Abstract

An investigation into steady state supersonic and transonic viscous corner flows has been conducted. The supersonic research focused on the development of the three shock structure along various fillet and sharp corner geometries, specifically the formation and growth of the shear layers that result from the Mach reflection. The resultant effects of these shear layers on the pressure distributions, shear stresses and the changes in Mach numbers were analyzed together with the shock wave boundary layer interaction. Experimental supersonic work includes the use of the oil film flow visualization technique to visualize the surface flow patterns. The transonic research focused on numerically verifying the existence of the transonic shock wave within a corner configuration. The supersonic and transonic flows considered are symmetric about the corner bisector. These flows are numerically calculated by using the CFD code of Fluent and include the use of standard turbulence models. The geometries analyzed resembled simplified wing body-fuselage and wing-winglet/wingtip intersections for both supersonic and transonic aircraft. These geometries had varying geometric parameters. The supersonic results showed that the inclusion of a fillet profile between two aerodynamic surfaces or wing sections results in the delay of the formation of the Mach reflection and shear layer. Neglecting the effect of the fillet profile (sharp corner) resulted in the formation of the Mach reflection and shear layer starting at the leading edge of the geometry, hence a greater increase in pressure and shear stress was seen on the sharp corner geometries. The impingement of the reflected shock waves on the boundary layer results in a large variation in the boundary layer thickness for the sharp corner geometries however no separation is observed. The supersonic experimental work validates the numerical results produced by accurately depicting the surface flow patterns. The transonic numerical results verified the existence of a transonic shock wave within a corner configuration for all the geometries analyzed. The shock wave boundary layer interaction was strong enough to cause reversed flow and separation within the transonic corner.