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Effect of wall-mounted V-baffle position in a turbulent flow through a channel: Analysis of best configuration for optimal heat transfer

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Abstract

Purpose: The purpose of this paper is to carry out a numerical study on the dynamic and thermal behavior of a fluid with a constant property and flowing turbulently through a two-dimensional horizontal rectangular channel. The upper surface was put in a constant temperature condition, while the lower one was thermally insulated. Two transverse, solid-type obstacles, having different shapes, i.e. flat rectangular and V-shaped, were inserted into the channel and fixed to the top and bottom walls of the channel, in a periodically staggered manner to force vortices to improve the mixing, and consequently the heat transfer. The flat rectangular obstacle was put in the first position and was placed on the hot top wall of the channel. However, the second V-shaped obstacle was placed on the insulated bottom wall, at an attack angle of 45°; its position was varied to find the optimum configuration for optimal heat transfer. Design/methodology/approach: The fluid is considered Newtonian, incompressible with constant properties. The Reynolds averaged Navier–Stokes equations, along with the standard k-epsilon turbulence model and the energy equation, are used to control the channel flow model. The finite volume method is used to integrate all the equations in two-dimensions; the commercial CFD software FLUENT along with the SIMPLE-algorithm is used for pressure-velocity coupling. Various values of the Reynolds number and obstacle spacing were selected to perform the numerical runs, using air as the working medium. Findings: The channel containing the flat fin and the 45° V-shaped baffle with a large Reynolds number gave higher heat transfer and friction loss than the one with a smaller Reynolds number. Also, short separation distances between obstacles provided higher values of the ratios Nu/Nu0 and f/f0 and a larger thermal enhancement factor (TEF) than do larger distances. Originality/value: This is an original work, as it uses a novel method for the improvement of heat transfer in completely new flow geometry. © 2018, Emerald Publishing Limited.

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