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Combined Effect of Roughness and Suction on Heat Transfer in a Laminar Channel Flow

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Abstract : Owing to wide range of the micro-device applications, the problems of mixing at small scales is of significant interest. Also, because most of the processes produce heat, it is needed to develop and implement strategies for heat removal in these devices. There are many studies which focus on the effect of roughness or suction on heat transfer performance, separately, although it would be useful to take advantage of these two methods to improve heat transfer performance. Unfortunately, there is a gap in this area. The present numerical study is carried to investigate the combined effects of roughness and wall suction on heat transfer performance of a laminar channel flow; suction is applied on the top and back faces of the roughness element, respectively. The study is carried out for different Reynolds numbers, different suction rates, and various locations of suction area on the roughness. The flow is assumed two dimensional, incompressible, laminar, and steady state. The governing Navier-Stokes equations are solved using ANSYS-Fluent 18.2 software. The present results are tested against previous theoretical results. The results show that by adding suction, the local Nusselt number is enhanced in the channel. In addition, it is shown that by applying suction on the bottom section of the roughness back face, one can reduce the thickness of thermal boundary layer, which leads to an increase in local Nusselt number. This indicates that suction is an effective means for improving the heat transfer rate (suction by controls the thickness of thermal boundary layer). It is also shown that the size and intensity of vortical motion behind the roughness element, decreased with an increasing suction rate, which leads to higher local Nusselt number. So, it can be concluded that by using suction, strategically located on the roughness element, one can control both the recirculation region and the heat transfer rate. Further results will be presented at the conference for coefficient of drag and the effect of adding more roughness elements.

Keywords : heat transfer, laminar flow, numerical simulation, roughness, suction
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