World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:11, No:07, 2017

Hazardous Effects of Metal Ions on the Thermal Stability of Hydroxylammonium Nitrate

Authors : Shweta Hoyani, Charlie Oommen

Abstract : HAN-based liquid propellants are perceived as potential substitute for hydrazine in space propulsion. Storage stability for long service life in orbit is one of the key concerns for HAN-based monopropellants because of its reactivity with metallic and non-metallic impurities which could entrain from the surface of fuel tanks and the tubes. The end result of this reactivity directly affects the handling, performance and storability of the liquid propellant. Gaseous products resulting from the decomposition of the propellant can lead to deleterious pressure build up in storage vessels. The partial loss of an energetic component can change the ignition and the combustion behavior and alter the performance of the thruster. The effect of largely plausible metals- iron, copper, chromium, nickel, manganese, molybdenum, zinc, titanium and cadmium on the thermal decomposition mechanism of HAN has been investigated in this context. Studies involving different concentrations of metal ions and HAN at different preheat temperatures have been carried out. Effect of metal ions on the decomposition behavior of HAN has been studied earlier in the context of use of HAN as gun propellant. However the current investigation pertains to the decomposition mechanism of HAN in the context of use of HAN as monopropellant for space propulsion. Decomposition onset temperature, rate of weight loss, heat of reaction were studied using DTA- TGA and total pressure rise and rate of pressure rise during decomposition were evaluated using an in-house built constant volume batch reactor. Besides, reaction mechanism and product profile were studied using TGA-FTIR setup. Iron and copper displayed the maximum reaction. Initial results indicate that iron and copper shows sensitizing effect at concentrations as low as 50 ppm with 60% HAN solution at 80°C. On the other hand 50 ppm zinc does not display any effect on the thermal decomposition of even 90% HAN solution at 80°C.

Keywords : hydroxylammonium nitrate, monopropellant, reaction mechanism, thermal stability
Conference Title : ICEM 2017 : International Conference on Energetic Materials
Conference Location : Zurich, Switzerland
Conference Dates : July 27-28, 2017