NUMERICAL INVESTIGATIONS OF HYPERSONIC FLOW IN THE LONGSHOT FACILITY

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The project stands to investigate the flow field and the boundary layers in the Longshot contoured nozzle. Both the reservoir and the the convergent-divergent nozzle have been considered.

After a brief presentation of the Longshot facility, the reservoir and the contoured nozzle. Physics analysis of the flow in the nozzle has been done. The effects of high temperature and high pressure in the reservoir were investigated. It has been shown that there is no dissociation of the Nitrogen in the reservoir for the range of temperature used in the operating conditions. The high pressure effect plays an important role especially in the reservoir where the real gas effect should be taken into account. The Perfect gas equation is not accurate for the range of pressure considered and other state laws were presented and the accuracy of each one was discussed.

Euler and Navier-stokes computation were performed for different stagnation conditions. Both Nitrogen and Carbonedioxide were used as a perfect gas. It has been shown that the effect of gamma was important in the boundary layer and in the free stream. The influence of the wall boundary condition was also investigated by considering two test cases where the stagnation conditions where similar and the boundary conditions were different: adiabatic and isothermal wall. The wall condition has only a small effect on the free stream conditions but it has a major effect on the boundary layer and especially the thermal boundary layer.

Finally investigations of hypersonic boundary layer profile in the nozzle were also done, different stagnation conditions were used in order to check the nature and behavior of the boundary layer within a real shot. It has been shown that with the high Mach number reached at the exit section of the nozzle, a very thick boundary layer is present.

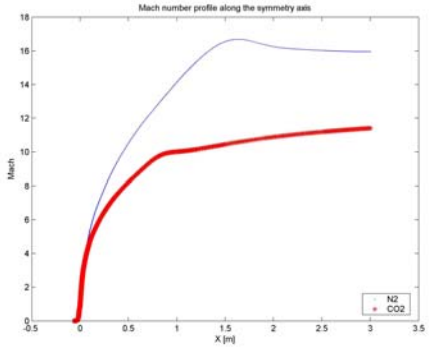

Figure 1: Mach number distribution along the symmetry axis

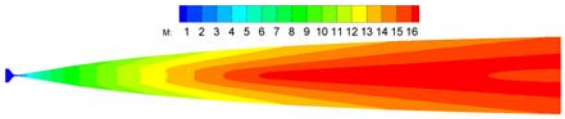

Figure 2: Mach number field in the nozzle.