An Update of Effluent Limitation Guideline Treatment Options for Coal-Fired Power Plants

2018 Review Meeting for Crosscutting Technologies

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Overview

1. Coal regulatory overview

2. Existing sources ELG overview

3. Recent regulatory developments/technology needs

4. New sources ELG overview

5. Spray dryer evaporator for zero liquid discharge
Total Emissions from Coal-Fired Generation

*Dramatic Reduction Despite Increase in Usage*

Changes from 1970

Sources: EPA National Air Pollutant Emission Trends, EIA Annual Energy Review
Pulverized Coal Power Plant

Air Quality Regulations: Water Impacts

- Wet FGD to control HCl (MATS), SO₂ (CSAPR) – *FGD Wastewater regulated by ELG rule*
- FF or ESP (NSPS, MATS), to control PM - *fly ash transport water covered by ELG rule*
- Carbon injection to control Hg (MATS) – *FGMC water covered by ELGs*
- Dry sorbent injection to control HCl (MATS) – *flue gas Hg control transport water covered by ELG rule*
- SCR for NOx control (NSPS, CSAPR, Regional Haze) could require DSI

Diagram:

- Cooling Tower
- Coal
- Air
- FGD
- Wastewater
- Fly ash
- Fly ash transport
- PM
- Carbon injection
- Carbon injection to control Hg (MATS) – FGMC water covered by ELGs
- Dry sorbent injection to control HCl (MATS) – flue gas Hg control transport water covered by ELG rule
- SCR for NOx control (NSPS, CSAPR, Regional Haze) could require DSI
- Wet FGD to control HCl (MATS), SO₂ (CSAPR) – FGD Wastewater regulated by ELG rule
- FF or ESP (NSPS, MATS), to control PM - fly ash transport water covered by ELG rule
- Carbon injection to control Hg (MATS) – FGMC water covered by ELGs
### Table VIII-1: Final Rule: Steam Electric Main Regulatory Options

<table>
<thead>
<tr>
<th>Wastestreams</th>
<th>Technology basis for the main BAT/NSPS/PSES/PSNS regulatory options</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>FGD Wastewater</td>
<td>Chemical Precipitation</td>
</tr>
<tr>
<td></td>
<td>Dry handling</td>
</tr>
<tr>
<td>Fly Ash Transport Water</td>
<td>Impoundment (Equal to BPT)</td>
</tr>
<tr>
<td>Bottom Ash Transport Water</td>
<td>Dry handling</td>
</tr>
<tr>
<td></td>
<td>Evaporation</td>
</tr>
<tr>
<td>FGMC Wastewater</td>
<td>Dry handling</td>
</tr>
<tr>
<td>Gasification Wastewater</td>
<td>Evaporation</td>
</tr>
<tr>
<td>Combustion Residual Leachate.</td>
<td>Impoundment (Equal to BPT)</td>
</tr>
<tr>
<td>Nonchemical Metal Cleaning Wastes.</td>
<td>[Reserved]</td>
</tr>
</tbody>
</table>

**Legend:**

- **Red Box:** Existing Source Standard
- **Blue Box:** New Source Standard
Existing Sources (Direct & POTW)

• **FGD Wastewater**: Chemical precipitation followed by biological treatment
  – BAT is chemical precipitation systems that employs hydroxide precipitation, sulfide precipitation, and iron coprecipitation, followed by anoxic/anaerobic fixed film biological treatment

• **Fly ash transport water**: Dry handling
  – BAT is dry vacuum system using mechanical exhauster to pneumatically convey fly ash from hoppers to a silo
Existing Sources (Direct & POTW)

• **Bottom ash transport water: Dry handling**
  – Water quench/mechanical drag conveyor (incline dewatering)
  – Recovered water reused in quench

• **Flue gas Hg control wastewater: Dry handling**
  – BAT is dry vacuum system using mechanical exhauster to pneumatically convey fly ash from hoppers to a silo (same as fly ash)
• Combustion residual leachate
  – Combustion residuals: wastes generated from combustion, generally collected by pollution control technologies, stored at the plant in landfills or surface impoundments. Leachate includes liquid, including suspended or dissolved solids, that has drained from landfill materials or that has passed through a containment structure (example: water leaking from an ash pond)
  – BAT: surface impoundments
• Specific deadline for compliance is at the discretion of the permitting authority, but should be as soon as possible beginning November 1, 2018, but no later than December 31, 2023

• Voluntary incentive option for FGD wastewater from existing sources
  — Adopting the more stringent FGD wastewater standard based on evaporation (i.e., the new source FGD wastewater standard) allows more compliance time
ELG Rule Update

SUMMARY: Under the Clean Water Act ("CWA"), the Environmental Protection Agency (EPA) intends to conduct a rulemaking to potentially revise certain best available technology economically achievable ("BAT") effluent limitations and pretreatment standards for existing sources ("PSES") for the steam electric power generating point source category, which were published in the Federal Register on November 3, 2015. EPA is, accordingly, postponing the associated compliance dates in the 2015 Rule. In particular, EPA is postponing the earliest compliance dates for the new, more stringent, BAT effluent limitations and PSES for flue gas desulfurization ("FGD") wastewater and bottom ash transport water in the 2015 Rule for a period of two years. At this time, EPA
Technology Needs During Reconsideration

• Regulatory reform agenda places a premium on existence of sufficient data on which to base regulations

• Utility Water Act Group (UWAG) comments in petition for reconsideration:
  – Demonstration of biological treatment for plants burning subbituminous & lignite
  – Impact of FGD wastewater variability on compliance
Technology Needs: Assessing Biological Treatment for Subbit, Lignite Plants

Wide variability in FGD wastewater composition based on coal type

UWAG: biological treatment cost, effectiveness depends on full pollutant “matrix”

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Unit</th>
<th>4-Day Average Dissolved Effluent, Allen (E. Bituminous)</th>
<th>4-Day Average Dissolved Effluent, Belew Creek (E. Bituminous)</th>
<th>4-Day Average Dissolved Effluent, Pleasant Prairie (PRB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>(ug/l)</td>
<td>NQ&lt;sup&gt;100&lt;/sup&gt;</td>
<td>ND</td>
<td>NQ</td>
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<tr>
<td>Arsenic*</td>
<td>(ug/l)</td>
<td>NQ</td>
<td>NQ</td>
<td>4.85</td>
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<td>Boron</td>
<td>(ug/l)</td>
<td>58,600</td>
<td>150,000</td>
<td>9,930</td>
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<tr>
<td>Calcium</td>
<td>(ug/l)</td>
<td>1,750,000</td>
<td>3,490,000</td>
<td>639,000</td>
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<tr>
<td>Chloride</td>
<td>(mg/l)</td>
<td>3,300</td>
<td>7,780</td>
<td>1,950</td>
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<tr>
<td>Magnesium</td>
<td>(ug/l)</td>
<td>396,000</td>
<td>738,000</td>
<td>3,560,000</td>
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<tr>
<td>Manganese</td>
<td>(ug/l)</td>
<td>393</td>
<td>NQ</td>
<td>10,800</td>
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<td>Mercury</td>
<td>(ng/l)</td>
<td>342</td>
<td>46,200</td>
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<tr>
<td>Nitrate/Nitrite</td>
<td>(mg/l)</td>
<td>13.3</td>
<td>19.8</td>
<td>160</td>
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<tr>
<td>Selenium</td>
<td>(ug/l)</td>
<td>91.1</td>
<td>1,210</td>
<td>2,080</td>
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<tr>
<td>Sodium</td>
<td>(ug/l)</td>
<td>31,300</td>
<td>48,900</td>
<td>518,000</td>
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<tr>
<td>Sulfate</td>
<td>(mg/l)</td>
<td>1,400</td>
<td>1,380</td>
<td>15,500</td>
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<tr>
<td>TDS</td>
<td>(mg/l)</td>
<td>7,560</td>
<td>20,100</td>
<td>22,400</td>
</tr>
</tbody>
</table>

*The pollutants highlighted are those for which EPA set new BAT limits.
Technology Needs: Assessing Impact of FGD Wastewater Variability on Biological Treatment

- Technology need during reconsideration: ability of biological treatment to demonstrate consistent performance with changing FGD wastewater quality

- Factors that impact FGD wastewater quality:
  - Coal quality
  - FGD cycles of concentration that affect Cl, TDS
  - Cl, Mg levels in limestone reagent
  - Various forms of Se in FGD wastewater
  - Coal plant cycling
  - FGD wastewater temperature swings
Technology Needs: Determining Speciation of Heavy Metals in Coal Plant Wastewater

• “EPA intends to fully evaluate all of the issues raised in the petitions, including concerns about: cost and impacts to steam electric facilities, public availability of information on which the rule is based, lack of data for plants that burn certain types of coal, and validity of certain pollutant data used in EPA’s 2015 Rule analysis.”*

• Similar to Hg air emissions, need to characterize speciation of heavy metals in wastewater streams as functions of coal type, pollution controls

• Understanding coal plant early retirement drivers, and necessary lifespans for FGD wastewater treatment systems

New Sources (Direct & POTW)

• **FGD Wastewater:**
  – BADCT/NSPS (Direct discharge): Limits on As, Hg, Se, TDS based on evaporation
  – Pretreatment Standards for New Sources (PSNS): Applies to units discharging to POTW, standard is limits on As, Hg, Se, TDS based on evaporation

• **Fly ash transport water: Dry handling**
  – Dry vacuum system using mechanical exhauster to pneumatically convey fly ash from hoppers to a silo
  – BADCT/NSPS for direct discharge units, PSNS for units that discharge to POTW
New Sources (Direct & POTW)

• **Bottom ash transport water**: Dry handling – BADCT/NSPS (direct discharge) and PSNS (POTW discharge)
  - Water quench/mechanical drag conveyor (incline dewatering)
  - Recovered water reused in quench

• **Flue gas Hg control wastewater**: Dry handling – BADCT/NSPS (direct discharge) and PSNS (POTW discharge)
  - Dry vacuum system using mechanical exhauster to pneumatically convey fly ash from hoppers to a silo (same as fly ash)
- Wet FGD purge evaporated in spray dryer (zero liquid discharge)
- Spray dryer used for evaporation of water (any SO$_2$ removal?)
- SCR discharge (700 ºF) used as heat source for evaporation
Spray Dryer Evaporator – FGD Wastewater ZLD

• Controlling chloride levels in wet FGD blowdown a driving force in spray dryer evaporator design
  – Wet FGD & spray dryer materials of construction

• Evaporation heat source is flue gas “robbed” from air preheater in boiler; spray dryer evaporation degrades plant heat rate
  – 900 MW low-Cl PRB unit ≈ 30 – 50 gpm blowdown, 2-3% flue gas bypass
  – 900 MW eastern coal unit ≈ 170 – 200 gpm blowdown, 10-12% flue gas bypass

• Baghouse will see 5 – 10% increase in solids loading

1. “Salt Dryers for TRUE Zero Liquid Discharge from WFGD Wastewater,” S. Feeney and M. Klidas, POWER Engineering, June 20, 2016
Acknowledgements

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