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Investigation of nozzle contour in the CSIR supersonic wind tunnel

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ABSTRACT

The nozzle contour profiles of the CSIR's supersonic wind tunnel (high speed wind tunnel) were designed to produce smooth, uniform and shock-free flow in the operating section of the facility. The existing profiles produce weak waves in the test section region which induces flow gradients and flow angularities in the air flow, effectively degrading the air flow quality, which in turn perturbs the wind tunnel data. The wind tunnel geometry and tunnel constraints were employed in accordance with the method of characteristics technique to design the supersonic nozzle profiles. The Sivells' nozzle design method was deemed the most feasible which calculates the profile downstream of the inflection point. The throat block profile was amalgamated with this profile to yield a profile from the throat to the test section. A boundary layer correction was applied to the profiles to account for viscous effects which cause a Mach number reduction from the desired test section Mach number. An automatic computation was used for the profile design and a computational method analysed the Mach distribution, flow angularity and density gradient (to determine the occurrence of shocks and expansions) of the profiles implemented in the tunnel, for the full Mach number range of the HSWT. The methods used, achieved uniform and shock-free flow such that the Mach number and flow angularity were within the acceptable quality limits of the HSWT.