Abstract

Ground testing methods of hypersonic airbreathing propulsion systems, such as
direct-connect and free jet testing, is a hostile environment for intrusive instrumentation,
limiting the data that can be extracted accurately and reliably. In this thesis, a one-
dimensional, steady flow equilibrium chemistry analysis software tool was developed in
MATLAB to extract as much useful data from test data collected in direct connect tests
for RAMjet and scRAMjet engines. The tool utilizes a space marching, Euler method
approach to evaluate thermodynamic and transport properties along the axis of the engine
that are useful in assessing an engine design. When iterating on an early stage RAMjet or
scRAMjet flowpath design, a fast and accurate cycle tool for predicting engine
performance is critical. A one-dimensional, steady flow prediction method for other
scaled, skewed, or altered airbreathing engine designs was also developed for this thesis
in order to predict if a design can operate as a dual mode combustion system (i.e.,
subsonic or supersonic combustion), and assess its axial bulk thermodynamic, flow, and
transport property profiles by applying the heat release profile derived from the results of
the analysis method previously mentioned. This thesis provides a description of the
models and methods used in determining the bulk thermodynamic properties in both the
analysis method and prediction method implemented in the software tool, as well as the
integrated GUI system. The analysis method was performed on a geometry profile from
Innoveering, LLC, and heat release profiles derived was applied in prediction mode in
order to compare to direct connect test data for that geometry to assess the tools accuracy,
showing an isolator pressure rise prediction mode error of 3.5%, as well as a thermal
throat location from analysis mode error of 2.4% as compared to a separate analysis.