Paper ID: 38994
oral

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Interactive Presentations (IP)

Author: Dr. Yi Li
Northwestern Polytechnical University, China

Mr. Su Cao
Northwestern Polytechnical University, China
Dr. Chunlin Gong
Northwestern Polytechnical UniversityNPU, China

AN INVESTIGATION ON THE STAGING AERODYNAMICS OF A TWO-STAGE-TO-ORBITAL VEHICLE POWERED BY RBCC ENGINE

Abstract

In this work, the aerodynamic problems of a Two-Stage-To-Orbit (TSTO) vehicle are numerically investigated. The TSTO vehicle has a full reusable booster stage which and a single-stage rocket as the upper stage. The booster has a lifting-body configuration and is powered by an air-breathing Rocket-Based Combined-Cycle (RBCC) engine. It can horizontally take off from a civil airport carrying the upper stage on the top. At an altitude of about 40 km, when the flight Mach number is between 5 and 8, the booster separates the upper stage that flies continually into space. The booster will however return and land horizontally on the airport.

Before the separation of the upper stage, as the flight Mach number is high, the shocks originate from the leading edge of the nose and the vertical wing are strong. The separation of the upper stage may be hindered by the strong shocks. During the separation, there should be no collisions between the two stages. The attitude of the upper stage should also maintain stable, then its control system can successfully steer the rocket after the separation.

The flow field of the TSTO vehicle is carefully studied with CFD code and the aerodynamic risks during the separation are investigated. With these inputs, the separation procedures and mechanisms are thereafter discussed. A few coupled simulations of CFD and Flight Mechanics are carried out to predict the unsteady motions of the upper stage, with which the separation quality can be evaluated.