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Innovative Approach for Cooling Using Water and Nanofluids in Channels

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Abstract

Experimental and numerical analysis of heat transfer enhancement in porous and clear channels received a lot of attention lately. Researchers focussed on conducting heat and fluid flow in porous channels having different type of permeability at a constant porosity of 0.9. Such approach proved to be effective in heat removal but at the expenses of large pressure drop. Different flow rates demonstrated that as the Reynolds number increase the heat removal increase respectively. Water being the fluid used in some analysis have been replaced with nanofluid and hybrid nanofluid since this new type of fluid has higher thermal conductivity. In one hand it enhances further the heat removal by a 5% to 7% but at the expenses of large pressure drop. Another issue with such nanofluid is sedimentation at the bottom of the channel. Regardless the fluid to be used, it was found that the thermal and velocity boundary layers reduce further the heat rate removal. In order to overcome this problem different twisted tape shape was introduced. The objective of this tape is in one hand to create mixing even at the laminar regime but also destroy the formation of the boundary layer. Location of the twisted tape is found to be important to achieve higher heat enhancement.

Heat enhancement and hear removal remains an important topic in engineering. Furthermore, flow in laminar regime can reduce the cost of cooling. In the present study, flow in mini channels in a rectangular cavity is investigated with water as circulating fluid. The height of the channels in the cavity is varied and free flow above the channels with flow through the channel has been investigated. It is shown that a combination of these two flows can provide the optimum heat removal at a Reynolds number of 750. This finding is valid if one ignores the friction effect to the wall. If the pressure drop is taken into consideration then the performance evaluation criterion shows that the mini-channel with aspect ratio (AR) equal to 12 is the best configuration. Different correlations have been obtained between the Nusselt number, pressure drop, friction factor, performance evaluation criterion and the Reynolds number and the channels height.