The objective of the current study is to use hotwire anemometry as a tool to conduct 1D time-resolved turbulent measurements on the flow field of staggered multi-row film cooling arrays with cylindrical and diffuser shaped holes inclined at 20 degrees to the freestream. The study aims to investigate the flow field to determine why the performance of diffuser shaped jets is enhanced even at high blowing ratios. In addition, blowing ratio effects and flowfield discrepancies at set downstream locations in centerline array centerline plane are also investigated.

Mean streamwise velocity profiles were found to scale with blowing ratio for both geometries. A strong dependence of turbulence levels on velocity gradients between jets and the local fluid was also noticed. For cylindrical jets, attached cases displayed lower integral length scales in the near wall region compared with higher blowing ratio cases due to entrainment of mainstream fluid showing increased momentum transport below the jets. Diffuser cases at all blowing ratios tested do not show increased length scales near the wall demonstrating their enhanced surface coverage.

Row-to-row discrepancies in axial velocity and turbulence level are only evident at extremely high blowing cases for cylindrical, but show significant deviations for diffuser cases at all blowing ratios. Unlike the cylindrical cases, jets from diffuser shaped holes, due to their extremely low injecting velocities, ‘dragged’ the boundary layer with each row of blowing. Increased velocity gradients create a rise in peak turbulence levels at downstream locations. At high blowing ratios however, faster moving fluid, due to injection, at lower elevations acts as a shield for downstream jets allowing significantly further propagation downstream. Near the wall low magnitude integral length scales are noticed for diffuser jets indicating low momentum transport in this region.

The results show good agreement with effectiveness measurements of a previous study at a higher density ratio. However, to accurately draw conclusions, effectiveness measurements should be conducted at a density ratio of 1. Recommendations were made to further the study of multi-row film cooled boundary layers.

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The public is welcome to attend.