CO$_2$ Capture at the Kemper County IGCC Project

2011 NETL CO$_2$ Capture Technology Meeting
Kemper County IGCC Overview

- **2x1 Integrated Gasification Combined Cycle (IGCC)**
  - 2 TRansport Integrated Gasifiers (TRIG™)
  - 2 Siemens SGT6 - 5000F CTs
  - 1 Toshiba Steam Turbine (Tandem Compound Double Flow)
  - 582 MW peak and 524 MW on syngas
  - Heat Rate 11,708 Btu/kWh (29.5% HHV Efficiency w/ CO₂ control and 40+% moisture coal)
  - Selexol for H₂S and CO₂ removal
  - 65+% CO₂ capture (~800 lb/MWh emission rate)
  - Mine Mouth Lignite

- **Owner & Operator:** Mississippi Power
- **Over $2 billion capital investment**
- **Commercial Operating Date:** May 2014
- **Use treated effluent from Meridian as makeup water**
- **By-Products (TPY)**
  - ~3,000,000 - Carbon dioxide used for EOR
  - ~135,000 - Sulfuric acid
  - ~20,000 - Ammonia

### Kemper Lignite Composition

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Content</td>
<td>btu/lb</td>
<td>5,290</td>
<td>4,765</td>
</tr>
<tr>
<td>Moisture</td>
<td>%</td>
<td>45.5</td>
<td>42</td>
</tr>
<tr>
<td>Ash</td>
<td>%</td>
<td>12.0</td>
<td>8.6</td>
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<tr>
<td>Sulfur</td>
<td>%</td>
<td>1.0</td>
<td>0.35</td>
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Proposed Kemper County IGCC Project Map

- ~70 miles transmission
- ~60 miles CO₂ pipeline (for EOR)
- ~5 miles natural gas pipeline
- ~31,000 acre mine site
- ~2,900 acres plant site
- ~30 miles treated effluent line
**TRIG™ Attributes/Advantages**

- **Simple, well established design**
  - Based on technology in use for 70 years

- **Either Air- or Oxygen-blown**
  - Air for power
  - Oxygen for liquid fuels and chemicals

- **High Reliability Design**
  - Non-slagging design:
    - Provides 10-20 year refractory life,
    - Eliminates black water system
    - Provides non-fouling syngas cooler operation
  - No burners to fail and be replaced
  - Dry dust removal eliminates gray water system

- **Lower Fuel Costs**
  - Coarse, dry coal feed allows:
    - Fewer, lower power pulverizers, and
    - Less drying than other dry-feed gasifiers
  - Cost-effective using high moisture, high-ash, low rank coals (PRB and lignite).

- **Excellent Environmental Performance**
  - Lower water use compared to pulverized coal (PC)
  - Excellent emissions performance
  - Easier to permit compared to PC
  - Lower cost carbon capture compared to PC
Evolution of Acid Gas Removal at Kemper County IGCC

- Originally, no CO$_2$ removal. H$_2$S removed with amine.
- With CO$_2$ removal added to scope, design team explored three main options based on a physical solvent:
  - 25% CO$_2$ removal (1,500 lb CO$_2$/MWh).
    - Case 1: No WGS, Selexol for sulfur removal, amine for CO$_2$
    - Case 1A: One stage of WGS, with Selexol for all acid gas removal.
  - 50% CO$_2$ removal (1,000 lb CO$_2$/MWh).
    - Case 2: One Stage WGS with steam injection with Selexol for AGR.
    - Case 2A: Case 1A retrofitted to Case 2 in 2020
    - Case 2B: Case 1 retrofitted to Case 2 in 2020.
  - 65% CO$_2$ removal (800 lb CO$_2$/MWh).
    - Case 3: Two stages WGS with steam injection and Selexol for AGR.
Physical Solvent Selection

The operating costs for an amine were too expensive, due to high steam usage for regeneration. Therefore, a physical solvent was selected.

<table>
<thead>
<tr>
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<th>Selexol</th>
<th>Rectisol</th>
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<tbody>
<tr>
<td>Volatility</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Solvent Price</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Emissions Concern</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Both good options, but Selexol was chosen.
Commercial Selexol Plant

- CO₂ Absorber
- Concentrator
- Flash Drums
- Lean-Rich Exchanger
- H₂S Absorber
- Regenerator
- Reboiler
CO₂ Capture Scheme for 800 lb/MWh

- Two Stages WGS
- Selexol Physical Solvent
- Refrigerated to 40 F

- Carbon Capture: >65%
- CO₂ Emissions: 800 lb CO₂/MWh
- Yield: >3 MM Tons/yr CO₂
- CO₂ compressed and used for EOR
- Acid gas converted to sulfuric acid via WSA process.

Acid gas converted to sulfuric acid via WSA process.
Kemper County IGCC

2 x 1 Combined Cycle

Water Supply Pond

Coal Dome

Water Treatment

Flare

Warehouse

Control/Admin Bldg.

Process Air Compressors

Gasifier Structure: Gasifiers, Syngas Cooling/Filtration

Coal Prep

Sulfuric Acid Production

Sulfur/CO2 Removal

Cooling Towers

Coal Loading Hoppers

Electrical Switchyard

Gas Turbine Electric Generator

2 x 1 Combined Cycle
Project Status

- On June 3, 2010, the Mississippi Public Service Commission certified the project.
- Mississippi Power has entered into CO2 offtake agreements with Denbury Onshore and Treetop Midstream Services, LLC.
- MDEQ issued the final PSD permit on March 9, 2010.
- Procurement: All major equipment awarded. Equipment fabrication underway. First major pieces arriving on site.
- Construction: Site cleared and graded. Foundation and pedestal work underway. Sumps, duct banks, underground piping being installed.
Kemper Procurement Update
2nd Quarter - 2011

Top of CO₂ Absorber
Base of CO₂ Absorber
Base of Concentrator
Lean/Rich Exchanger Plates
Kemper County IGCC Construction Update

1st Quarter - 2011

Began Installation of Underground Electrical and Mechanical Systems
Kemper County IGCC Construction Update

2nd Quarter - 2011

Steam Turbine Columns

AGR Area Sumps

96” Circ. Water Pipe

Deep Foundations/ Major Equipment Foundation Installation/U/G Utilities
Kemper County IGCC Construction Update

End of 2\textsuperscript{nd} Quarter - 2011

- Steam Turbine Operating Deck
- Circulating Water Pipe
- Plant Site as of July 2011
- Gasifier Pile Caps/Deep Foundation Installation

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Summary

- Physical solvents were selected for the Kemper design due to reduced steam usage.

- The facility will use Selexol coupled with two stages of water-gas-shift, resulting in a CO\textsubscript{2} emission rate of 800 lb/MWh (a nominal 65% reduction).

- 3 million tons/year of CO\textsubscript{2} captured at the Kemper site will be used for EOR, and will meet offtaker specifications.

- Commercial operations are expected in May 2014.