SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

Author: Prof. Lachlan Thompson
RMIT University, Australia, Australia

Mr. Mark Grollo
Grollo Aerospace Ltd, Australia

COMBINED CYCLE PROPULSION FOR HIGH SUPERSONIC FLIGHT VEHICLES

Abstract

The project is aimed at evaluating the operation of an unmanned wave rider vehicle in the earth's upper atmosphere, propelled by a combined cycle propulsion system. A simulation of the flight process will initially be carried out and followed by actual flight testing. The design uses existing technologies to develop a low cost reusable vehicle, which will serve as a platform for the parametric study of Propulsion and thermal management of high velocity Aerospace vehicle in a rarified environment. By employing off the shelf technologies, both the development time and cost of the vehicle can be significantly reduced. A modular configuration allows the vehicle to be adapted to carry small payloads, of both commercial and military in nature.

A wave rider is a vehicle that generates aerodynamic lifting from supersonic compression (shockwaves) of the airflow underneath the vehicle, therefore not requiring wings. The wingless vehicle has greatly reduced aerodynamic drag, thus achieving extremely high supersonic and hypersonic velocities. However, at such high velocities, extremely high vehicle skin temperatures are generated, which cannot be cooled by radiation, or conventionally by using the airflow. The advantages of a wave rider/propulsion system for space applications are that it uses aerodynamic lift for the spacecraft whilst in the atmosphere which significantly reduces the quantity of fuel required to enter orbit. These qualities in a military application mean high altitude, high velocity and therefore ultra long range.

Ground test firing of the rocket component of the combined cycle propulsion system have been successfully completed. Design of the ramjet section has been completed using computational fluid analysis to develop the inlet and ramjet combustion phases. This includes ramp optimization. The flight test propulsion system has been completed and has completed ground testing. The flight test vehicle flight controller is based on a Canadian Micro pilot autopilot specifically modified to facilitate high supersonic flight management. Comparison with high supersonic CFD simulation and autopilot response showed anomalies due to shock position prediction and speed of travel. The detected CFD prediction errors resulted in corrections to the CFD algorithm prior to flight. The fight vehicle is a composite airframe with nickel alloy materials for high temperature sections such as engine inlet, shock ramps and combustion chamber, the rocket motor is a retentively cooled liquid oxygen and kerosene engine with throttle control over thirty five percent of total thrust. These technologies facilitate edge of space intercontinental hypersonic civil transport.