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Title: *The First Step in Solar Hydrogen Production: Development of a Solar Thermal Reactor for the Reduction of Metal Oxide Particles*

Abstract:

A solar thermal reactor has been designed to experimentally investigate promising paths for reducing metal oxide particles to reduced oxidation states (e.g.  $\text{Fe}_2\text{O}_3$  to  $\text{Fe}_3\text{O}_4$ ) utilizing concentrated solar energy. This reactor is windowless and is able to handle internal cavity temperatures in excess of 1700 K. It also has a quasi-continuous feed system that allows the particle residence times to be varied for particles between 0.044 mm and 1 mm in diameter. Furthermore, this reactor utilizes an instrumentation system for the measurement of temperature, particle residence time, particle mass flow rate, and solar flux.

In an industrial setting, a large-scale metal oxide reactor would serve as the first step in a metal oxide solar thermal electro-chemical cycle. After the particles are reduced at elevated temperatures using concentrated solar energy, they are used in an electrolysis process to facilitate the production of hydrogen from water. In this process, the reduced metal oxide particles are reoxidized at the anode and hydrogen is liberated at the cathode. The presence of the metal oxide enables hydrogen to be produced with an ideal cell potential of 0.21 V, a potential substantially below the ideal value of 1.2 V for traditional water electrolysis.