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SPACE PROPULSION SYMPOSIUM (C4)
New Missions Enabled by New Propulsion Technology and Systems (6)

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UNIQUE ADVANTAGES OF HYBRID ROCKET TECHNOLOGY FOR MARS MISSIONS

Abstract

It is likely that future Mars missions will increasingly require the utilization of rocket systems for transport from the planet surface to a low transfer orbit and also for point to point transportation on Mars surface. Application of rocket systems for Mars missions is a challenging undertaking due to 1) the low storage and operational temperatures, 2) high level of expense for transporting rocket systems and propellants from Earth, 3) requirement for remote operations and 4) need for reliable ignition following long duration storage. Hybrid rocket systems have some unique advantages over liquids and solids that make them ideal for Mars missions. Specifically solid systems are not suitable for storage and operation at temperatures below -50 C due to the possibility of deboning and propellant cracking. The liquid fuels commonly used in space applications have high freezing temperatures generating operational difficulties for the use of liquid systems for Mars missions. Recently SPG scientists have formulated a fast burning hybrid rocket fuel that can be stored and operated at temperatures as low as -80 C. These formulations also have high melting temperatures, and retain acceptable mechanical properties all the way up to 60 C. Oxidizers with low freezing temperatures such as nitric acid, MON, nitrous oxide, Nytrox can be used in the hybrid configuration for Mars missions. For nitric acid and MON based systems, ignition of the hybrid motor can be achieved by doping the fuel grain with solids that would be hypergolic with the selected oxidizer. Ignition of nitrous oxide or Nytrox systems can be achieved by the catalytic decomposition of N2O. Depending on the oxidizer selection, hybrids, especially the ones that are loaded with energetic additives, can generate Isp values better than solids and similar to hydrazine based liquids. Moreover N2O/CO2 mixtures as an oxidizer, which can partially be obtained from Mars atmosphere, can be burned with good performance by the inclusion of metallic additives such as aluminum in the hydrocarbon fuel binder.