"Generation and Recovery of Volatiles in Low Pressure Environments"

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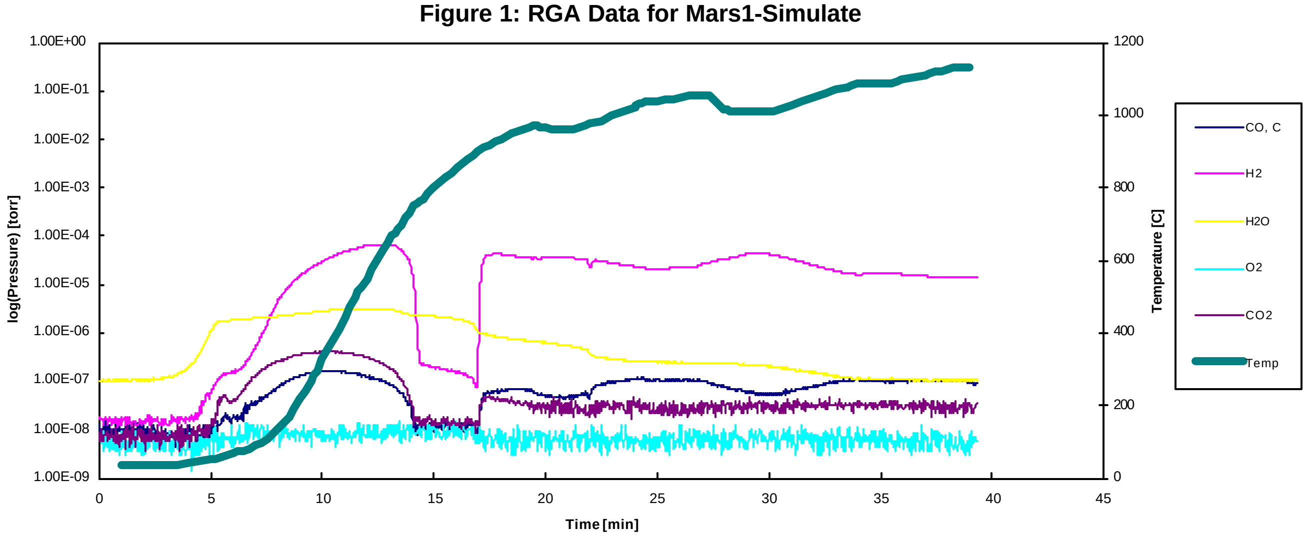
The generation and condensation of water vapor from regolith simulants in low-pressure environments has been investigated experimentally. Two distinct experiments were performed. The first examined the dynamics of volatile vaporization from simulants in a tubular furnace. The second experiment examined the recovery of water vapor that is expanded to a low-pressure environment.

The reactor design that proved to be the most promising was based on the use of a cylindrical coordinate system. A cylindrical reactor allowed the use of symmetry for many of the calculations involved in the characterization of the tested Martian regolith. This design of the reactor also provided the bases for a continuous prototype process that is currently being researched, studied and designed by another team. The chamber was maintained at Martian environmental conditions, P ~ 5 torr of CO_2, and the volatile evolution was monitored as a function of time and temperature using a quadrapole mass spectrometer (QMS).

The use of LAB View as the primary DAQ platform gave the ability to characterize the regolith tested in the reactor, this was accomplished by remotely monitoring two temperatures continuously, at a specified and know separation distance, during the transient heating of the regolith. Using a finite difference method the thermal conductivity of the regolith was calculated. This proved to be valuable in calculating the baseline power requirements of a prototype system. Using sand of known thermal conductivity, the process of characterizing the regolith was tested. The system produced highly accurate data for the thermal conductivity of the sand.

The QMS became available for the use of characterizing the release of volatiles with respect to time and temperature. Relative amounts of H_2, H_2O, CO/N_2, and CO_2 were released and measured by the QMS system (Figure 1). There was an interesting and unexpected spike from H_2, there was considerably more hydrogen released then any other volatile. To this point we don't know what to attribute this to exactly. We are currently in the process of conduct some different tests to determine the source of the H_2 release. There is an initial spike

Figure 1: RGA Data for Mars1-Simulate



in the hydrogen gas release after energizing the furnace and then a second one that begins around 900^oC that continues to release through the allowed temperature range of the furnace (thru 1100^oC). This release of hydrogen is two orders of magnitude greater then the water release, which is the next largest volatile, measured. There is also a considerable change in the composition of the MARS-1 simulate during the heating process. At temperatures greater then 900^oC the regolith changes from its reddish appearance to a dark, burned, almost lava rock appearance. Like earlier tests, water was primarily released around 600^oC. This brings us up to the present day.

The goal of the condenser studies was to design, build and test a condenser apparatus for recovery of water in the Martian atmosphere. Two types of condensers (one straight, one curved) were tested over a range of pressures, and also run under various surrounding temperatures to yield a range of data.

The condenser system was run under two changes in pressure: the first system was heated in a pressurized vessel and evacuated to atmospheric pressure, and the second system was heated in an atmosphere pressure vessel and evacuated to a vacuum at 5 torr. It was found that a change in pressure of 1 atmosphere yielded approximately 80 percent higher recovery in system 1 versus system 2. This showed that an atmospheric system would not be able to be used to model a vacuum system. Also, it emphasizes the difficulty of recovering water in a near-zero pressure environment.

Surrounding temperatures of 10, 5, 0, and –5 °C were used to observe temperature effects on percent recovery of water. As expected, the cooler the surrounding temperature, the higher percent recovery of water. Changing the surrounding temperature did not have a large effect on the percent recovery.

Finally, tortuosity, the measure of a distance traveled by a particle versus the distance traveled if particle had followed a straight line, was then used to compare a straight condenser to a curved condenser. The straight condenser had a tortuosity of 1, where as the curved condenser had a tortuosity of 1.167. The curved condenser produced a percent recovery approximately 8% higher than that of the straight condenser.