Mars Atmospheric Conversion to Methane and Water: An Engineering Model of the Sabatier Reactor with Characterization of Ru/Al_2O_3 for Long Duration Use on Mars

Anne J. Meier[1*], Malay Shah[1], Elspeth Petersen[2], Paul Hintze[1], Tony Muscatello[1]

[1]NASA, Kennedy Space Center, Florida, USA
[2] Iowa State University, Department of Chemical Engineering, Iowa, USA
*Anne.Meier@NASA.gov

The Atmospheric Processing Module (APM) is a Mars In-Situ Resource Utilization (ISRU) technology designed to demonstrate conversion of the Martian atmosphere into methane and water. The Martian atmosphere consists of approximately 95% carbon dioxide (CO_2) and residual argon and nitrogen. APM utilizes cryocoolers for CO_2 acquisition from a simulated Martian atmosphere and pressure. The captured CO_2 is sublimated and pressurized as a feedstock into the Sabatier reactor, which converts CO_2 and hydrogen to methane and water. The Sabatier reaction occurs over a packed bed reactor filled with Ru/Al_2O_3 pellets. The long duration use of the APM system and catalyst was investigated for future scaling and failure limits. Failure of the catalyst was detected by gas chromatography and temperature sensors on the system. Following this, characterization and experimentation with the catalyst was carried out with analysis including x-ray photoelectron spectroscopy and scanning electron microscopy with elemental dispersive spectroscopy. This paper will discuss results of the catalyst performance, the overall APM Sabatier approach, as well as intrinsic catalyst considerations of the Sabatier reactor performance incorporated into a chemical model.