Abstract Submitted
for the SES10 Meeting of
The American Physical Society

Fluid Flow and Heat Transfer in Polygonal Micro Heat Pipes
SAI SASHANKH RAO, HARRIS WONG, Department of Mechanical Engineering, Louisiana State University, Baton Rouge, Louisiana, USA — Micro heat pipes have been used to cool micro electronic devices, but their heat transfer coefficients are low compared with those of conventional heat pipes. A typical micro heat pipe has a long and narrow cavity of polygonal cross section. A long vapor bubble occupies the center of the cavity, while the liquid fills the rest. As one end of the pipe is heated, the liquid evaporates and increases the vapor pressure. The higher pressure drives the vapor to the cold end where the vapor condenses and releases the latent heat. The condensate moves along the liquid-filled corners of the pipe back to the hot end to complete the cycle. We solve the steady-flow problem assuming a small imposed temperature difference between the two ends of the pipe. This leads to skew-symmetric fluid flow and temperature distribution along the pipe so that we only need to focus on the evaporative half of the pipe. Since the pipe is slender, the axial flow gradients are much smaller than the cross-stream gradients. Thus, we can treat the evaporative flow in a cross-sectional plane as two-dimensional. Analytic solutions are derived for the temperature distribution and fluid flow along the pipe. Our model provides an explanation for the comparatively low effective thermal conductivity in micro heat pipes, and points to ways to improve their heat transfer capabilities.

Sai Sashankh Rao
Department of Mechanical Engineering,
Louisiana State University, Baton Rouge, Louisiana, USA

Date submitted: 12 Aug 2010 Electronic form version 1.4