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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems (4)

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# A SUBORBITAL REUSABLE LAUNCH VEHICLE CONCEPT UTILIZING RBCC PROPULSION TECHNOLOGY

**Abstract**

In response to fast access to near space, a horizontal take-off and horizontal landing (HTHL) Suborbital Reusable Launch Vehicle (SRLV) concept is provided in this research. This vehicle is powered by six Rocket Based Combined Cycle (RBCC) engines with fuel of JP-10 and LOX. SRLV is designed to deliver 20,000 kg payload to altitude of 50km and velocity of 10 Ma, and can fly back to launch site by RBCC engines. During ascent phase, the six engines all work by four modes of injection(0 2.0Ma), ramjet(2.0 5.0Ma), scramjet(5.0 8.0Ma), and rocket (8.0 10.0Ma). After payload separated, SRLV turns around and descends to 25km with engines power-off. Then, it cruises in altitude of 25km by two engines in ramjet mode. When the distance to launch site is about 30km, SRLV will descend and land to site. Details of the vehicle design including aerodynamic shape, flow geometry of RBCC, internal structures, aeroheating and thermal protection system (TPS), ascent and flyback trajectory are provided. A wave-rider aerodynamic concept is used to produce large L/D during high velocity flight and provide perfect inflow conditions for engines. A couple of large trapeziform wings located in middle part are used to produce enough lift during taking off and landing. The variable geometric inlet is designed to meet inflow condition requirements of three air-breathing modes. The structural concept includes a lot of composite material skins distributed in all outer surfaces, and an underlying grid of longitudinal keel beams and transverse bulkhead beams to carry axial load, bi-directional bending, and torsion. Passive TPS is used at any location where the aeroheating will cause the structural temperature to be exceeded and/or the thermal stresses to be too high. Active cooling system is used in combustor and nozzle. Since the interactions between disciplines of aerodynamics, propulsion, structure, thermal and trajectory are very tightly, it is necessary to utilize Multi-Disciplinary Optimization (MDO) technology in the closure process. After the baseline created, all relevant design and analysis models were built and integrated into a synthesis model, include CFD based aerodynamic analysis, RBCC cycle analysis, TPS and structural sizing, trajectory optimization, etc.. Response Surface Method (RSM) and Sequential Quadratic Programming (SQP) algorithm were used to get closure and optimal design. The result shows that for given launch task and with all design constraints satisfied, the minimal take-off weight is about 120 tons.