PA Electric Power Generating Industry TDS Issues

Presented to PADEP WRAC – TDS Subcommittee

October 16, 2009

PA Coal-Fired Electric Generation

- PA ranks 2nd in electric generation
- 26 coal-fired plants
  - 19,500 MW of generation capacity
  - 15 scrubbed (FGD) plants (52% of capacity)
- 15 waste-coal plants
  - 1,500 MW of generation capacity
- Represents 41% of PA generating capacity and 54% of generation

Power Plant Sources of TDS & SO_4

	TDS Concentration (mg/L)	Sulfate Concentration (mg/L)	TDS Loading (lbs./day)
FGD Blowdown (~0.5 MGD)	15,000 - 30,000	>1,000	62,600 – 125,000
Boiler Makeup Water Waste Stream (~0.040 MGD - Inter.)	>20,000	>11,000	~6,700
Coal Pile Runoff	>500	>250	Rainfall Dependent
CCB Landfills	1,200 - 2,500	>250	Rainfall Dependent
Cooling Tower Blowdown (~3.6 MGD – 2500-gpm)	300 - 2500	>250	9,000 – 75, 000
Waste Coal Plants (~0.25 MGD)	~2,000		1,600-4,000

TDS Treatment Options for FGD Bleed Stream

- Deep well injection
- Membrane treatment
- Filtration
- Evaporation
- Recycle and Solids Retention
- Emerging technologies

- Deep well injection
  - Geologic and regulatory constraints
- Membrane treatment
  - Reverse Osmosis (RO)
    - Largely ineffective
    - Higher TDS levels = higher reject water volume
    - Severe scaling & fouling issues
  - Electrodialysis (ED)
    - Unproven with FGD bleed stream

- Filtration – neither Micro-filtration (0.1 – 10 µm) nor Ultra-filtration (0.001 – 0.1 µm) effective for removal of TDS

Parameter	Unfiltered*	Filtered*
TDS	18,867	18,867
Sulfate	1,173	1,100
Chloride	8,573	7,617

*/ mg/l

- Recycle and Solids Retention
  - Effective for TDS reduction
    - ✓ Depending on site, recycle can achieve >30% reductions
    - ✓ Solids retention has demonstrated 30% to 50% reductions
  - But incapable of achieving PADEP proposed levels

Evaporation

Brine Concentrator & Crystallizer

- Used on cooling tower blowdown
- Rarely used for FGD bleed stream
  - Handful in operation worldwide
- Minimum 36 months to design, procure, construct, & commission
  - Longer for plant-wide treatment
  - Plus permitting time
- Significant transportation impacts (additives & waste)
- Significant capital, O&M, and energy costs

Permitting Time

- E&SC (3-6 mos)
- NPDES modification (24 mos)
- WQM Part II (9-12 mos)
- Solid waste/landfill expansion (36-48 mos)
  - EPA designation of CCB will affect
- Air/material handling (6-12 mos)

Evaporation (cont.)

- 400 GPM avg. flow rate
  - Power requirement = 4.0 MW/hour of operation
    - Equivalent to lighting 4000 homes
  - Solids production = 150 tpd
    - Landfill cost ~ $2,175/day ($14.50/ton)
      - ~ $750,000/year (dispatch dependent)
  - Soda ash consumption = 2,000# per hour
      - Salt conversion
      - Est $1.6 million/year (dispatch dependent)

Evaporation Costs

- FGD only (assume 400 GPM Flow)
  - Capital costs of ~ $60 million
  - Annual O&M costs ~ $4-6 million
  - Annual solids ~ $750,000
- All wastewater streams (assume 2 to 5 MGD flow)
  - Capital costs $200-$500 million
  - Annual O&M $15-$40 million
  - Power consumption 14 – 35 MW
  - Greater solids generation

Table 3-2
Evaporator System Cost Summary

System Description	Basis	Estimated Capital Cost (2008 $)	Estimated Operating Cost (2008 $/yr)
1. Brine Concentrator (2 x 60%)	240 gpm	12,900,000	
2. Crystallizer (1 x 100%)	60 gpm	9,700,000	
3. Salt Conversion	400 gpm	5,000,000	
4. Storage Tank	250,000 gal	400,000	
5. Balance of Plant		4,000,000	
6. Pre-Engineered Building	9,000 ft^2	2,800,000	
7. Site Development	32,000 ft^2	750,000	
8. Electrical Equipment		7,700,000	
9. Operating Labor	3 FTE		344,000
10. Electrical Demand	4,000 kW		2,103,000
11. Trucking	150 tpd		219,000
12. Soda Ash	2,000 lb/hr		1,621,000
13. Other Chemicals			150,000
14. Indirect Cost Multiplier	30%	12,980,000	
15. Owner Costs	10%	5,700,000	
Total Costs		61,930,000	4,437,000

Evaporation Costs (cont.)

- 15 PA plants FGD wastewater stream
  - Annual O&M costs $70 million
  - Capital costs approach $1 billion
  - Power needs 60 MW
  - 2250 tpd solids
- 15 PA plants all wastewater streams
  - Capital costs $3 – $7.5 billion
  - Annual O&M costs $230 - $600 million
  - Power needs 200 – 520 MW (a new plant)
  - Greater solids generation

Caveats

- 11 PA non-scrubbed stations?
  - “New source” issue or
  - CAIR II, MACT, etc.
- Assumes limits similar to those currently being imposed in permits
- Assumes all plants have FGD bleed stream
  - Technology dependent
- Conceptual cost estimates

Caveats (cont.)

- Non TDS/Sulfates permit requirements timelines (sooner) vs. TDS/Sulfates limits (later)
  - Need policy that is not economically wasteful
- Landfill capacity and technology
- Need nuclear cooling tower blowdown data

Water Impairment Issues

- Significant problems with the Mon River “impairment” finding
  - Insufficient time period
  - No river segmentation
  - Missing data
  - Flawed statistics
- Statewide, the sources and relative contributions for TDS are still unknown; for the Mon, WV and PA contributions still unknown
- PA and WV should follow the approach taken in the Chesapeake Bay

Conclusions

- There is no demonstrated, cost-effective technology to achieve the PADEP proposed levels
- However, electric generating stations can achieve significant reductions in TDS using recycle and entrainment methods
- A holistic assessment of the sources and relative contributions should be conducted **before** developing proposed solutions

Questions