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THE POTENTIAL OF ALUMINIUM METAL POWDER AS A FUEL FOR SPACE PROPULSION SYSTEMS

Abstract

Metal powder propulsion systems have been addressed intermittently since the Second World War, initially in the field of underwater propulsion where research in the application of propelling torpedoes continues until this day. During the post war era, researchers attempted to apply metal powders as a fuel for ram jet applications in missiles. The 1960's and 1970's saw additional interest in the use of 'pure powder' propellants, i.e. fluidised metal fuel and oxidiser, both in solid particulate form. Again the application was for employment in space constrained missiles where the idea is to maximise high energy density powder propellant performance in order to enhance the missile flight duration by omitting the use of binders, curing agents and high energy plasticisers. Volumetric propellant density for both underwater and ramjet propulsion would decrease since the oxidiser component, sea water and ram-air, respectively, would not have to be stored within the system. These ordnance delivery systems did not however see the light of day and attention thereafter, i.e. 1980's onwards, expanded to include the use of metal powder as possible fuel for in-situ resource utilisation propulsion systems where the emphasis was on the use of gaseous oxygen or liquid oxygen combined with aluminium metal powder for use as a "lunar soil propellant" or carbon dioxide and magnesium metal powder as a "Martian soil propellant".

Albeit metal powder concepts are lower in performance than pure cryogenic engines, the former does have an advantage inasmuch the propulsion system is generic, i.e. it can be powered with chemicals mined and processed on Earth, the Moon, Mars, Asteroids and moons orbiting the gas giants. Thus, the lower performing metal powder system has a much higher ΔV for multiple missions than the cryogenic concept which is only suitable for one planet/one mission scenarios.

This paper presents a historical review of metal powder propulsion systems and reports on continuing privately funded research on this concept.