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NUMERICAL STUDY OF IMPINGING COOLING OF A POROUS BLOCK UNDER A STRAIGHTENING OR NON-STRAIGHTENING JET FLOW

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This work numerically investigated the thermal characteristics of the aluminum-foam block under the confined impinging air jet flow with straightening (model A) or non-straightening (model B) jet flow models. The dimensions of the aluminum-foam block were 60 mm in length (L) and 60 mm in width (W). Two kinds of aluminum foams with different porosities (ε)/pore densities (PPI) were applied: ε = 0.93/20 PPI and ε = 0.97/5 PPI. Two computational domains were employed to build the jet flow models: (1) model A (excluding the jet-nozzle region) whose jet velocity profile was uniform; and (2) mode B (including a sufficiently long jet-nozzle region) whose velocity profile was uniform at the inlet of the jet nozzle and changed at the exit of the jet nozzle via numerical results. For model B jet flow, a quasi-parabolic velocity profile would be formed at the nozzle exit when the w_j/L *was small enough; however, a saddle-shape velocity profile gradually appeared when the* w_j/L *increased. Relevant parameters were the jet Reynolds number (*$Re = 250 \sim 1000$*), the relative jet nozzle width (*$w_j/L = 0.125 \sim 1$*), the relative impinging distances (*$C/L = 0 \sim 0.5$*), and the relative porous block heights (*$H/L = 0.125 \sim 1$*). Generally, a quasi-parabolic velocity profile will have a bigger momentum to make more fluid to penetrate the porous block and reach near the heated wall, promoting the total heat transfer. On the contrary, the saddle-shape velocity profile leads much more fluid to bypass the porous block, reducing the total heat transfer. The results indicate that the present results agreed with those of others studies reasonably. At* $C/L = 0$*, the 0.93-porosity Al-foam block generally had a bigger* $\overline{Nu}$ *than the 0.97-porosity one; but the contrary result was found at* $C/L = 0.5$*. Besides, increasing* C/L *and* w_j/L *would decrease the* $\overline{Nu}$*. The* $\overline{Nu}$ *sharply fell first and then changed smoothly as increasing* w_j/L*. Moreover, model A was generally better than model B in heat transfer, particularly for those cases with bigger* w_j/L*. However, at* $C/L = 0.5$ *and small-*w_j/L *condition, the* $\overline{Nu}$ *of model B was higher than that of model A. Furthermore, the* $\overline{Nu}$ *generally declined with increasing the* H/L*, but might first raise and then drop when increasing the* H/L *when the* C/L *or* w_j/L *is bigger. Finally, the correlations of* $(H/L)_{OPT}$ *having the maximum* $\overline{Nu}$ *and the corresponding parametric ranges were provided.*

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