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Small-Scale Vortical Motions induced by Aeroelastically Fluttering Reed for Enhanced Heat Transfer in a Rectangular Channel[1]
SOURABH JHA, PABLO HIDALGO, ARI GLEZER, Georgia Inst of Tech — Small-scale vortical motions effected by an aeroelastically fluttering thin reed cantilevered across the span of a rectangular channel are exploited for heat transfer enhancement at transitional Reynolds numbers. The reed's concave/convex surface undulations lead to the time-periodic formation, advection, and shedding of vorticity concentrations that scale with the motion amplitude. The reed motion is captured using phase-locked imaging and its interactions with the core flow and surface boundary layers are investigated using high-resolution PIV. Phase-averaged distributions of the reed's mechanical energy demonstrate variations of the vibration modes across the channel. The reed's impact on the surface is accompanied by transitory vorticity shedding coupled with a local increase in the turbulent kinetic energy that results in a strong increase in heat transfer. The reciprocal interactions between the reed dynamics and the channel flow are captured using cross stream velocity distributions along the channel (L/W =50) that link the kinetic energy shape factor to the rise in heat transfer (e.g., Nu) relative to the base flow. It is shown that the reed-induced heat transfer increases with Re and results in significant improvement in the global coefficient of performance.

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