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CHLORIDES FOR IN-SITU RESOURCE UTILIZATION ON MARS

Abstract

In-situ resource utilization (ISRU) is vital for sustainable solar system exploration. There has been excellent progress in using Lunar and Martian regolith for construction, as well as oxygen and metal extraction. However, Mars has another resource to consider for exploitation: chloride salt.

On Earth, sodium chloride salt (NaCl) production and its transportation drove the growth of civilisations and global economy. Although many uses of salt are not applicable to Mars settlements, chlorides are nonetheless an extremely useful compound for many chemical and industrial processes. For example, liquid water is potentially present on Mars as groundwater brine. NaCl is a major component in drilling fluid used to prevent clays from hydrating and dispersing when drilling water wells. Further, NaCl and KCl are used to replenish ion-exchange resins during water softening – purifying brines while extracting other metals. Salt can depress the melting point of Martian ice. Similarly, salts can be used to de-ice pathways and to suppress dust to protect machinery from and structures from unnecessary wear. Domestically, salt curing is the simplest method of preserving food grown in Martian greenhouses and can be used in simple cleaning solvents in place of difficult to recycle detergents. Saltwater reacts with volcanic ash to form bentonite, a highly absorbent clay used as an industrial sealant. Other manufacturing applications include glass making, where NaCl prevents air bubbles, and Na2CO3 lowers the melting point of silica.

NaCl and KCl can be processed into other useful materials through electrolysis and the Solvay process. NaCO3, Na2CO3, CaCl2, and HCl are potential products that have their own applications that can be explored for Mars ISRU.

Multiband spectral imaging from the Thermal Emission Imaging System shows over 600 chloride-rich sites on Mars (Osterloo et al. 2010), which are most likely NaCl or KCl. In addition to reviewing ISRU potential, we provide a higher resolution map of chloride deposits in Terra Sirenum, where they are most abundant. We measure salt deposits up to 8 m thick, making it viable for quarrying.

Although many uses for chlorides depend on the availability of water, and other materials, (e.g. ammonia for the Solvey process, or ion-exchange resin for water softening), it is always beneficial to know what resources are readily available near prospective landing sites. Given the importance of salt throughout human history, it has the potential to greatly influence how we develop technologies and habitats required for sustained human presence on Mars.