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IN-SITU-RESOURCE-UTILIZATION WATER-FARMS FOR MARS AND EARTH ARID REGIONS

Abstract

As space exploration expands it becomes more urgent the need to develop In-Situ Resource Utilization (ISRU) techniques that provide resources on other celestial bodies such as the Moon, Mars and asteroids or that reuse waste products in spacecrafts. One of the most critical valuables for planetary exploration is water, which can be used by the crew, for greenhouses, but also to produce O2 and H2 for propulsion systems, and O2 for respiration. The focus of this work is to demonstrate the operability of a self-sustained water-farm for Mars and on analogue arid regions on Earth.

The BOTTLE (Brine Observation Transition To Liquid Experiment), one of the components of the HABIT instrument onboard the ExoMars 2020 Surface Platform (ESA-IKI Roscosmos), shall be the first In-Situ Resource Utilization (ISRU) technology demonstrator for water moisture capture and release on Mars. BOTTLE will include deliquescent salts that can absorb moisture from the air, when the temperature and relative humidity conditions are such that hydration or deliquescence is possible. In this later case, the salts melt into a liquid brine. Finally, the captured water can be released back to the atmosphere provided that T is increased (and RH decreases).

This process is here adapted to a water-farm that captures atmospheric water and recovers the purified, brine-released, water vapour in a separated container. We have developed a self-sustainable, scalable water-farm demonstrator that adapts the BOTTLE experiment within a structure that works in a similar way to the popular solar still. The prototype has two openings for communication with the external atmosphere a transparent inclined roof for solar heating and water condensation. This prototype incorporates a number of sensors, an ambient temperature and a relative humidity sensor, and a brine temperature sensor together with a thermal heating resistor. The efficiency of capture and release in representative environmental conditions is investigated here and interpreted with the phase diagrams of the deliquescent salt in terms of grams of water captured, power required to release and condense pure water and size. The operability of the water farm is tested over multiple days in a dedicated environmental chamber and in analogue conditions. This system is scalable, portable and robust and its applicability in a potential future mission to Mars is here discussed. The water-farm can also provide low-cost water access to arid regions on Earth.

Keywords: ISRU; Mars; Human Exploration; Water; Deliquescence