Paper ID: 75146
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IAF SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations - IAF SPACE PROPULSION SYMPOSIUM (IPB)

Author: Prof. Rachid Amrousse
Chouaib Doukkali University, Morocco

PROSPECTS IN GREEN PROPELLANTS AND GREEN PROPULSION SYSTEMS

Abstract

Although hydrazine is a remarkable chemical, the challenges associated with handling it and the true hazard it poses in the event of human exposure have driven a search for a more benign alternative that meets or exceeds the performance of hydrazine. The term "green monopropellant" encompasses a reduction in overall handling and safety requirements low toxicity, non-carcinogenic, noncorrosive, low vapor pressure to reduce exposure routes and flammable headspace. The 2006 European Union (EU) Regulation (EC) No. 1907/2006 requires all chemical substances produced or used by industry to be registered with the European Chemicals Agency (ECHA). Substances of very high concern (SVHC) are given a sunset date after which the manufacture, import, and use of the substance in the EU will be prohibited unless specific authorizations granted by ECHA. Hydrazine was added to the candidate list of SVHCs in 2011; while no sunset date has been assigned, it is clear to industry that hydrazine will need to be replaced in order to comply with EU regulations. For all green monopropellants, the strategy for achieving the safety goals is generating ternary ionic solutions based on an oxidizing salt and fuel mixture with water. Common oxidizing salts are HAN, ADN, HNF and AN. The European search for a hydrazine replacement began in earnest in 2008 with a project called GRASP, a consortium of 12 universities and organizations. The GRASP program identified a number of possible hydrazine replacements; including some already well into their development, such as FLP-106 and LMP-103S. Both of these propellants are based on ADN, a strong oxidizer originally discovered at the Zelinsky Institute of Organic Chemistry in Moscow in 1971. ADN remained a state secret until it was rediscovered in 1988 by researchers at Stanford Research Institute in the U.S. Both FLP-106 and LMP-103S have been in development since the late 1990s by Total försvarets forsknings institute, the Swedish Defense Research Agency (FLP-106), and commercial firm Ecological Advanced Propulsion Systems (LMP-103S). These propellants, which have demonstrated low toxicity and high performance, are viable candidates for replacing hydrazine for monopropellant space propulsion systems. LMP-103S has been flight tested on the Prisma satellite launched in 2010 and demonstrated 2-3 hours of accumulated firing time through the summer of 2011. Other solutions based on HAN developed by American researchers called AF-315E and by Japanese agency JAXA called SHP163. Both HAN solutions were tested on the green propellant missions.