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ADVANCED ROOM TEMPERATURE PROPELLANTS FOR ROCKETS AND SPACECRAFTS

Abstract

Advancements in Rocket propulsion technology designs have been reaching greater performance levels than ever before by utilizing new systems engineering processes and practices. Historically, high performance rockets have utilized cryogenic propellants for higher performance and storage densities. However, this presents a complication to the entire process of manufacture, storage, preservation and flow control of propellants before and during launch. This has prompted many research efforts into efficient and economic solutions and alternatives.

This study was motivated by the need for high-performance liquid propellants which have enhanced stability, storage and mass production at room temperature. The study includes the findings into the efforts to investigate:

1) Alternative high-performance liquid propellant compositions for space propulsion. 2) The key performance parameters for evaluating these propellants and their supporting systems. 3) The practicality of these high-performance alternative propellants for future propulsion systems.

Systematic simulations were conducted using the NASA Computer program CEA (Chemical Equilibrium with Applications) which calculates chemical equilibrium compositions and properties of complex mixtures for theoretical rocket performances. Propellent mixtures composed of Dinitrogen Tetroxide (N2O4) and Monomethyl Hydrazine (MMH) with a fixed operating pressure, O/F ratio and area expansion ratio were used as the bases for the different analysis. Various catalysts were introduced and simulated with the base propellent mixtures to enhance performance and operability. The relative performance of the mixtures was evaluated in terms of different key parameters including: specific impulse, characteristic velocity, specific impulse in vacuum and thermodynamic potential, evaluated as a function of chamber pressure and supersonic nozzle expansion ratio. The results provide useful insight into the propellant combustion phenomenon and distinguished, ordered and distinctive hybridization. The study also investigates the operational advantages of the room temperature propellants including simplified storage and handling, stability, and cost effectiveness for spacecraft and launch vehicle propulsion applications.