Propulsion, Engines and Missiles ▪ Solid Propellant Rocket Engines

# BERYLLIUM EROSION CORROSION INVESTIGATION FOR SOLID ROCKET NOZZLES

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**Abstract:** This program is directed toward understanding the basic mechanisms of corrosion and erosion of graphite, tungsten and ablative plastic materials exposed to state-of-the-art beryllium propellant exhausts. The results of 18 solid propellant firings are presented and evaluated. The 100-pound grains were in end burner, center perforated and key configurations. Submerged, steep inlet and conventional nozzle contours were tested. Four of the nozzles used dense tungsten inserts; the others were edge grain pyrolytic graphite. Carbon cloth and asbestos phenolics were used as aft closure, nose cap and entrance cone insulation. Three beryllium formulations and one **aluminum** analog (one test) were used. Pressure, thrust, and thermocouple data are included. Nozzle throat thermal histories and convective heat transfer coefficients were calculated. **Oxide** deposition effects provided extensive thermal insulation and corrosion protection of the nozzle contour. Throat corrosion occurred on only 7 tests. The key grains produced two axial grooves in the nozzles. Almost no evidence of physical erosion was found. Corrosion, deposition, heat transfer and ballistic performance are discussed in terms of physical and analytical models. The motor test results tend to confirm the original hypotheses concerning the beryllium nozzle erosion problem. Designs for the 500-pound grain motor tests and progress in the development of analytical design techniques are also discussed.



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