Experimentation and Simulation of Volatile Transport within Airless Bodies. G. L. Schieber[1], B. M. Jones[2], T. M. Orlando[2], P. G. Loutzenhiser[1], [1]George W. Woodruff School of Mechanical Engineering and [2]School of Chemistry and Biochemistry, Georgia Institute of Technology

Understanding gas transport through lunar regolith is important to further the scientific understanding of phenomena on the lunar surface and for designing *in-situ* resource utilization systems. Several hydrogen sources have been identified on the moon, including ice trapped below the surface at the poles and in dark craters. The focus of this work is to characterize and model the transport of H_2O vapor and other volatiles through regolith under lunar conditions.

The experimental apparatus schematically depicted in Figure 1 was designed and fabricated to measure the permeability of lunar regolith. Vacuum chambers with pressure sensing instrumentation surrounds, on both sides, a central column of regolith. The volatile was introduced during experimentation, and the pressure difference across the packed bed was studied under steady and transient conditions. The temperature was controlled with heat tape and liquid nitrogen and was monitored with six internal thermocouples. The experimental results were compared with a numerical model that coupled Darcy's Law to the mass continuity equation in a transient form. The model predicts the pressure profile within the packed bed, composed of the regolith simulant JSC-1A over a range of temperatures between 150 K and 400 K. The transition regime permeation through the regolith was modeled using correlations based on the Knudsen number (Kn, the ratio between the molecular mean free path to a length scale) for permeability. Several correlations were investigated by comparing result from numerical models to experimental results. The numerical model was structured using finite volume analysis and generalized by introducing dimensionless variables. A heat transfer model was coupled to the analysis for predicting the local Kn in one-dimension (axial) and two-dimensions (axial and radial). Model verification was completed by comparing the results with a suite of experiments in the experimental apparatus.

The combined heat transfer and volatile transport models may be used to predict sublimation rates of wet regolith and, therefore, a model of H_2O losses is possible. These results provide the building blocks needed for designing, modeling, and fabricating the infrastructure required to utilize the lunar resources.

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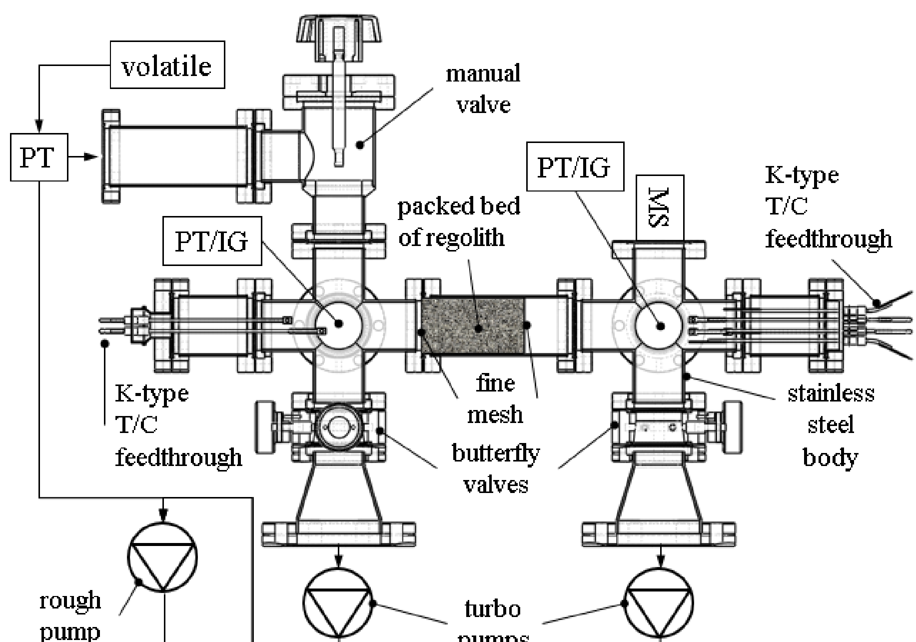

Figure 1: Schematic of the experimental apparatus used to measure the permeability of regolith to volatiles. PT/IG: Pressure transducer/Ion gauge, MS: Mass spectrometer, T/C: Thermocouple