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CONVECTIVE HEAT TRANSFER AUGEMENTATION BY FLEXIBLE FINS IN LAMINAR CHANNEL PULSATING FLOW

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ABSTRACT Fluid-structure interaction (FSI) of thin fins coupled with convective heat transfer has applications in energy harvesting and in understanding functioning of several biological systems. We numerically investigate FSI of the thin flexible fins involving large-scale flow-induced deformation as a potential heat transfer enhancement technique. An in-house, strongly-coupled fluid-structure interaction (FSI) solver is employed in which flow and structure solvers are based on sharp-interface immersed boundary and finite element method, respectively. We consider twin flexible fins in a heated channel with laminar pulsating cross flow. The vortex ring past the fin sweep higher sources of vorticity generated on the channel walls out into the downstream – promoting the mixing of the fluid. The moving fin assists in convective mixing, augmenting convection in bulk and at the walls; and thereby reducing thermal boundary layer thickness and improving heat transfer at the channel walls. The thermal augmentation is quantified in term of instantaneous Nusselt number at the wall. Results are presented for two limiting cases of thermal conductivity of the fin - an insulated fin and a highly conductive fin. We discuss feasibility of flexible fins and effect of flow cycle-to-cycle variation on Nusselt number. Finally, we investigate the effect of important problem parameters - Young's Modulus, flow frequency and Prandtl number - on the thermal augmentation.