Documents

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Analysis of fluid dynamics and heat transfer in a rectangular duct with staggered baffles

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Abstract

This computational fluid dynamic analysis attempts to simulate the incompressible steady fluid flow and heat transfer in a solar air channel with wall-mounted baffles. Two 'S'-shaped baffles, having different orientations, i.e., 'S'-upstream and 'S'-downstream, were inserted into the channel and fixed to the top and bottom walls of the channel in a periodically staggered manner to develop vortices to improve the mixing and consequently the heat transfer. The analyses are conducted with the Commercial CFD software FLUENT using the finite volume method for Reynolds number varying from 12,000 to 32,000. The numerical results are presented in terms of streamlines, velocity-magnitude, x-velocity, y-velocity, dynamic pressure coefficient, turbulent kinetic energy, turbulent viscosity, turbulent intensity, temperature field, coefficient and factor of normalized skin friction, local and average numbers of normalized Nusselt, and thermal performance factor. The insertion of the S-shaped baffles in the channel not only causes a much high friction loss, f/f0 = 3.319 - 32.336, but also provides a considerable augmentation in the thermal transfer rate in the channel, Nu/Nu0 = 1.939 - 4.582, depending on the S-baffle orientations and the Reynolds number. The S-upstream baffle provides higher friction loss and heat transfer rate than the S-Downstream around 56.443 %, 55.700 %, 54.972 %, 54.289 % and 53.660 %; and 25.011 %, 23.455 %, 21.977 %, 20.626 %, and 19.414 % for Re = 12,000, 17,000, 22,000, 27,000, and 32,000, respectively. In addition, the result analysis shows that the optimum thermal performance factor is around 1.513 at the highest Reynolds number and S-downstream. © 2019 by the authors.

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