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Heat Transfer Enhancement in High Performance Heat Sink Channels by Autonomous, Aero-Elastic Reed Fluttering[1] SOURABH JHA, THOMAS CRITTENDEN, ARI GLEZER, Georgia Inst of Tech — Heat transport within high aspect ratio, rectangular mm-scale channels that model segments of a high-performance, air-cooled heat sink is enhanced by the formation of unsteady small-scale vortical motions induced by autonomous, aeroelastic fluttering of cantilevered planar thin-film reeds. The flow mechanisms and scaling of the interactions between the reed and the channel flow are explored to overcome the limits of forced convection heat transport from air-side heat exchangers. High-resolution PIV measurements in a testbed model show that undulations of the reed's surface lead to formation and advection of vorticity concentrations, and to alternate shedding of spanwise CW and CCW vortices. These vortices scale with the reed motion amplitude, and ultimately result in motions of decreasing scales and enhanced dissipation that are reminiscent of a turbulent flow. The vorticity shedding lead to strong enhancement in heat transfer that increases with the Reynolds number of the base flow (e.g., the channel's thermal coefficient of performance is enhanced by 2.4-fold and 9-fold for base flow Re = 4,000 and 17,400, respectively, with corresponding decreases of 50 and 77% in the required channel flow rates). This is demonstrated in heat sinks for improving the thermal performance of low-Re thermoelectric power plant air-cooled condensers, where the global air-side pressure losses can be significantly reduced by lowering the required air volume flow rate at a given heat flux and surface temperature.

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