IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Electrohydrodynamically Driven Two-Phase Heat Transport Devices for Space and Ground Applications

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Seminar on October 17, 2017 at 11:00 am in 2004 Black
Seminar host: James Michael

Abstract
Electrohydrodynamic (EHD) conduction pumping of a dielectric liquid arises from the interaction of the induced electric fields and flow fields via the Coulomb force. The required free charges come from the dissociation and recombination of neutral electrolytes present in the fluid. When the external electric field exceeds a threshold, the rate of dissociation exceeds that of recombination. There is a non-equilibrium heterocharge layer that forms in the vicinity of each electrode due to ion motion caused by the Coulomb force. The attraction of the ions present within the heterocharge layers to the adjacent asymmetric electrodes of a given pair causes bulk fluid motion in the desired direction.

This presentation will fundamentally illustrate the EHD conduction pumping mechanism and its resultant transport characteristics. Specifically, the heat and mass transport resulting from EHD conduction pumping of a dielectric fluid in macro-, meso-, and micro-scales in the presence and absence of phase change (liquid/vapor) will be described. The recent results of two-phase heat transport experiments that were conducted on board variable-gravity parabolic flights will be presented. Furthermore, the EHD conduction driven liquid film boiling experiment that is scheduled for the International Space Station will be briefly presented.

From an application perspective, the EHD conduction pumping technology is expected to provide technological advances that will support NASA's various missions. EHD pumps are simple in design, light weight, non-mechanical, free of vibrations and noise, and they allow for effective active control of heat transfer and mass transport. EHD pumps require minimal electric power to operate. The resultant heat transport capacity is typically three orders of magnitude larger than the electric input power.

Dr. **Jamal Yagoobi** received his PhD degree from the University of Illinois at Urbana-Champaign in mechanical engineering in 1984. After receiving his PhD, he worked for Westvaco Corporation as a research engineer before joining Texas A&M University (TAMU) in 1987. At TAMU, he was the Paul John Faculty Fellow, the TEES Senior Fellow, founding director of the Drying Research Center, and director of the Electrohydrodynamics (EHD) Laboratory . Yagoobi joined the Illinois Institute of Technology (IIT) in 2002 as the Chair of the Mechanical, Materials and Aerospace Engineering Department until 2011. In 2012, he joined WPI as the George I. Alden Professor and Head of Mechanical Engineering department. At WPI, he is the founding director of the newly established US National Science Foundation Industry-University Cooperative Research Center entitled, “Center for Advanced Research in Drying – CARD.” He is also the director of the Multi-Scale Heat Transfer Laboratory at WPI.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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