IM Characteristics of Large Diameter Extruded Double Base Rocket Motors with Composite Cases

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Traditional Extruded Double Base IM Response

- Typical IM response of extruded double base motors well characterized
  - Violent reactions for metal combustion chambers
    - Bullet Impact*
    - Frag Impact
    - Slow Cookoff
    - Fast Cookoff*

- Larger diameters are typically less favorable
  - Critical diameter can be a factor
  - Long L/D may present additional challenges

*Not all EDB motors exhibit a violent response to this stimulus
The Root of the Problem

- Inherent properties of EDB propellants
  - Both NG and NC are sensitive as individual components
  - The combination **REDUCES** the sensitivity of the materials
  - EDB propellants are the lowest card gap (least shock sensitive) in the Army production inventory

- Confinement
  - Confinement of double base is a known hazard
  - Metal cases provide minimal release in the event of a bullet or frag impact
  - Without bulkhead release mechanisms, cookoff results in the same issue
The Root of the Problem

• Lethal Fragments
  • Even less violent energetic reactions are a problem in the presence of lethal fragmenting materials

• Diameter
  • Even small diameters (less than 2”) result in violent reactions
Previous Work on Composite Cases

- Hydra Missile (2.75” Diameter)
  - Previous work on the Mk. 66 motor shows improved IM response with composite cases
  - Simulated release mechanisms improved responses to cookoff environments
  - Tests may improve by performing system level test (including payload on the forward interface)

- Conclusions and Questions
  - Violent IM response not inherent to the energetic in the Mk. 66 configuration
  - Composite cases are a viable mitigation for EDB propellants
  - Is there a diametric limitation?

*All information from IMEM 2006, Paper 7A, Farabaugh et. al.*
Extension to Large Diameter

- Large Diameter Tactical Motors
  - Development of large diameter tactical motors using EDB propellants ongoing
  - Benefits in cost, volume, complexity, manufacturability
  - Can IM properties be retained?
Recent Large Diameter Tactical Work

- Design and Manufacturing Development
  - Composite case EDB motors up to 6” in diameter have recently been developed for tactical application
  - More than double the web of the Mk. 66 rocket motor
  - Grain extrusion, machining, inhibition as well as motor performance in static testing have all been successfully demonstrated
Demonstrated IM Properties of Large Diameter EDB Motors

- Technologies incorporated for IM
  - Low shock sensitivity EDB propellant
  - Filament-wound graphite epoxy motor case
  - Shape memory alloy retention rings for forward and aft bulkheads

http://www.gd-ots.com
Demonstrated IM Properties of Large Diameter EDB Motors

- Tests
  - Fragment Impact
  - Slow Cookoff
  - Fast Cookoff

- Results
  - Even at the larger diameter and length, the composite case motors retain the IM properties demonstrated in the 2.75” size
Future Large OD Motor Work

• Larger Diameters
  • Demonstration of manufacturing and diameters larger than 6”
  • Evaluate IM response at thicker webs

• Additional IM mitigation
  • Evaluate IM response at a system level (payload, packaging)
  • Investigate IM response as a function of grain design (perf, L/D etc.)
  • Additional reduction in propellant shock sensitivity
  • Maintenance of shock sensitivity at higher energies