffles, a numerical analysis of the heat transfer mechanism and flow topology of channels was carried out. The effects of geometric parameters: pitch ratios (PR = 0.5, 1.0, 1.5 and 2.0), blockage ratios (BR = 0.1, 0.15 and 0.2), wing attack angles ($\theta = 5^o$, 10^o and 15^o) on heat transfer of air flow were studied in the turbulent region. The results of the channel installed with SCW-PVBs were compared with those of a smooth channel and the one with solid V-type baffles (VBs). The numerical results showed that the application of the SCW-PVBs having smaller pitch ratios and larger blockage ratios resulted in better heat transfer enhancement and higher pressure drop. The maximum heat transfer enhancement of 5.57 times over the smooth channel was found at a pitch ratio of 0.5, a blockage ratio of 0.2, wing attack angle of 10^o. In addition, SCW-PVBs gave higher heat transfer and thermal performance factors (TPF) and lower pressure losses than VBs by around 1.73-8.98%, 5.41-26.84% and 4.51-15.22%, respectively depending on Reynolds number, blockage ratio, pitch ratio and wing attack angle. The maximum TPF of 2.6 was achieved by the SCW-PVBs having a blockage ratio of 0.1, a pitch ratio of 0.5 and wing attack angle of 10^o.

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The second part of the thesis aimed to experimentally investigate heat transfer enhancement in the channels installed with (1) perforated transverse baffles with square wings (SW-PBs) and (2) perforated V-type baffles with semi-oval/square/delta wings (SOW-PVBs/SW-PVBs/DW-PVBs). The effects of wing attack angles (θ = 0° (solid baffles), 22.5°, 45°, 67.5°, and 90°) and Reynolds numbers on the heat transfer performance characteristics were examined. All channels had an aspect ratio (*W:H*) of 3.75:1. All baffles had a width (*w*) of 150 mm and a perforated cross-sectional area of 64 mm^2. During experiments, the lower walls of the channels were evenly heated, while the other walls were insulated. The temperature contours on the heated surface were acquired via a thermochromic liquid crystal (TLC) image-processing method. At the proper attack angles (θ = 22.5° and 45°), the modified baffles offered greater heat transfer rates and caused lower friction losses, resulting in higher TPFs than the solid baffles. In the current thesis, the greatest TPF was found at θ of 45°. The Nusselt number contours indicated that the modified baffles introduced multiple impinging jets which suppressed the size of the recirculation flow and allowed better contact between the fluid flow and the channel walls as compared to the solid ones. The jets impinged on the wall in different ways depending on the shapes of the wings and attack angles. Experimental results also suggested that the SW-PVBs gave TPF over those of the other modified baffles (SW-TBs/DW-PVBs/SOW-PVBs), owing to the higher heat transfer rate and lower pressure losses. The findings in this thesis are applicable to improving solar air heaters also other thermal systems.