ESTIMATION OF DISCHARGE COEFFICIENT OF COMPARTMENT VENTING DURING ATMOSPHERIC REENTRY OF THE SPACE CAPSULE

R. C. Mehta
Department of Aeronautical Engineering
Noorul Islam Centre for Higher Education
Kumaracoil-629180, India
Email : drrakhab.mehta@gmail.com

Abstract

The problem of re-pressurization of compartment of reentry space capsule through vent holes is formulated using equation of mass conservation, isentropic relation and perfect gas equation of state. Resulting, a one-dimensional nonlinear compressible transient equation is numerically integrated employing fourth-order Runge-Kutta scheme in order to obtain compartment pressure using knowledge of the discharge coefficient of the orifice. An inverse venting analysis is carried out to estimate the discharge coefficient using measured and computed compartment pressure time history during the reentry phase of the space capsule. The inverse venting problem is solved using the Newton-Raphson method coupled with a direct-search algorithm utilizing pseudo-random numbers. The inverse venting algorithm estimates the discharge coefficient of the vent holes in a stepwise manner as a function of the reentry flight Mach number. The reconstructed compartment differential pressure is compared with pre- and post-flight data. It is observed that the estimated values of the discharge coefficient depend on the accuracy of the transmitted telemetry data, dispersion of the reentry trajectory, pressure acting on the base of the capsule and atmospheric pressure.

Keywords: Discharge Coefficient, Inverse Problem, Numerical Analysis, Reentry Space Capsule, Re-Pressurization, Venting