UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF ENGINEERING, SCIENCE & MATHEMATICS

SCHOOL OF ENGINEERING SCIENCES

Doctor of Philosophy

NUMERICAL SIMULATIONS OF A TRANSVERSE SONIC JET IN A LAMINAR HYPERSONIC FLOW

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This report is aimed at studying the flow field resulting from the interaction of a laminar hypersonic flow with a transverse sonic jet. Numerical simulations were carried out using a code developed previously at the University of Southampton. The research involved the simulation of a Mach 6.7 laminar Nitrogen flow, of unit Reynolds number of 5.54 x 10^6/m, over a flat plate (with a sharp leading edge) which has a transverse underexpanded sonic jet issuing from it. Three cases were looked at: a slot jet in two dimensions, a slot jet in three dimensions and a jet from a square hole (a three-dimensional flow field).

The two-dimensional slot jet study was used initially as a means of testing the code for consistency and as an initial means of validation with past experimental work. Then, the two and three-dimensional slot jet results were compared, the aim of which was to highlight the differences in the flow fields, and to provide an explanation for those differences. The lateral spillage (venting) of the flow field was found to be the cause of these differences.

The initial motivation for the study of the square jet interaction flow field was to investigate the surface heating qualitatively and to compare the results with previously obtained experimental data, but was later expanded to investigate the induced surface pressure distribution and how the primary features of the interaction flow field scaled with the jet gas mass flow rate. The primary flow features were subsequently found to vary with the jet gas momentum.