

SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (9)

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NUMERICAL ANALYSIS OF MODE TRANSIENT PHENOMENA IN A ROCKED-BASED
COMBINED CYCLE ENGINE**Abstract**

Japan Aerospace Exploration Agency (JAXA) has been studying a rocket-based combined cycle (RBCC) engine which combines rockets and ramjets for a future reusable launch vehicle. The rocket is embedded inside the ramjet duct aim at reducing the total weight compared to an engine that comprises the two engine cycles separately. The engine operates by successively switching over four modes, namely, the ejector-jet, ramjet, scramjet and rocket modes, from take-off to engine burnout, so as to achieve efficient acceleration of a vehicle. In the ramjet mode, the rocket exhaust is mixed with the air ingested from the ramjet inlet to be a combustible mixture gas, which is burned by secondary fuel injection in the downstream combustor to produce the main thrust, while the rocket throttled is also used for stable ignition rather than thrust augmentation. The air flow entering into the combustor remains supersonic and becomes subsonic through pseudo shock waves, which are formed by combustion with the air and move upstream due to boundary layer separations. The subsonic flow causes thermal choking due to the excessive combustion and changes into supersonic flow by a diverging flow passage. In the scramjet mode, however, the rocket works at full throttle and produces a large part of the total thrust, since a pure scramjet could not produce the thrust required for acceleration in hypervelocity ranges. The flow remains supersonic through the combustor and combustion with the air is accomplished by containing residual fuel in the rocket exhaust. Therefore flow structures inside the engine are drastically different at the two distinct engine modes. In this study, an attempt is made on detailed description of mode transient phenomena between the ram and scramjet modes in the JAXA RBCC engine by using a hybrid LES/RANS approach in order to reveal the flow dynamics and engine working characteristics. Then the rocket operation which can change the engine mode will be varied in a certain period continuously to attain a transient condition. The detailed results will be given in the full-length paper presented at the conference.