Updates on the Performance of Selected Circulation Dry Scrubbers

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Outline

- Introduction
- Generic process flow diagrams of a circulation dry scrubbing (CDS) systems
- Locations of CDS installed at U.S. power plants
- Performance of CDS in
  - SO$_2$ removal
  - handling higher S coal
  - handling load swing
  - HAPs removal
- Conclusions
Graymont Lime Group Production and Terminal Facilities

18 Lime & 2 PCC Plants
Lime Capacity ~5.6 Million Tons Per Year
PCC Capacity ~ 236 Thousand Tons Per Year

- Pavilion
- Exshaw
- Faulkner
- Summit
- St. Helens (PCC only)
- Indian Creek (Lime & PCC)
- Cricket Mountain
- Pilot Peak
- Superior
- Bedford
- Indian Creek
- Port Inland
- Green Bay
- Green Bay
- Eden
- Genoa
- Pleasant Gap
- Havelock
- Joliette
- Marbleton
- Tacoma (Lime & PCC)
CDS at Graymont’s Pleasant Gap Lime Plant

Pleasant Gap, PA
Kiln #7
Type: Rotary
Capacity: 1,050 tpd lime
Power Plant: 3.5MW
Fuel: coal/petcoke

CDS Reactor: Solios
Engineering: Graymont
Startup: January 2008

CDS Performance:
for 3% sulfur coal
> 93% SO$_2$ Removal
(kiln outlet-to-stack)
Graymont’s Portable CDS Unit

Graymont Joliette Lime Plant

BH Ash Out

Gas In

Gas Out

Sorbent In
Graymont’s Portable CDS Unit

Graymont’s Portable CDS Unit

- Cleaned Flue Gas
- Fresh Ca(OH)$_2$
- Ash Recycling
- Baghouse
- CDS
- Mixer/Hydrator
- Water Tank
- Control Room
- Raw Flue Gas
Generic Process Flow Diagram of a CDS System

System Advantages:

- Recirculation of ash provides high lime efficacy
- No spray nozzles/atomizers & no circulation pumps keep capital and O&M costs low
Lurgi Type of CDS Reactor

Key: (1) Fly ash, hydrated lime & recycled ash are suspended and fluidized.
(2) A flue gas re-circulation duct is required when operated at reduced load.

Source: Douglas J. Roll et al., Follow-on Turbosorp® Testing Results from the Greenidge Multi-Pollutant Control Project, Power-Gen International 2007, New Orleans, LA
Transport-Reactor Type of CDS System

Key Components:
- Fabric filter
- Reactor
- Recycle Feeder
- Mixer
- Hydrator
- Fluid trough

Vendors:
- ALSTOM Power - NID
- Hitachi/Solios – EAD
- Solios

Key: (1) Fly ash, hydrated lime & recycled ash flow with the flue gas (no venturi).
(2) Modular design (45 – 90 MW)

Source: Lawrence Gatton, Next Generation NID for PC Market, Coal-Gen, August 17019, 2011
Locations of CDS Installed at U.S. Power Plants

- **Operating CDS - PC Boiler**
- **Operating CDS - CFB Boiler**
- **CDS Under Construction**

- Units range from 58 to 690 MW
- Fuel sources range in sulfur content
Larger Units Need Multiple CDS Reactor Vessels

- For the following NID systems:
  - Indian River Unit 4 (440 MW) : 8 J-tube reactors
  - Brayton Point Unit 3 (670MW): 8 J-tube reactors
  - Homer City Units 1 and 2 (690 MW each): 10 J-tube reactors for each unit
  - Boswell Unit 4 (558 MW): 8 J-tube reactors
  - Flint Creek Unit 1 (558 MW): 8 J-tube reactors

- The following Lurgi types of CDS systems are built with 2 parallel reactor vessels
  - Big Stone Unit 1 (500 MW)
  - Edgewater Unit 5 (460 MW)
  - Michigan City Unit 12 (540 MW)
This unit uses ESP to control particulate emission.
AES Greenidge Station - Unit 4 (NY, PC / 115MW / 2007)

Ca/S Molar Ratio = 1.65

Babcock Power
Dry Fork Station - Unit 1 (WY, PC / 425MW / 2011)

Monthly Avg. Coal SO\textsubscript{2} & Monthly Avg. SO\textsubscript{2} Emission Rate (lb/MM Btu)

- Coal SO\textsubscript{2}
- SO\textsubscript{2} Emission
- SO\textsubscript{2} Removal

SO\textsubscript{2} Removal

NE/FW

NE/FW
Sandow Station - Unit 5A (TX, CFB / 315MW / 2009)

Monthly Avg. Coal SO$_2$ & Monthly Avg. SO$_2$ Emission Rate (lbf/MM Btu)

- **Coal SO$_2$**
- **SO$_2$ Emission**
- **SO$_2$ Removal**

SO$_2$ Removal

Coal SO$_2$: 0.00 - 2.50
SO$_2$ Emission: 0.00 - 2.50
SO$_2$ Removal: 0.00 - 100%

Data points:
- 2009 Oct
- 2010 Jan
- 2010 Apr
- 2010 Jul
- 2010 Oct
- 2011 Jan
- 2011 Apr
- 2011 Jul
- 2011 Oct
- 2012 Jan
- 2012 Apr
- 2012 Jul
- 2012 Oct
- 2013 Jan
- 2013 Apr
- 2013 Jul
- 2013 Oct

ANDRITZ
The average monthly SO₂ emission from Sep/2012 to Dec/2013 was 0.0076 lb/MMBtu.
Indian River Station – Unit 4 (DE, PC / 440MW / 2012)

Coal SO2  SO2 Emission  SO2 Removal

Monthly Avg. Coal SO2 & SO2 Emission Rate (lbs/MM Btu)


SO2 Removal

0.00  0.50  1.00  1.50  2.00  2.50  3.00  3.50  4.00

20%  30%  40%  50%  60%  70%  80%  90%  100%

ALSTOM Power
John Twitty Station – Unit 2 (MO, PC / 300MW / 2011)
AES Greenidge – Results of Performance Tests

Hg (Ibs/TBtu)

Test 1  MATS

No Activated Carbon Injection

fPM (Ibs/MM Btu)

Test 1  Test 2  MATS

HCl (Ibs/MM Btu)

Test 1  Test 2  MATS
Sandow Station - Utility MACT ICR Data

- **Hg (lbs/TBtu)**
  - Unit 5A
  - Unit 5B
  - MATS

- **fPM (lbs/MM Btu)**
  - Unit 5A
  - Unit 5B
  - MATS

- **HCl (lb/MM Btu)**
  - Unit 5A
  - Unit 5B
  - MATS
Conclusions

- In the U.S. power industry, 4 lime-based circulation dry scrubbing (CDS) technologies have been installed in 12 PC boilers and 12 CFB boilers. Constructions are underway at 15 PC boilers.
- Multiple CDS reactor vessels can be placed in parallel to process flue gases from larger units.
- These CDS technologies are applied to solid fossil fueled electricity generating units with sizes ranging from 58 to 690 MW.
- These technologies are well proven, capable of handling solid fuels with various sulfur contents.
- Data obtained from AES Greenidge and Sandow No. 5 Stations showed that the emission limits of mercury, filterable particulate, and hydrogen chloride mandated under the Mercury and Air Toxics Standards were met.