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1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

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Inventors

Mai Xu
Shuguang Deng
Ellen Stechel
Ivan Ermanoski

Contact

Physical Sciences Team

Sorbent-Based Oxygen Separation for Energy Storage Systems

Background

Thermochemical energy storage has many practical implementation challenges, one of which is creating and maintaining a low oxygen partial pressure (pO2) during the thermal reduction step. In order to reduce the pO2, current approaches are to either purge the reactor with an inert sweep gas, or vacuum pumping. However, both of these approaches are energy-intensive and are expensive to implement.

Oxygen separation systems are designed to remove oxygen from the reduction sweep gas and produce an inert sweep gas back to energy storage reactors. Since oxygen is the unwanted component from the gas being separated, it is preferred to use an oxygen-selective sorbent, such as YBC114, that has the ability of temperature swing oxygen adsorption/desorption (TSA) at a relatively low temperature (less than 400 degrees Celsius). However, there is currently no system available that is cost-effective and does not require high energy input to operate.

Invention Description

Researchers at Arizona State University have developed a novel method for separating oxygen from the reduction sweep gas of energy storage reactors. This method provides an inert sweep gas for reducing pO2 during the thermal reduction in energy storage systems. The oxygen separation is based on a TSA process with an oxygen selective sorbent YBC114. This method provides an economical and efficient option to create and maintain a low pO2 during the thermal reduction step, and significantly reduce the overall energy cost for energy storage.

The TSA process consists of four steps: adsorption, heating, counter-current desorption, and cooling. The process can be carried out in a sorption system with a single sorption unit or multiple units. The oxygen separation system includes one or multiple sorption units, one or multiple heaters (depending on the number of sorption units), measurement devices for monitoring or controlling the pressure, temperature and gas flow rates at the inlets and outlets of the sorption unit(s), and pneumatic valves for automatic operation of the process.

Potential Applications

- Thermal reduction in energy storage reactors
- Gasification systems (oxygen-free inert gas produced with carbon dioxide or steam)
- Oxygen combustion systems (oxygen-concentrated gas produced with

recycled flue gas)

Benefits & Advantages

- Less expensive (simple equipment, inexpensive system parts, low cost of materials)
- Highly efficient (faster operation, continuous production of inert gas, consistent performance)
- Safer to operate (low operating temperature, can be remotely controlled)

Related Publication: Sorbent-based oxygen separation with YBC114 for energy storage systems

Faculty Profile: Dr Shuguang Deng - DREAM Lab (asu.edu)