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ENERGY BALANCE IN A MICROFLUIDIC HOTSPOT COOLING DEVICE

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Abstract.

Within the electronics industry and its increasing compactness, typical of 3D integrated circuits, it is becoming mandatory to cool hot spots with high concentrated heat fluxes. Microfluidic systems, characterized by the reduction in hydraulic diameter and augmentation of surface area in relation to volume, present favorable prospects for incorporating thermal designs owing to their remarkable heat dissipation efficiency. Many computational studies on microfluidic hotspot cooling devices often rely on simplified assumptions and conventions that fail to capture the full complexity of the problem. In this study, we employ the finite volume method utilizing OpenFOAM software to investigate both transient and steady-state regimes. Various Reynolds numbers for the coolant and input powers for the hotspot are considered in our simulations. Our objective is to assess the significance of incorporating certain factors in our physical model, including fluid compressibility, radiation and convection effects on the external walls of the device, as well as temperature-dependent viscosity. Through an energy balance analysis, we compare the impact of accounting for these factors against typical studies where these conditions are generally neglected. By analyzing the energy losses associated with these considerations, we aim to determine the extent to which they influence the overall thermal behavior of the microfluidic system. Our findings are expected to provide valuable insights into the influence and significance of incorporating these factors in future studies, thus contributing to a more comprehensive understanding of the thermal behavior of microfluidic systems.