

NEW AND EMERGING TECHNOLOGIES FOR CCR/ELG COMPLIANCE

SUPPORTED BY REVIEW AND ELECTRIC PennEnergy

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ENERGY

CentralionHub.

OWNED& PC

BOTTOM ASH TECHNOLOGIES

REMOTE DRAG CHAIN CONVEYOR

> Advantages

- Minimal outage & demo
- Minimal impact on boiler footprint
- Fully redundant system (with dual conveyors)
- > No water discharge

Disadvantages

- High capital cost
- Regulatory uncertainty (ELG)
- Aging sluice system remains a part of the system
- Distance from the plant makes O&M difficult
- Manual loading of ash
- Potential risks associated with TSS carryover
- New application of a technology



MAGALDI ASH COOLER

Advantages:

- Completely dry system
- Local or remote storage silo

Disadvantages:

- Boiler space requirements
- Major demolition
- Longer outage
- Only PC boilers



BOTTOM ASH CONVERSION MAJOR TECHNOLOGIES AVAILABLE

Pneumatic Ash Extractor (PAX)

Advantages:

- Completely dry system
- Local or remote storage silo
- Piping more easily routed than conveyors

Disadvantages:

- Boiler space requirements
- Major demolition
- Longer outage
- Higher O&M cost
- Higher power requirements



DEWATERING BIN SYSTEM

Advantages

- Minimal outage & demo
- Minimal impact on boiler footprint
- No water discharge
- System loads directly to truck

Disadvantages

- High capital cost
- Maintenance intensive with poor history
- Chemical addition required
- Regulatory uncertainty (ELG)
- Aging sluice system remains a part of the system
- Distance from the plant makes O&M difficult
- Potential risks associated with TSS carryover



ADDITIONAL TECHNOLOGIES

Vibratory Bottom Ash Conveyor (VAX)

- Completely dry
- Lower O&M cost
- Installation #1
- Boiler space requirements
- Major demolition, longer outage <u>Magaldi Ash Recycling (MAR)</u>
- Completely dry
- Eliminates bottom ash stream (all recycled to fly ash)
- No US installations
- PC boilers only
- Boiler space requirements





SETTLING BASIN OPTION

Advantages

- Minimal outage & demo
- Minimal impact on boiler footprint
- Fully redundant system
- No water discharge
- Low cost
- Few moving parts
- Large volume for extended ash storage





SETTLING BASIN OPTION

Disadvantages

- Short track history
- Chemical addition may be required
- Regulatory uncertainty (ELG) with excess water
- Aging sluice system remains a part of the system
- Distance from the plant makes O&M difficult
- TSS carryover risks
- Large footprint
- Ability to dewater the ash
- Potential for double handling
- Loadout to trucks
- Winter freezing issues with slope





SETTLING BASIN OPTION

Closing the loop

- Water chemistry
 - Coal additives?
 - Scrubber available?
- Water Balance
 - Very little water leaving
 - Rainwater
 - Tube leaks
 - Wet pump seals



GEOTEXTILE TUBES

- Some clients are investigating bottom ash sluicing directly to geotextile tubes
- Tubes installed on temporary poly liner
- Decant water routed either to pond or to discharge point
- Sample to meet permitted TSS limit
- Cycle between tube laydown areas – approx 30 days to dewater in temps above freezing



FRAC TANKS WITH LAMELLA CLARIFIER INSERTS

- TSS Reduction
 - Bulk and Polishing TSS
- Passive System
- Temporary Rental
- May be used in series
- Typical hydraulic treatment flowrate of up to 200 gpm



FGD WASTEWATER TREATMENT

PHYS-CHEM TREATMENT WITH ORGANOSULFIDE

FGD Wastewater

Desaturation

Lime Silo

me Mix

Primary Clarifier Coagulant

М

Flocculant

Secondary Clarifier

Organosulfide

Μ

Equalization Chemical

- Established process
 - Many steps
- Removes metals/solids
- ► <u>Not:</u>
 - Selenium
 - ► Nitrate
- Multiple vendors
 - Equipment
 - Chemicals
- Effluent polishing required
 - ► Biological
 - ► Thermal
 - Other/developing

BIOLOGICAL TREATMENT

- Most established
- EPA's Technology Basis
- Currently in use at several facilities
- Bacteria convert:
 - Selenate or selenite to elemental Se
 - Mercury to insoluble salts
 - \triangleright Nitrate to N₂

- Limited number of vendors
- More are developing
- May require polishing

FGD Wastewate

Phys-Chem T

Sludge

ological Treatn

EMERGING TECHNOLOGIES - ZERO VALENT IRON

- Phys-chem process replaces bacteria
 - Uses zero valent iron to reduce arsenic, selenium and mercury
- Limited number of vendors
- In pilot testing
 - Nitrate removal
 - Guarantees
- High reagent use = high sludge



Frontier – Modularized Systems

- Primary Bioreactor
- Secondary Reduction
- Ultrafiltration

Pilots

- New Installs
- Up to 250 gpm
- See presentation in this session for additional details



THERMAL EVAPORATOR/CRYSTALLIZER

- Established technology
 - In use at Merrimack, Duke, others
- Produces low TDS reusable waste stream

- Limited number of vendors
- High parasitic power
- Expensive
- Operator-intensive





EVAPORATION INTO FLUE GAS

- Installations in progress
 - Commercial in 2017
- Spray dryer technology is well understood in other applications
- Uses "spare" heat to dry FGD wastewater

- No wastewater discharge
- Impact to baghouse
- Materials of construction



EVAPORATION INTO FLUE GAS



- Suppliers
 - Alstom
 - ► B&W
 - Mitsubishi
 - ► Etc.
- Design Considerations
 - Multiple Unit Sites
 - Load Following Conditions
 - Outages
 - Isolation Dampers/Online Maintenance

Courtesy: Mitsubishi





NAES Dense Slurry Systems



EVOLVING TECHNOLOGIES - MEMBRANES

► VSEP©

- Vibrating Vertical Membranes
- Kleenwater High Pressure Reverse Osmosis (and similar)
- Forward Osmosis



QUESTIONS?

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