SPACE LIFE SCIENCES SYMPOSIUM (A1)
Astrobiology and Exploration (6)

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BIOMETHANATION FOR IN-SITU FUEL GENERATION ON NEAR-EARTH OBJECTS

Abstract

Creating a readily available source for hydrocarbon-based fuels in space has the potential to reduce launch costs and increase the mass and lifetime of spacecraft. Carbonaceous asteroids are one potential source of fuel. Biomethanation – the production of methane by microbes – is viable for Earth-based operations, thus applications in space under controlled conditions have potential. We have performed a feasibility study to demonstrate the potential of biological resource extraction methods on asteroids. Experimental testing of aerobic and anaerobic microbial strains showed interesting initial results for in-situ applications. Three bacterial (*P. Aeruginosa*, *B. Subtilis* and *E. Coli*) and three archaea (*M. Barkeri*, *M. Mazei* and *M. Taylorii*) strains were exposed to a vacuum at 0.025% Earth atmospheric pressure to test post-exposure viability. Cell degradation and colony size reduction were quantified for aerobic strains. Adverse effects due to vacuum treatment were exhibited more so in gram-negative than gram-positive strains. Archaea showed limited to no cell degradation. A significant decrease in methanogenesis rates was observed in all three archaea strains for the one, five and ten minute exposed samples. Interestingly, the 30 and 60 minute samples exhibited not only near-complete recovery in methanogenesis rates, but also an increase in methane production over the respective control samples. This is of significance as vacuum exposed microbes could potentially exhibit increased production capabilities after longer exposure times and undergo limited negative effects in vacuum, demonstrating the potential of microbial in-situ biogas operations. If successful a sustainable and cost-effective method of producing methane based fuel reserves could revolutionise in-situ resource and fuel generation for spacecraft, thus enhancing spacefaring capabilities.