Mechanical Erosion of Graphite Nozzle Material in Solid-Propellant Rocket Motors

A detailed theoretical/numerical framework is established to study the mechanical erosion of graphite nozzle materials in solid rocket motors at practical operating conditions. The propellant considered is aluminized AP/HTPB composite propellant. A combined Eulerian-Lagrangian approach is used to treat the multiphase flow inside the motor. The multi-component gas-phase dynamics is modeled using the conservation equations of mass, momentum, and energy in the Eulerian framework. Turbulence closure was achieved using the standard k-epsilon two-equation model. The dispersed phase consisting of aluminum and aluminum oxide droplets are treated using Lagrangian framework. Two correlations were employed to predict the mechanical erosion of the nozzle surface. The calculated mechanical erosion rates fall in the range of the available experimental data. The erosion is prevalent in the convergent section of the rocket nozzle. No mechanical erosion was observed at the nozzle throat and its downstream.

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