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Modeling and analysis of solar air channels with attachments of different shapes

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Abstract

Purpose: This paper aims to report the results of numerical analysis of turbulent fluid flow and forced-convection heat transfer in solar air channels with baffle-type attachments of various shapes. The effect of reconfiguring baffle geometry on the local and average heat transfer coefficients and pressure drop measurements in the whole domain investigated at constant surface temperature condition along the top and bottom channels' walls is studied by comparing 15 forms of the baffle, which are simple (flat rectangular), triangular, trapezoidal, cascaded rectangular-triangular, diamond, arc, corrugated, +, S, V, double V (or W), Z, T, G and epsilon (or e)-shaped, with the Reynolds number changing from 12,000 to 32,000. Design/methodology/approach: The baffled channel flow model is controlled by the Reynolds-averaged Navier–Stokes equations, besides the k-epsilon (or k-e) turbulence model and the energy equation. The finite volume method, by means of commercial computational fluid dynamics software FLUENT is used in this research work. Findings: Over the range investigated, the Z-shaped baffle gives a higher thermal enhancement factor than with simple, triangular, trapezoidal, cascaded rectangular-triangular, diamond, arc, corrugated, +, S, V, W, T, G and e-shaped baffles by about 3.569-20.809; 3.696-20.127; 3.916-20.498; 1.834-12.154; 1.758-12.107; 7.272-23.333; 6.509-22.965; 8.917-26.463; 8.257-23.759; 5.513-18.960; 8.331-27.016; 7.520-26.592; 6.452-24.324; and 0.637-17.139 per cent, respectively. Thus, the baffle of Z-geometry is considered as the best modern model of obstacles to significantly improve the dynamic and thermal performance of the turbulent airflow within the solar channel. Originality/value: This analysis reports an interesting strategy to enhance thermal transfer in solar air channels by use of attachments with various shapes © 2018, Emerald Publishing Limited.

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