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.