BOC – Low-Cost Oxygen

Project Title:

Pilot-Scale Demonstration of a Novel, Low-Cost Oxygen Supply Process and its Integration with Oxy-Fuel Coal-Fired Boilers

Technology Area:	**Technology Maturity:**
Oxygen Supply	Pilot-Scale, 0.7 tonnes O_2/day

Primary Project Goal:

The BOC Group, now Linde, LLC, conducted pilot-scale tests of its Ceramic Auto-Thermal Recovery (CAR) oxygen (O_2) generation process, integrated with a coal-fired combustor, to produce a carbon dioxide (CO_2)-rich flue gas.

Technical Goals:

Phase I:

- Evaluate the performance of a 0.7-tonne/day, O_2 pilot-scale CAR system (long- and short-duration), when fully integrated with a pilot-scale coal combustor, and determine the optimum operating conditions of this unit.
- Perform a techno-economic evaluation of a commercial-scale, O_2-fired power plant that utilizes a CAR system to provide the O_2.

Phase II:

- Design and construct a nine-tonne/day, O_2 pilot-scale CAR unit.

Technical Content:

In the CAR process, O_2 is separated from an air stream using a perovskite ceramic oxide adsorbent (composed of lanthanum, strontium, cobalt, and iron) at high temperature (800°C to 900°C). As shown in Figure 1, the process involves two separate beds that are cycled to deliver the O_2 flow (one bed is adsorbing the oxygen, while the other is desorbing). The O_2 is desorbed from the catalyst by a partial pressure swing using a purge gas containing low levels of O_2 in standard runs; CO_2 is used for this purpose. Half cycle times are varied for most efficient operational parameters, but fall in the range of 30 seconds to one minute. Multiple temperatures are monitored in the catalytic bed and are spatially placed to give an accurate representation of the bulk temperatures in the ceramic bed.

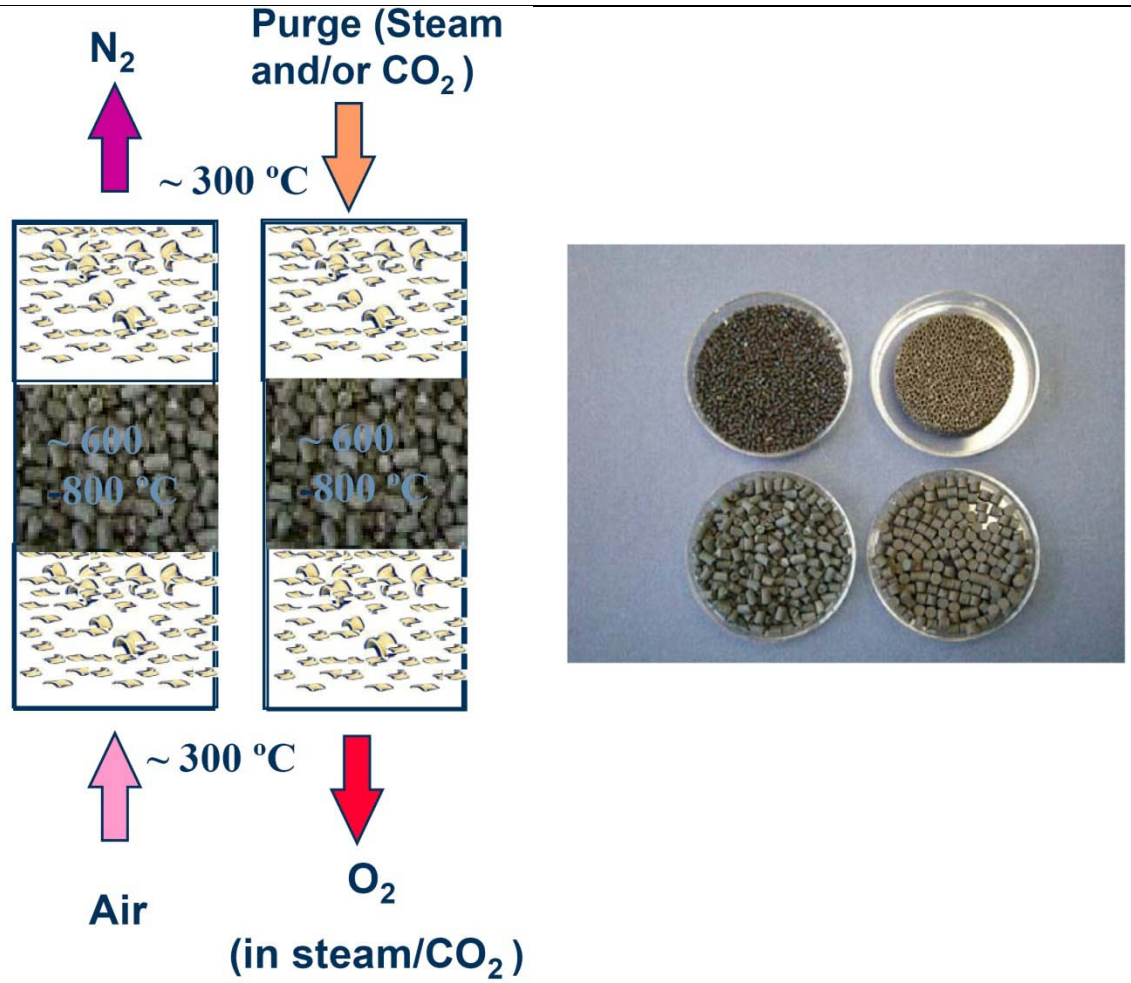

Figure 1: Ceramic Auto-Thermal Recovery (CAR) Two-Bed Oxygen Separation Process

Technology Advantages:

The O_2 production process has shown a clear advantage in performance and cost compared to an air separation unit (ASU).

R&D Challenges:

Although the CAR process alone compares favorably to an ASU, the techno-economic analysis has shown that overall capital costs, heat losses, and fuel consumption make the CAR process unfavorable compared to an ASU unless the working oxygen capacity of the CAR adsorbent can be increased from the current level of approximately 0.5 wt% to approximately 1.0 wt%. In addition, long duration tests have shown that the perovskite adsorbent experiences substantial mechanical breakdown and decline in performance when exposed to sulfur dioxide (SO_2).

Results To Date/Accomplishments:

Completed Phase I activities include:

- Evaluated the performance of the 0.7-tonne/day, O_2 pilot-scale CAR system (long- and short-duration) and determined the optimum operating conditions of the unit.
- Performed a techno-economic evaluation of a commercial-scale, O_2-fired power plant that utilizes

a CAR system to provide the O_2.	
Next Steps: Phase I results led to cancellation of Phase II activities; project completed September 2008.	
Available Reports/Technical Papers/Presentations: May 2007 Presentation, 6th Annual Conference on Carbon Capture and Sequestration, Pittsburgh, Pennsylvania.	
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