Announcing the Final Examination of Weston Olson for the degree of Master of Science

Time & Location: April 3, 2020 at 10:00 AM in Virtual Virtual
Title: Rotational and Shower Head Cooling Hole Effects on Leading-Edge Jet Impingement Heat Transfer

Jet impingement and shower head cooling are critical cooling techniques used to maintain turbine blades at operational temperatures. Jet impingement is extremely effective at removing large amounts of heat flux from the target surface, inner blade wall, through stagnation point heat transfer. Shower head cooling produces a cooling film around the exterior of the blade, in return reducing external heat flux. When angled with the radial direction the shower head cooling holes also act as a convective cooling channel, extracting heat from the surrounding metal as it makes its exit to the external gas. This study consists of investigating the jet impingement effectiveness with rotational effects along with the pressure gradient created by the shower head cooling holes. The analysis was conducted numerically using STAR CCM+ with the Lag EB K-Epsilon turbulence model. The blade used was NASA/General Electrics E^3 row 1 blade. A conjugate heat transfer model was developed for just the leading-edge portion of the blade. The external blade temperature, local Nusselt Number and surface area average Nusselt Number for impingement section were evaluated. The rotational effects were analyzed by comparing the potential core velocity profiles for stationary and rotating blades. The effects of the shower head holes were studied by comparison to leading-edge section without shower head holes. Results of the study show that jet impingement effectiveness is enhanced with application of shower head cooling holes, due to the direction of the pressure gradient produced by shower head holes. The investigation showed that rotational effects produce turbulence within the jet’s potential core, reducing the incoming jet velocity and hence reducing impingement effectiveness. Despite a reduction in impingement effectiveness rotational effects could have a positive effect on internal heat transfer due to an increase in turbulence for the wall jets.

Major: Mechanical Engineering

Educational Career:
Bachelor of Mechanical Engineering, BS, 2010, University of Central Florida

Committee in Charge:
Jayanta Kapat, Chair, MAE
Erik Fernandez, MAE
Samik Bhattacharya, MAE

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

The public is welcome to attend.