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RECENT DEVELOPMENT OF HYDROXYLAMMONIUM NITRATE (HAN) GREEN LIQUID MONOPROPELLANT IN MALAYSIA

Abstract

Recently, the Malaysia government has announced National Space Policy 2030, with ambition to develop space sector and relevant industries in Malaysia. One of the focus area is the development of green monopropellant aimed for liquid-based micropropulsion system for satellites, which is the collaborative effort between the university of Nottingham Malaysia Campus and National Space Agency Malaysia (ANGKASA), since Year 2009.

Hydroxylammonium nitrate (HAN), with the chemical formula NH3OHNO3, has high energy density, low handling and low storage cost. However, several crucial challenges, such as combustion stability and reliable ignition need to be resolved, in order to further develop potential usage of HAN in miniaturized satellites, such microsatellites or cubesats.

Conventional methods in decomposing HAN include thermal and catalytic decomposition or combination of both. Our research group focus on electrolytic decomposition of HAN propellant. The HAN solution was prepared in house via titration between aqueous solution of hydroxylamine and nitric acid, followed by concentration in a rotary evaporator. HAN ternary mixtures were prepared by adding additive fuel into the concentrated HAN solution.

In our initial work of investigation into utility of electrodes [1]. copper electrode were used to create a competitive environment during initiation stage because both copper and water undergo oxidation at anode with oxidation of copper electrode favored ahead of water due to its relatively lower standard electrode potential. Initiation of HAN electrolytic decomposition is independent of its concentration before reaching 100 C, the boiling point of water at standard condition. The solution near to the anode started to turn into light blue which indicates the occurrence of Cu2+ ion.

In another work, transparent microreactors with simple chamber layout were used to investigate electrolytic decomposition of HAN solution by different number of pairs of electrodes and visualization on the decomposition phenomena [2]. The decomposition starts at anode and it takes 120 ms for the decomposition to achieve steady state using 3 pairs of electrodes.

Current work in the group including energy release mechanism and effect of nanoparticles in the electrolytic decomposition behaviour HAN ternary mixtures.

[1] K.S. Koh, J. Chin, T.F.W.K. Chik, Role of Electrodes in Ambient Electrolytic Decomposition of Hydroxylammonium Nitrate (HAN) Solutions, Propulsion and Power Research 2 (2013) 194-200 [2] W. S. Chai, J. Chin, K.S. Koh, T.F. Wahida, Qualitative Study on Electrolytic Decomposition of Hydroxylammonium Nitrate (HAN) solution in PDMS-based Micro-combustion Chambers, International Symposium on Space Technology and Science, JSASS, Nagoya, Aichi, 2013, pp. ISTS 2013-b-2018