Advanced sorbents for modular oxygen production for REMS gasifiers

Project DE-FE0031528
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National Energy Technology Laboratory
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Prime Contractor:
Thermosolv LLC
Partners:
Western Research Institute
SigmaInnova LLC (Vendor)

Project Kick-off Meeting
February 8, 2018

Vijay K. Sethi, CEO

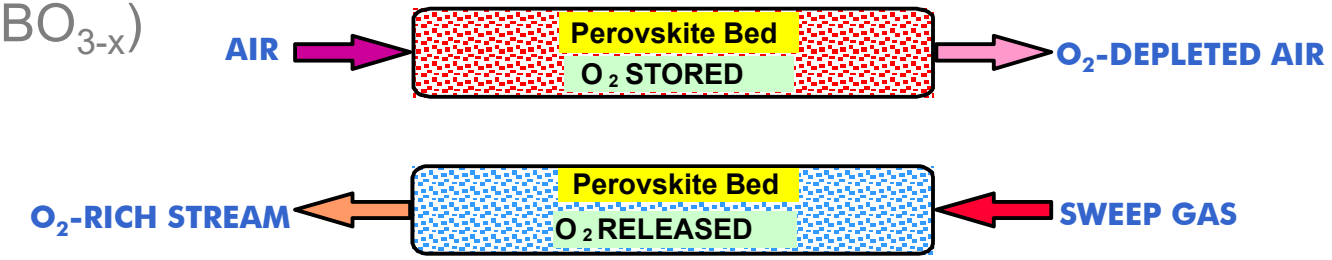
THERMOSOLV LLC

Agenda

- Background
- Project Objectives
- Statement of Work
- Project Schedule
- Project Milestones
- Identification of Risks and Mitigation Strategies
- Success Criteria
- Technology Maturation Plan
- Project Team

Background

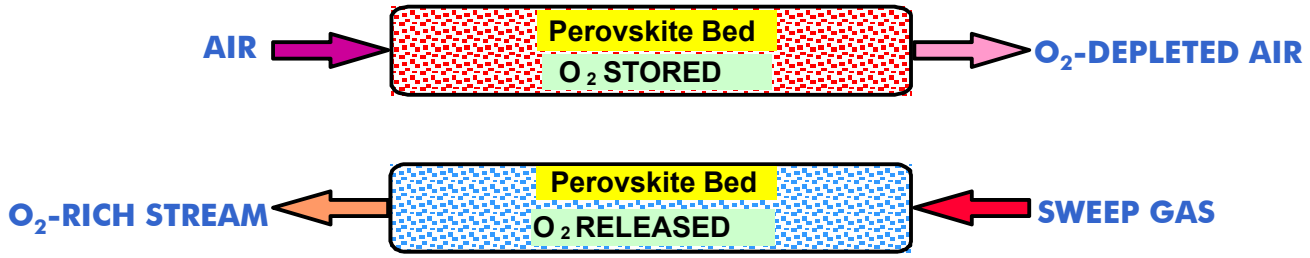
Sorbent-based Oxygen Production Process (ABO_{3-x})



- Adsorb O_2 from air in a solid sorbent
- Use of CO_2-rich flue gas and/or steam as sweep gas allows optimization of the O_2 concentration
- Use of vacuum or condensing steam sweep to produce oxygen
- High-temperature process driven by partial pressure of oxygen

Background

Sorbent-based Oxygen Production Process



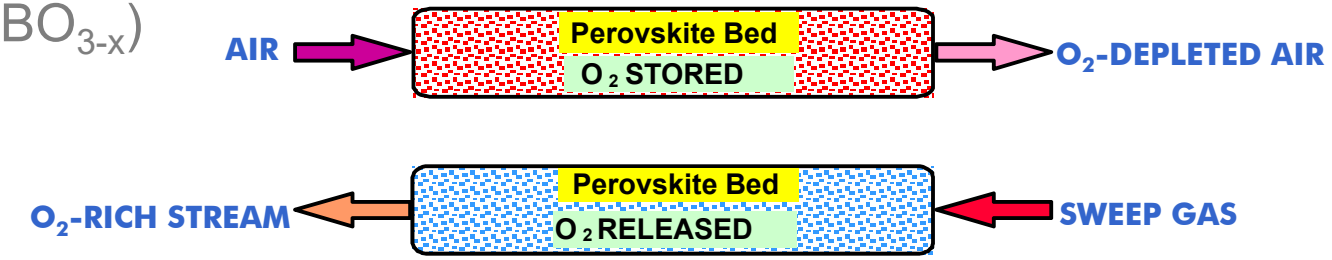
Between 2005 and 2008, under two separate Cooperative Agreements, a two-bed, 60-pph unit was developed by BOC/Linde and tested at WRI. The unit was integrated with an existing 250,000 Btu/h Combustion Test Facility to demonstrate oxy-fuel combustion concepts.

Conclusions:

- Improve oxygen uptake capacity
- Lower operating temperature from 850° C to about 500° C
- Improve desorption kinetics

Background

Sorbent-based Oxygen Production Process (ABO_{3-x})



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- Perovskite with order-disorder transition
  - Lower heat of oxygen sorption
  - Improved oxygen uptake capacity
  - Lower operating temperature from 850° C to about 500° C
  - Improved desorption kinetics

Project DE-FE0028002…

- Design and Build a 1-tpd Oxygen Plant
  - Sorbent manufacturing scale-up underway
  - Equipment Design completed
  - Reactors and other vessels out for fabrication bids
  - **Cost of Sorbent?**

Background

High Cost of Sorbent…

- Starting Materials
- Small Niche Market
  - High Purity
  - Fuel Cells
  - Membranes
- Limited Manufacturing Capabilities

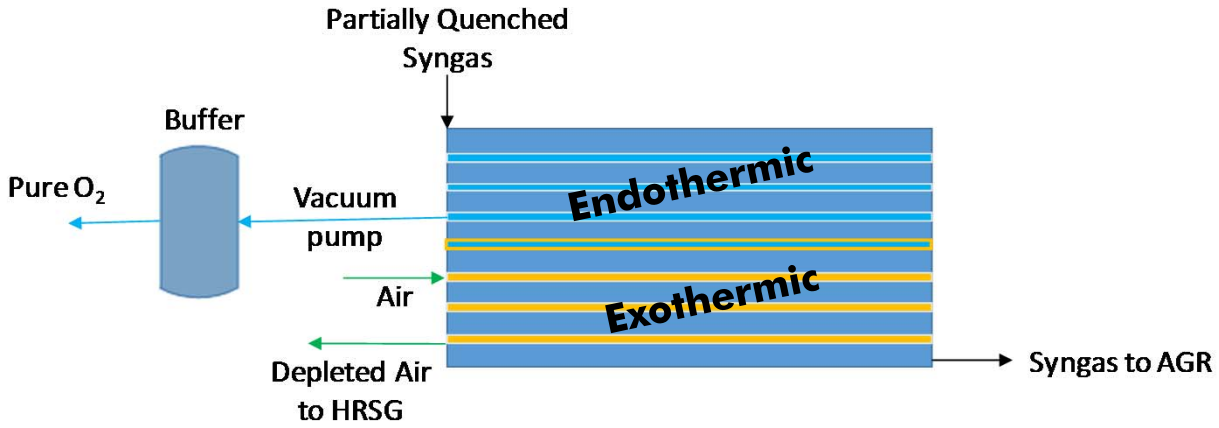
Strategies for Reducing Cost…

- Bulk Manufacturing with “Standard” Purity Materials
- Alternate Cheaper Chemistries
  - Ca, Mn, Fe with and without dopants
- “Coated/Supported” Sorbent

REMS Gasifier

Low-cost Oxygen for Small-scale Modular Gasification

- Fully integrated >95% purity oxygen process for small-scale modular < 5MW coal gasification plants



Process gas is used to maintain temperature

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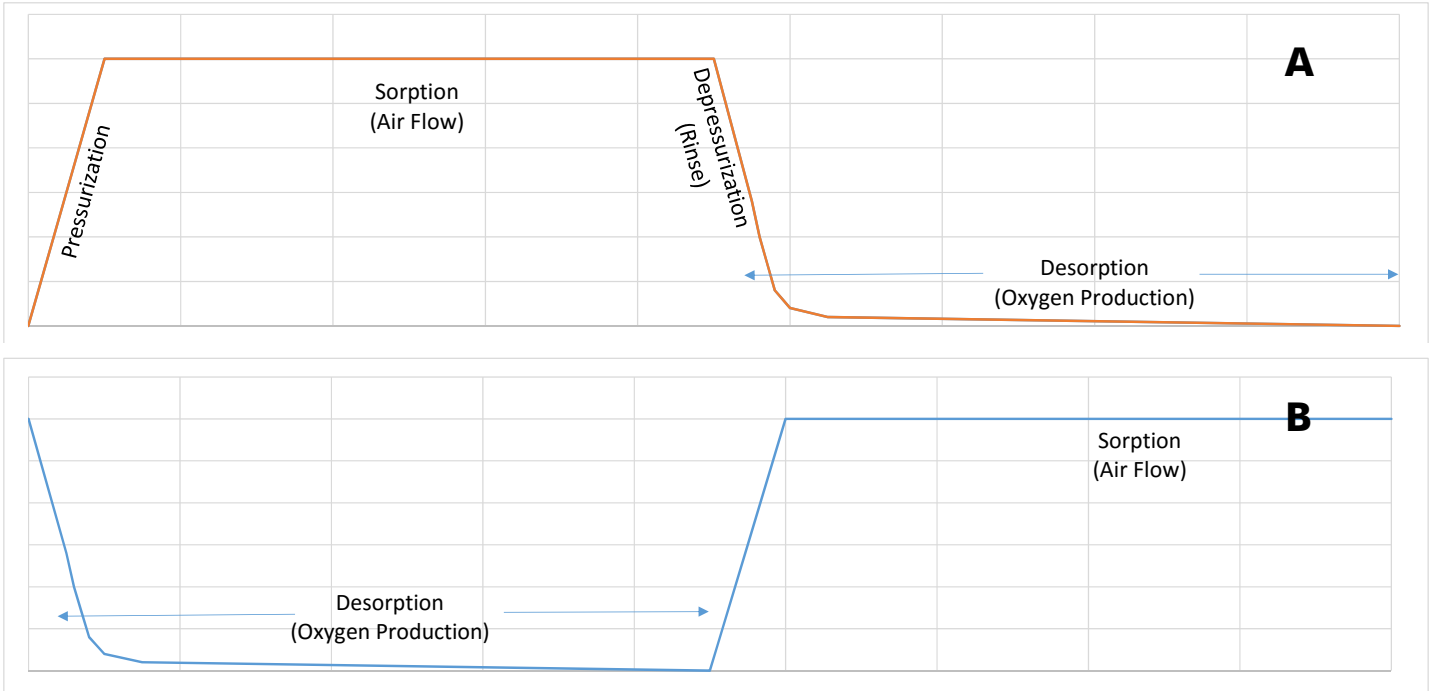
Two-Bed VPSA Cycle



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Goal

The goal of the proposed work is to develop the advanced oxygen sorbents fully utilizing high oxygen storage capacity of perovskites, and to scale up the sorbent manufacturing to 80-250 kg per batch. The targeted sorbents will be utilized in modular oxygen production plant able to support the oxidant feed of an oxygen-blown REMS gasifier scaled to a range of 1 to 5 MW.

Objectives

- Develop and test composite pellets comprising an inert core coated with the functional LSCF material.
- Optimize the adsorption, rinse, desorption cycles as a function of operating temperature and pressure.
- Perform long-term performance tests to establish sorbent durability and service life.
- Develop credible process economics for small-scale modular coal gasification power plants in the less than 5MW size range.

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Advanced Sorbents for Modular Oxygen Production for REMS Gasifiers

Scope of Work

- ***Task 2.0 - Develop Composite Sorbents***
  - *Subtask 2.1 - Fabricating Pellets Comprising an Inert Core Coated with the Functional Material* (mullite, corderite, alumina, silica, magnesia and similar)
  - *Subtask 2.2 - Testing the Sorbents*
  - *Subtask 2.3 - Long-term Testing*
  - *Subtask 2.4 - Stability Testing of Composite Pellets*

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Advanced Sorbents for Modular Oxygen Production for REMS Gasifiers

Scope of Work

- ***Task 3.0 – Scale-up Sorbent Manufacturing***
  - *Subtask 3.1 - Initial Manufacturing*
  - *Subtask 3.2 - Scale-up Manufacturing*
  - *Subtask 3.3 - Produce and Test Sorbent*

- ***Task 4.0 – Alter Existing Equipment for Advanced Sorbent Testing***
  - *Subtask 4.1 - Modify Bench System*
  - *Subtask 4.2 - Modify Pilot System*

- ***Task 5.0 – Qualifying a Large Batch of Supported Sorbent***
  - *Subtask 5.1 - Sorbent Qualification*
  - *Subtask 5.2 - Charge Pilot Reactor with Sorbent*

- ***Task 6.0 – Testing at the 1-ton/d Plant***
  - *Subtask 6.1 – Scale Testing of Sorbent*
  - *Subtask 6.2 – Techno-Economic Analysis*

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Deliverables

- ***Quarterly and Final Reports***
- ***Briefings & Technical Presentations***
- ***Topical Reports (if, as and when requested by Project Officer)***
  - *Sorbent Performance*
  - *Test Plans*
  - *Supported Sorbent Manufacturing Information (yields, performance, etc.)*

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Advanced Sorbents for Modular Oxygen Production for REMS Gasifiers

Success Criteria and Decision Points

- ***Thermally and chemically stable supported sorbent with sorption desorption performance comparable to parent material***
- ***Commercially produced sorbent performance at par with laboratory batches***
- ***Deliver >95% pure oxygen***
- ***>30% improved economics over VPSA***

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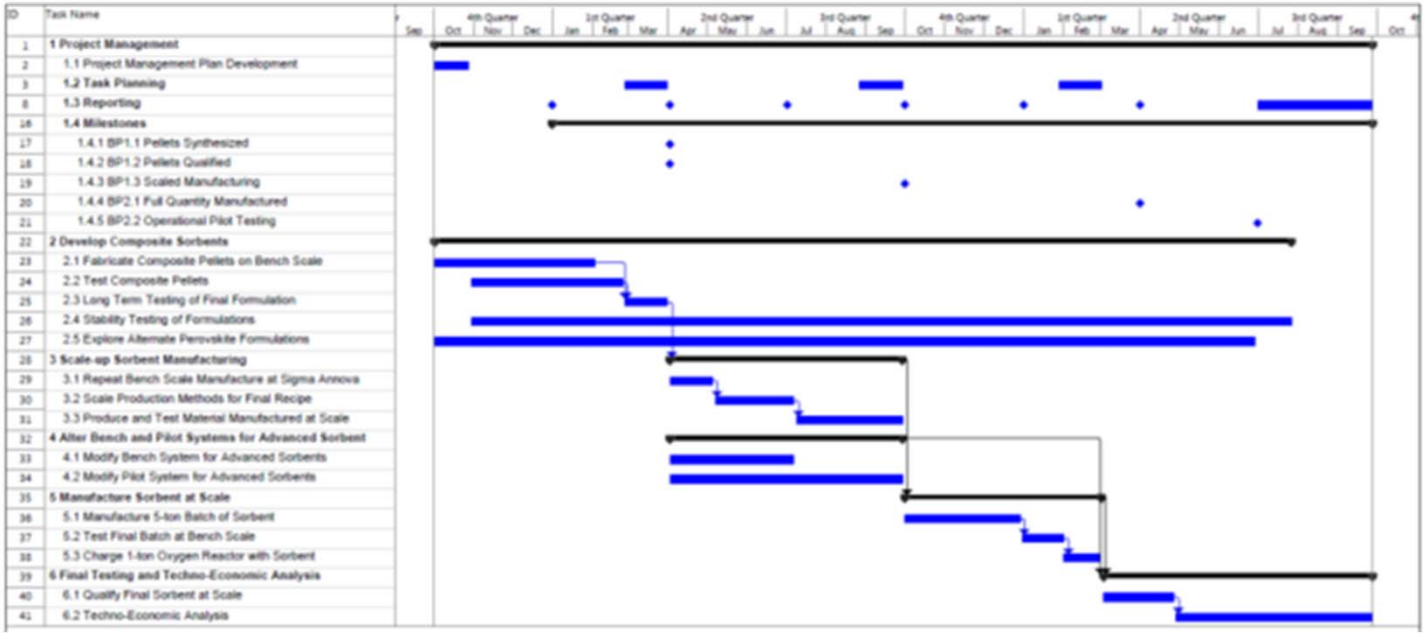
Schedule



ID	Task Name
1	**1 Project Management**
2	1.1 Project Management Plan Development
3	**1.2 Task Planning**
8	**1.3 Reporting**
16	**1.4 Milestones**
17	1.4.1 BP1.1 Pellets Synthesized
18	1.4.2 BP1.2 Pellets Qualified
19	1.4.3 BP1.3 Scaled Manufacturing
20	1.4.4 BP2.1 Full Quantity Manufactured
21	1.4.5 BP2.2 Operational Pilot Testing
22	**2 Develop Composite Sorbents**
23	2.1 Fabricate Composite Pellets on Bench Scale
24	2.2 Test Composite Pellets
25	2.3 Long Term Testing of Final Formulation
26	2.4 Stability Testing of Formulations
27	2.5 Explore Alternate Perovskite Formulations
28	**3 Scale-up Sorbent Manufacturing**
29	3.1 Repeat Bench Scale Manufacture at Sigma Annova
30	3.2 Scale Production Methods for Final Recipe
31	3.3 Produce and Test Material Manufactured at Scale
32	**4 Alter Bench and Pilot Systems for Advanced Sorbent**
33	4.1 Modify Bench System for Advanced Sorbents
34	4.2 Modify Pilot System for Advanced Sorbents
35	**5 Manufacture Sorbent at Scale**
36	5.1 Manufacture 5-ton Batch of Sorbent
37	5.2 Test Final Batch at Bench Scale
38	5.3 Charge 1-ton Oxygen Reactor with Sorbent
39	**6 Final Testing and Techno-Economic Analysis**
40	6.1 Qualify Final Sorbent at Scale
41	6.2 Techno-Economic Analysis

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Questions