Extracting Oxygen from Lunar Simulant using a Transparent Furnace Pulsed Fluidized Bed

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## Abstract

In the event that humans return to the moon, utilizing the local materials will be beneficial for extended stays. Rather than transporting resources, such as oxygen, from Earth, NASA is investigating methods of extracting it from lunar regolith. One promising process is hydrogen reduction. In the hydrogen reduction process, lunar regolith is heated to 1000°C in the presence of hydrogen. The iron oxide (Fe-O) bonds, found in lunar material, are broken and the hydrogen attracts the oxygen to produce water vapor [Allen et al., 1996].

$$FeO + H_2 \rightarrow Fe + H_2O$$

The water vapor is then captured, cleaned, and electrolyzed. The hydrogen is recycled back to the reduction process and the oxygen is stored until consumed by an end user (propulsion, life support, etc.). To obtain a good oxygen yield, the majority of lunar regolith must be exposed to the hydrogen gas and have a high rate of heat transfer from heat source to particle. This is achieved with good solids mixing via fluidization or mechanical agitation.

In Generation II of the ROxygen program, the ROxygen Team at Johnson Space Center (JSC) investigated the feasibility of gas only pulsed fluidization as the only means to mix synthetic lunar regolith (simulant) at high temperatures. Fluidized beds have been used in industry to effectively process powders for decades. They consist of gas flowing upward through a bed of particles. The stirring action continuously moves the grains around to achieve uniform mixing of gas, solids, and heat [Geldart, 1986]. A transparent furnace unit was developed by Thoughventions Unlimited LLC (TvU) to aid in the qualitative observation of the fluidization behavior at high temperatures. Multipoint thermocouples and pressure sensors provided quantitative information regarding the quality of mixing. The water produced was measured using humidity sensors and captured using a NASA designed and built condenser. Once the simulant was processed, pneumatically transporting the 'hot' simulant out of the furnace was investigated.