

Demonstration of Robustness and Integrated Operation of a Series-Bosch System

Manned missions beyond low Earth orbit will require highly robust, reliable, and maintainable life support systems that maximize recycling of water and oxygen. Bosch technology is one option to maximize oxygen recovery, in the form of water, from metabolically-produced carbon dioxide (CO₂). A two stage approach to Bosch, called Series-Bosch, reduces metabolic CO₂ with hydrogen (H₂) to produce water and solid carbon using two reactors: a Reverse Water-Gas Shift (RWGS) reactor and a carbon formation (CF) reactor. Previous development efforts demonstrated the stand-alone performance of a NASA-designed RWGS reactor designed for robustness against carbon formation, two membrane separators intended to maximize single pass conversion of reactants, and a batch CF reactor with both transit and surface catalysts. In the past year, Precision Combustion, Inc. (PCI) developed and delivered a RWGS reactor for testing at NASA. The reactor design was based on their patented Microlith® technology and was first evaluated under a Phase I Small Business Innovative Research (SBIR) effort in 2010. The RWGS reactor was recently evaluated at NASA to compare its performance and operating conditions with NASA's RWGS reactor. The test results will be provided in this paper. Separately, in 2015, a semi-continuous CF reactor was designed and fabricated at NASA based on the results from batch CF reactor testing. The batch CF reactor and the semi-continuous CF reactor were individually integrated with an upstream RWGS reactor to demonstrate the system operation and to evaluate performance. Here, we compare the performance and robustness to carbon formation of both RWGS reactors. We report the results of the integrated operation of a Series-Bosch system and we discuss the technology readiness level.