

Plasma Abatement of Volatile Organic Compounds for Treatment of Spacecraft Trash Combustion Gaseous Effluents.

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ABSTRACT:

One approach that has been investigated for trash management aboard long-duration crewed exploration space missions is the so-called Trash-to-Gas approach. This technology uses a thermal process (i.e., combustion, pyrolysis, etc.) to convert crew trash into relatively non-reactive gases (i.e., CO₂, CO, etc.) that can be easily vented overboard. One difficulty with this approach is the potential for the contamination of the spacecraft habitable volume from the myriad volatile organic compounds (VOCs) that are concurrently produced from these thermal processes. One possible VOC abatement process is to apply a plasma to the effluent gases. Plasmas provide high energy electrons and ions that are capable of breaking down gaseous organic species generally into smaller compounds. To explore Plasma VOC abatement, the authors constructed a plasma gas system that recirculates a particular VOC-laden gas mixture through a plasma torch. This allows the periodic collection of aliquots of gaseous samples for subsequent analyses via gas chromatography mass spectrometry, designed to quantify the remaining VOC materials. The VOCs evaluated included 100 ppm of acetone, benzene, ethanol, and pentane in a background of carbon dioxide. The plasma conversion of all analytes followed first-order rate kinetics, and complete VOC elimination was observed after 10 min or less of treatment, for all analytes measured. Additionally, it was observed that the plasma caused the conversion of CO₂ into oxygen and CO.