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Session D2: Convection and Buoyancy-Driven Flows II: Heat Transfer

2:15 PM–4:25 PM, Sunday, November 24, 2013
Room: 324

Chair: Daniel Maynes, Brigham Young University

Abstract ID: BAPS.2013.DFD.D2.7

Abstract: D2.00007 : Solution breakdown due to natural convection of the boundary-layer radial flow on a constant temperature horizontal plate

3:33 PM–3:46 PM

Preview Abstract

MathJax **On** | *Off* *Abstract*

Authors:

Ramon Fernandez-Feria
(Universidad de M\'alaga)

Carlos del Pino
(Universidad de M\'alaga)

Alberto Fern\'andez-Guti\'errez
(Universidad de M\'alaga)

The boundary-layer flow of a cold horizontal current exiting radially from a cylindrical vertical surface with a constant velocity over a hotter horizontal wall with constant temperature is analyzed. The temperature and velocity fields are coupled by buoyancy through the pressure gradients, so that the boundary-layer equations are made dimensionless with a radial characteristic length in which natural and forced convection become of the same order of magnitude, being the Prandtl number the only nondimensional parameter governing the problem. A similarity solution valid for the leading edge boundary-layer flow is obtained, yielding as a first order correction the effect of natural convection on Blasius' thermal boundary layer. This solution is also used to start the numerical integration of the equations to find out the location where the boundary-layer flow blows up due to the termination of the solution in a singularity. The physical nature of this singularity is analyzed and its position is characterized numerically. The heat flux from the horizontal wall up to this singularity is also characterized and qualitatively compared with previous experimental results from a related experimental setup.

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