Update on Particulate Control Devices in Kemper County IGCC Project

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Kemper County IGCC Project
Kemper County IGCC Overview

- 2x1 IGCC
  - Two Transport Gasifiers (TRIG™)
  - Four Pall PCDs with CPP™ blowback
  - Two Siemens SGT6 - 5000F CTs
  - Toshiba steam turbine
  - 582 MW peak and 524 MW on syngas
  - 65% carbon capture
- Mine-mouth lignite
- Byproducts (TPY)
  - ~3,800,000 - CO₂ used for EOR
  - ~150,000 - sulfuric acid
  - ~19,000 – ammonia

Typical Syngas Composition from Gasifier

<table>
<thead>
<tr>
<th></th>
<th>H₂</th>
<th>CO₂</th>
<th>CO</th>
<th>H₂O</th>
<th>CH₄</th>
<th>H₂S</th>
<th>N₂</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11.5%</td>
<td>8.5%</td>
<td>18.1%</td>
<td>7.9%</td>
<td>2.6%</td>
<td>0.3%</td>
<td>50.2%</td>
<td>~1%</td>
</tr>
</tbody>
</table>

Fine Ash from Gasifier

<table>
<thead>
<tr>
<th>MMD</th>
<th>Carbon Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-15 microns</td>
<td>5-10 wt%</td>
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</table>
Project Initiation:
Groundbreaking: June 2010
Construction begins: Early 2011

Successfully commissioned
Achieved Fully Integrated Operation of Entire IGCC

Power Generation with up to 100% Syngas to Turbines in Both Trains

Produced Byproducts per Design Specifications

Gasification Operation Suspended Primarily due to Decrease in Price and Forecast for Natural Gas

Project Timeline

- **Combined cycle in-service:**
  - Aug 2014

- **First coal feed to dryers:**
  - Nov 2015

- **Offline coal feed testing:**
  - May 2016

- **First CO₂ capture First syngas to turbine:**
  - July 2016

- **Fluidization testing Train A:**
  - Jan 2016

- **Fluidization testing Train B:**
  - Feb 2016

- **First syngas production:**
  - July 2016

- **Fluid Bed Dryers:**
  - Oct 2016

- **Syngas Production:**
  - Oct 2016

- **First Full Integrated Operations First CO₂ To Pipeline First On-Spec Byproducts:**
  - Jan/Feb 2017

- **First Full Integrated Operation:**
  - Jun 2017

**Project Suspended**
PCD

Valve Actuation
Instrument Air

Blowback Valves

PCD Outlet

PCD Inlet

Emergency Nitrogen

Gasifier

Spent-coolers

PCD

Blowback Drum
PCD Design

• PCD Configuration
  – Two parallel PCDs in each of two separate gasifier trains
  – Total 684 filter elements in 18 clusters (38 x 18) in each PCD
  – Iron aluminide (FEAL) filter elements, 2.5 m long (designed for up to 3 m), built-in failsafes

• Back-Pulse (Blowback)
  – Coupled Pressure Pulse (CPP™) technology, first use in coal gasification and in such large scale
  – Fast-acting back-pulse valves
  – Typical valve operating parameters: 100 ms pulse timer, 4 bar pressure differential, 5 minute cycle

• Temperature Monitoring and Emergency Handling
  – Surface temperature measurements on selected filter elements for rate of change (ROC)
  – Nitrogen injection during thermal excursion (oxygen breakthrough)

• Monitoring Devices
  – Online particulate monitor (PCME) for leak detection at PCD outlet
  – Syngas composition analyzers (O₂ and CO) at PCD inlet and outlet
PCD Commissioning and Operational Summary

• Back-Pulse System
  – Tested in a wide range of operating parameters to fine-tune controls for CPP™
  – Large mass discharge variation due to valve-to-valve characteristic differences, but within required range
  – Satisfactory back-pulse performance for online filter element cleaning

• PCD Operation
  – Functioned well in filtration process during on-coal operation
  – Stable filtration capacity in extended operating periods with coal feed
  – Balanced flows in parallel paths
  – No oxygen breakthrough or thermal excursion during on-coal operation

• Inspections
  – Residual ash cake: thin and fluffy, uniform along length, no variation among clusters
  – No ash bridging or ash build-up between filter elements or on tubesheet
PCD Commissioning and Operational Summary (Continued)

• Some Mechanical Failures and Operating Difficulties That Required Repairs and Modifications, and Caused Schedule Delays
  – Missing support beams for the inlet pipes
  – Blowback pot design and fabrication issues
  – Master tubesheet flex seal weld leaks
  – Conax fitting weld leaks
  – Filter element damages caused by abnormal operation during a trouble-shooting event
PCD FL1106 Back-Pulse Test

- Dash Lines: 50 psig PCD Pressure
- Solid Lines: 300 psig PCD Pressure
- Dash-Dot Lines: 521 psig PCD Pressure
- Blue Lines: Low ΔP
- Red Lines: Medium ΔP
- Green Lines: High ΔP

Mass Discharge during Back-Pulse vs. Pulse Timer (ms)
FL2106 Back-Pulse Test

Mass Discharge during Back-Pulse

Back-Pulse Valves

- XV21358x
- XV21359x
- XV21360x
CFAD - Continuous Fine Ash Cooling and Depressurization

- **PCD**
- **Fine Ash Receiver & Cooler**
- **Pressure Let-Down Devices**
- **Discharge Line to Ash Silo**

Level is maintained by adjusting discharge rate.
CFAD Operation

Figure 7b. Illustration of the performance of the CFAD system.

- Fines inlet temperature (400~500°F)
- Fines receiver Level (35%-55%)
- Fines outlet temperature (110~130°F)
- Level Controller Output
- Fine ash Discharge Line Pressure
PCD Inspections

Inspection through PCD Manway

Offline Inspection

Wash Cleaned
Summary

• The PCDs were successfully commissioned with some repairs and modifications.
• The CPP™ blowback technology worked well for its first application in coal gasification and in such large scale.
• The PCDs performed well during extended on-coal operation.
• PCD mechanical integrity was well maintained.
• The CFAD system effectively cooled and depressurized the fine ash for discharge to ash silos.
Thank You