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CAVITY AND JET INJECTION EFFECTS ON SUPERSONIC COMPRESSIBLE RAMP FLOW

Abstract

Ramps, jets and cavities are components that commonly appear on high speed aircraft, rockets and reusable spacecraft. Their different combination can induce significant changes in flow structures including flow separation, shock-waves and aerothermodynamic load distributions. In this paper we look at effects of cavity and jet injection on supersonic compressible ramp flow based on the DLR windtunnel model of VEGA rocket(for stage separation research). Cavities with different length/depth ratios (L/D), as well as jets with different strengths are compared here. The orientation of jet injection is also studied. An in-house Fortran code, known as the Southampton SBLI code is used here to solve the NS equations. In the simulation of the ramp flow with jet cases, converged ramp flow is firstly obtained before turning on the jet injection.It is discovered that for the jet strengths and flow conditions used for the DLR wind tunnel experiment, the action of the jets is to completely separate the upstream flow, in a very short timescale. The rate of upstream motion of separation increases when the jets are pointed upstream or when a stronger jet is applied. An anomalously large upstream separation is found for the narrow cavity case(L/D of 0.3) due to the local flowfield distortion near the cavity. The L/D of 0.7 cavity studied here, does not influence the separation of the ramp flow except for an increase in the flow unsteadiness. All the cases with jet injection studied have separation developed to the inflow. This study could offer help to understand rocket stage separation.