Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Enhanced Small Scale Heat Transfer in Rectangular Channels using Autonomous, Aero-Elastically Fluttering Reeds[1] SOURABH JHA, THOMAS CRITTENDEN, ARI GLEZER, Georgia Inst of Tech — The limits of low Reynolds number forced convection heat transport within rectangular, mm-scale channels that model segments of air-cooled heat sinks are overcome by the deliberate formation of unsteady small-scale vortical motions that are induced by autonomous aero-elastic fluttering of cantilevered planar thin-film reeds. The coupled flow-structure interactions between the fluttering reeds and the embedding channel flow and the formation and evolution of the induced unsteady small-scale vortical motions are explored using video imaging and PIV. Concave/convex undulations of the reed's surface that are bounded by the channel's walls lead to the formation and advection of cells of vorticity concentration and ultimately to alternate shedding of spanwise CW and CCW vortices. These vortices scale with the channel height, and result in increased turbulent kinetic energy and enhanced dissipation that persist far downstream from the reed and are reminiscent of a turbulent flow at significantly higher Reynolds numbers (e.g., at $Re = 800$, TKE increases by 86% ,40 channel widths downstream of reed tip). These small-scale motions lead to strong enhancement in heat transfer that increases with Re (e.g., at $Re = 1{,}000$ and 14,000, Nu increases by 36% and 91%, respectively). The utility of this approach is demonstrated in improving the thermal performance of low-Re heat sinks in air-cooled condensers of thermoelectric power plants.

[1]NSF-EPRI

Sourabh Jha
Georgia Inst of Tech

Date submitted: 01 Aug 2017 Electronic form version 1.4