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Coaxial moist plumes in stationary and windy environments[1]
SHUO LI, MORRIS FLYNN, Department of Mechanical Engineering, University of Alberta, Edmonton, AB T6G 1H9 — We report on the dynamics of coaxial plumes in both stationary and windy ambient environments. The coaxial plumes consist of hot, humid air as the inner, circular plume and warm, less humid air as the outer, annular plume. For a stationary ambient, a double plume model is proposed using a three-way entrainment formulation that involves three undetermined entrainment coefficients. Two body force formulations are discussed, which regard either the ambient or the outer plume as the reference fluid for the inner plume. Meanwhile, a planar laser-induced fluorescence (PLIF) technique is employed to visualize the flow and quantify the scalar concentration of either the inner or outer plumes. The PLIF experiment reveals different near-field entrainment behaviors for cases wherein the inner plume is more/less buoyant than the outer plume. Moreover, the optimal values for the entrainment coefficients are determined by a pixel-by-pixel comparison of the scalar concentration between theory and experiment. For a windy ambient, theoretical results show that wind tends to rapidly dilute the heat and moisture transferred from the inner to the outer plume.

[1]Natural Sciences and Engineering Research of Canada (NSERC), International Cooling Tower Inc. and the China Scholarship Council (CSC)

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