The objective of the present study is the evaluation of the heat transfer difference between a novel jet plate configuration and a conventional flat jet orifice plate. Physical mechanisms that lead to a change in Nusselt number when comparing both configurations are discussed in two regions: impingement and crossflow. In the presented work, both plates with identical inline arrays of (20 x 26) circular air jets impinging orthogonally on a flat target comprised of 20 segments parallel to the jet orifice plates, are studied. The first is a staggered configuration of a pimple-dimple (convex-concave) plate. This plate features two jet diameters: (a) 4.63 mm emanating from negative sphere of 14.63 mm in radius inward imprint; (b) 2.19 mm emanating from a positive sphere of 17.07 mm in radius, protruding from the base of the plate. The second jet plate is flat, which serves as a baseline for the heat transfer study. This plate has a constant jet orifice diameters of 3.49 mm, found based on the definition of total average open area of the first plate (NPR configuration).

Heat transfer characteristics and turbulent flow structures are investigated over jet-averaged Reynolds numbers (Re_av_jet) of 5,000, 7,000, and 9,000. Jet-to-plate distance (Z/D_j) is varied between (2.4 - 6.0) jet diameters. A numerical study is used to compare various turbulence models (ke-EB, ke-Lag EB, ke-v2f, kw-SST, RST) with the experimental data. The convex-concaved plate yields lower globally-averaged heat transfer coefficients when compared to a flat jet plate in the impingement region. However, enhancement up to 23% is seen in the crossflow region, where the crossflow effects are dominant in a maximum-crossflow configuration.

Major: Mechanical Engineering

Educational Career:
Bachelor's of Mechanical Engineering, BS, 2015, University of Central Florida
Master's of Mechanical Engineering, MS, 2017, University of Central Florida

Committee in Charge:
Dr. Jayanta Kapat, Chair, MAE
Dr. Erik Fernandez, Co-Chair, MAE
Samik Bhattacharya, MAE
Amro Awad, CECS

Approved for distribution by Dr. Jayanta Kapat, Committee Chair, on July 20, 2020.

The public is welcome to attend.