

PROPULSION SYSTEM DESIGN CONCEPTS  
USING FREE RADICAL HEDM TECHNOLOGY

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ABSTRACT

**Issues** connected with propellant manufacturing, feed system and storage are identified and discussed. The criteria that drive the design of a HEDM propulsion system are established. Only current or near-term technologies are considered.

The merging of hybrid rocket technology with recent advances in densified cryogenic propellants is presented into a unified framework, and a rationale is presented for adopting the hybrid and/or reverse hybrid approach as most convenient propulsion system approaches for the implementation of HEDM technology. **Two major implementation strategies may be adopted for the engineering realization of HEDM propulsion systems.**

**One is** based on solid oxygen which leads to certain ease of implementation but which, given its higher matrix temperature, presents important limitations on the long-term stability of free radicals. Lower HEDM performance than is forecasted in the literature is consequently anticipated for this approach, but in turn, **its low cost and modest technology requirements make its field deployment quite attractive.**

The second approach is based on the selection of solid hydrogen as the HEDM matrix. **This scheme requires the solution of a few challenging engineering issues, but offers the promise of a full realization of the attractive HEDM performance which is presently entertained when using very energetic free radical atoms/clusters. This scheme, which uses solid hydrogen temperatures, can be enhanced when operating at high pressure, but there is a practical limit to the long term stability of the most energetic solid-hydrogen/atomic-hydrogen HEDM system by the pressures that could be achieved in a launch vehicle tank.**

A sketch on ground facilities for a HEDM launch vehicle and examples of launch operations and activities are also presented to focus HEDM technology requirements on the relevant issues that need to be resolved. A few major engineering problems are identified and recommendations are provided as to the possible near-term technological paths that could be implemented.