Improving the Measurement Accuracy of Water Partial Pressure Using the Major Constituent Analyzer

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The Major Constituent Analyzer (MCA) on board the International Space Station (ISS) is a mass spectrometer-based system designed to monitor the major constituents of the ISS internal atmosphere. Of these, nitrogen, oxygen, methane, carbon dioxide, and hydrogen are being monitored as originally designed. Obtaining accurate water vapor measurements, however, has been problematic. The primary issue for water vapor measurement is the adsorption of water onto the interior surfaces of the ISS sampling lines, MCA internal sample transport lines, and the MCA analyzer itself. Whenever the partial pressure of water in the sample stream changes, a new equilibrium between the adsorbed and gas phases must be reached before a measurement will reflect the actual partial pressure. Thus, while changes in the partial pressures of the other major constituents are detected in real-time, accurate measurement of the water partial pressure is delayed. Unfortunately, the time required to reach equilibrium is longer than current MCA operating parameters allow, so the measured values are not accurate.

This issue was apparent early on in the MCA program, when the temporal characteristics of humid air being transported from sample points in the ISS modules through various lengths of tubing was unknown. The decision was made at that time to descope water from the measurement process until a future date when the problem could be properly addressed. Recently, the MCA program has been authorized to revisit the issue as a sustaining engineering task and implement the findings as part of a series of upgrade and improvement tasks through NASA change request CR10773A.

This paper describes the basis for identifying the primary contributors to the water desorption time constant within the MCA, and an improved method for accurately determining the water vapor partial pressure. The method includes a revised procedure for calibrating the MCA water channel as well as a strategy, based on the modeling, for accurately estimating ISS humidity levels within the sampling times allocated for each module. The improved method is scheduled for implementation into the MCA firmware in the fall of 2009.