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MOXIE COMPOSITION SENSORS CALIBRATION AND CHARACTERIZATION

Abstract

MOXIE, the Mars Oxygen In-Situ Resource Utilization Experiment, is one of the payloads that will be carried on the Mars 2020 rover. It is being developed by MIT and NASA's Jet Propulsion Laboratory (JPL) to demonstrate, for the first time, In-Situ Resource Utilization (ISRU) technologies on another planet by extracting O_2 from CO_2 in the Martian atmosphere using solid oxide electrolysis (SOE). In order to inform and control its system, MOXIE has a set of temperature, pressure, and composition sensors that measure its internal gas flows. The four composition sensors present are all commercial off-the-shelf (COTS) hardware and include an oxygen sensor, 0 – 100% and a carbon dioxide sensor, 0 – 5% for the output gas stream from the SOE anode and another carbon monoxide sensor, 0 – 100% and a carbon dioxide sensor, 0 – 100% for the cathode. All of these composition sensors, except the luminescence oxygen sensor, are Non-Dispersive Infrared Radiation (NDIR) sensors that use Beer's law for their readings. However, these sensors are produced for Earth-ambient-conditions, and thus they lack any data that predict their behavior under Mars-like conditions. This research involves a series of tests under a range of temperatures, pressures and concentrations in order to properly calibrate and characterize (CC) the sensors to understand their future behavior on Mars. In order to simulate Mars's conditions and conduct the mentioned CC tests, this research involved designing and constructing a small temperature-controlled vacuum chamber. Following a set test plan, numerous sensor readings were recorded while varying the chamber gas composition, pressure and temperature. The main motivation behind these tests is to decode the proprietary algorithms that govern the sensor composition readings, which involves employing a modified version of Beer's law. Additionally, these tests are important for gaining a better understanding about the sensors' response time, aging, degradation, and cross-sensitivity between different gases. Thus this research helps in characterizing and calibrating the MOXIE sensors prior to their flight on the Mars 2020 rover in order to ensure full understanding of their readings.