Innovative approach for cooling using water and nanofluids in mini 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.

Biography

Prof M. Ziad Saghir is a Professor at Ryerson University and Canada's most experienced reduced-gravity researcher. He is Canada's top performer at leveraging departmental and provincial research funds with national (NSERC, CSA) and international funding agencies to pursue Canadian space science objectives onboard the International Space Station (ISS). His talent as a space scientist and university educator is consistently requested by the international space physical science mission community. He leads a group of very strong graduate students and post-docs that come from academia and industry, with interest in and application to deep hydrocarbon reservoirs. His innovation is recognized internationally through consistent invitations from European researchers that identify him as applying the maximum knowledge gained from long-duration gravity-driven phenomena in fluid physics to industrial processes. He has been PI or Co-I of Foton-M2 and M3 SCCO recoverable satellite missions (2007), the ISS SODI-IVIDIL (2009) and DSC (2010) missions, the ISS SODI-DCMIX mission (2011-15), and was the national coordinator of the CSA discipline working group on the role of gravity in metals and alloys. Canada's contribution to the SODI-DCMIX mission is to clarify the role of gravity on the movement of hydrocarbons across temperature gradients-important knowledge for Canada's deep oil reservoir sector (Hybernia Oil field and Northern exploration of oil reservoir deposits). Over the past decade, Prof. Saghir has been working in collaboration with TOTAL and researchers in France to apply innovation to benefit Canada's competitiveness in hydrocarbon extraction from oil reservoirs, a top priority of the Federal Government. He has published over 200 scientific journal paper related to energy. He is currently the chair of the International conference on Thermal Engineering (www.ictea.ca).