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CALIBRATION AND PRELIMINARY TESTS OF THE BRINE OBSERVATION TRANSITION TO LIQUID EXPERIMENT ON HABIT/EXOMARS 2020 FOR DEMONSTRATION OF LIQUID WATER STABILITY ON MARS

Abstract

The search for unequivocal proofs of liquid water on present day Mars is a prominent domain of research with implications on habitability and future Mars exploration. The HABIT (Habitability: Brines, Irradiation, and Temperature) instrument onboard the ExoMars 2020 Surface Platform (ESA-IKI Roscosmos) will investigate the habitability of present day Mars, monitoring: temperature, winds, dust conductivity, ultraviolet radiation and liquid water formation. The purpose of BOTTLE (Brine Observation Transition To Liquid Experiment) is to: (1) quantify the formation of transient liquid brines; (2) observe their stability over time under non-equilibrium conditions; and (3) serve as an In-Situ Resource Utilization (ISRU) technology demonstrator for water moisture capture and release.

In this work, we describe the calibration procedure of BOTTLE with standard concentrations of brines, the calibration functions and, the correction constants (for external factors such as temperature, degradation of electrodes, role of salt granularity, compactness and distribution, role of salt depth, response of brine to heating, etc.,) needed to interpret the observations on Mars.

BOTTLE consists of four containers with different deliquescent salts that have been found on Mars (calcium chloride and magnesium, sodium and calcium perchlorates) and two containers that are open to the air, to collect atmospheric dust. The salts are exposed to the martian environment through a High Efficiency Particulate Air (HEPA) filter (to prevent microbial contamination). The deliquescence process will be monitored by observing the changes in electrical conductivity (EC) in each container: dehydrated salts show low EC, hydrated salts show medium EC and, liquid brines show high EC values. We report and interpret the preliminary test results using the BOTTLE engineering model in representative conditions; and we discuss how this concept can be adapted to other exploration missions.

Our laboratory observations show that 1.2 g of $CaCl_2$ (tentative amount of salt in each container at lift-off) captures and releases about 3.7 g of liquid water as brine. This ISRU technology could potentially be the first attempt to understand the formation of transient liquid water on Mars and to develop self-sustaining in-situ water harvesting on Mars for future human and robotic missions.

Keywords: Deliquescence – Water on Mars – Electrical Conductivity – Instrument – ISRU – Mars Exploration