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Numerical Study of Fluid Flow and Heat Transfer in Microchannel with Thin Obstacles

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Abstract : Due to the miniaturisation process, in many technical devices, microchannels are used in cooling systems. Because of the small size of microchannels, the flow inside is laminar, which caused a slow heat exchange. In order to intensify the heat exchange, the flow must be disturbed, for example, by introducing obstacles. We present results on the influence of a thin obstacle, placed on microchannel wall, on the fluid and heat flow in the aspect of their use by constructors of heat exchangers. The obstacle is called 'thin' when its geometrical parameter (o=w/h, w- width, h - height of the obstacle) satisfies inequality: o < 0.5. In this work, we report numerical results on heat and mass transfer in the microchannels of 400 micrometer height (H - height of the microchannel), where thin obstacles are immersed on the walls, to disturb the flow. The Reynolds number of the flow in microchannel varies between 20 and 200 and is typical for the flow in micro heat exchangers. The equations describing the fluid and heat flows in microchannels were solved numerically by using the finite element method with an application of CFD&FSI package of ADINA R&D, Inc. 9.4 solver. In the case of flows in the microchannels with sequences of thin rectangular obstacles placed on the bottom and the top wall of a microchannel, the influence of distances s (s is the distance between two thin obstacles) and heights of obstacles on the fluid and heat transfer was investigated. Thermal and flow conditions of the application area of microchannels in electronic cooling systems, i.e., wall temperature of 60 °C, the fluid temperature of 20°C were used to solve equations. Additionally, the distance s between the thin obstacles in microchannels as a multiple of the amount of the channel height was determined. Results show that placing thin obstacles on microchannel walls increase the length of recirculation zones of the flow and improves the heat transfer.

Keywords : Finite Element Method, heat transfer, mechanical engineering, microchannel
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