An experimental investigation of friction and heat transfer behavior for a fully developed flow in a non-rotating square channel was conducted under a range of Reynolds numbers from 6,000 to 180,000. The test section was 22 hydraulic diameters (Dh) long, and made of four aluminum plates. One rib roughened bottom wall, and three smooth walls bounded the flow. Glued brass ribs oriented at 45° to the flow direction, with a ratio of rib height to channel hydraulic diameter (e/Dh) and a ratio of pitch to rib height (p/e) of 0.063 and 10, respectively, lined the bottom wall. A 20Dh long acrylic channel with a continuation of the test section’s interior was attached at the inlet of the test section to confirm the flow to be fully developed. Heat transfer tests were conducted from a Reynolds number range of 20,000 to 150,000. During these tests, the four walls were held under isothermal conditions. Wall-averaged, and semi-local Nusselt values were calculated from the log-mean temperature differences between the plate surface temperature and calculated, by energy balance, fluid bulk temperature. Streamwise Nusselt values become constant at an x/Dh of 8 within the tested Reynolds number range. Wall averaged Nusselt values were determined after x/Dh=8, and scaled by the Dittus-Boelter correlation, Nu0, for smooth ducts to yield a Nusselt augmentation value (Nu/Nuo). Non-heated friction tests were conducted from a Reynolds number range of 6,000 to 180,000. Pressure drop along the channel was recorded, and channel-averaged Darcy-Weisbach friction factor was determined within range of Reynolds number tested. Scaling the friction factor by the smooth-wall Blasius correlation, f0, gives the friction augmentation (f/f0). It was found that the Nusselt augmentation approached a constant value of 2 after a Reynolds number of 60,000 while friction augmentation continued to increase in a linear fashion past that point. This cause the overall thermal performance to decline as Reynolds number increased. Further studies were conducted in an all acrylic, non-heated version of the rig to study the fluid flow in the streamwise direction on, and between two ribs in the fully developed region of the channel. Single-wire hot-wire anemometry was used to characterize velocity magnitude profiles with great detail, as well as turbulence intensity for Reynolds numbers ranging from 5,000 to 50,000. It was seen that as the Reynolds number increased the reattachment point between two ribs remains relatively stationary while the turbulence intensity recedes to the trailing surface of the upstream rib, and dissipates as it travels. At low Reynolds numbers between 5,000 and 10,000 the velocity and turbulence intensity streamwise profiles seem to form two distinct flow regions, indicating that the flow over the upstream rib never attaches between the two ribs.

Major: Mechanical Engineering

Educational Career:
Bachelor’s of Mechanical Engineering, BS, 2014, University of Central Florida

Committee in Charge:
Jayanta Kapat, Chair, Mechanical & Aerospace Engineering
Subith Vasu Sumathi, Co-Chair, Mechanical & Aerospace Engineering
Kareem Ahmed, Mechanical & Aerospace Engineering

Approved for distribution by Jayanta Kapat, Committee Chair, on June 22, 2017.

The public is welcome to attend.