

REINHOLD ENVIRONMENTAL Ltd.



**2017 APC & Wastewater Round Table  
& Expo Presentation**

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APC and Wastewater  
Round Table 2017  
Charlotte, NC

# Issues Facing FGD Operations in Today's Operating Environment – Related Research in EPRI's Program 75



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**AECOM**

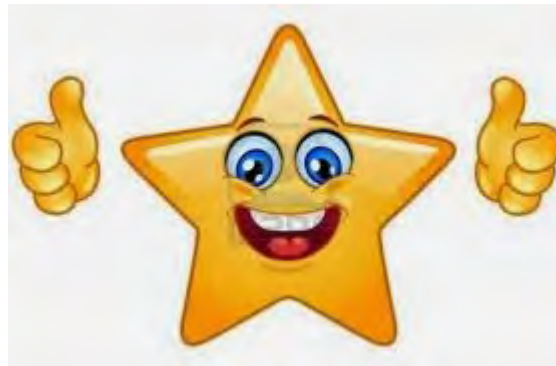
# Presentation Outline

- 2017 EPRI Program 75 research efforts
- Discussion of three FGD operations issues:
  1. In-line ORP probes: how accurately do they reflect sulfite oxidation rates in the scrubber?
  2. Best practices for FGD startup/shutdown to maintain MATS compliance
  3. Potential impacts of tightening the wet FGD water balance to reduce fresh water consumption and/or lower wastewater flow rates

# EPRI Acknowledgement

Information presented in this session was gathered from projects funded by EPRI

Thank you!



# 2017 EPRI P75 Research Efforts

## –Impacts on FGD chemistry:

- Unit load cycling
- Fly ash capture by wet FGD
- Tightening the water balance

## –Investigation of FGD operating issues:

- Impacts of:
  - Microbial activity in the absorber
  - Dissolved organics on Hg phase partitioning in absorber, Hg removal in WWT
  - Alternate makeup water sources (e.g., bottom ash transport system purge water)
- Causes and solutions for:
  - foaming in the absorber
  - poor gypsum quality

## 2017 EPRI P75 Research Efforts (cont'd)

- Multivariate Analysis (MVA) of FGD data
  - Goal to develop “universal” model to predict FGD ORP
  - Also developing unit-specific models to predict ORP or Hg emissions
- Case studies for FGD impacts on WWT processes
- Novel approaches to remove dissolved species from FGD waters in absorber or downstream
  - Selenite, selenate, chloride, nitrate removal being investigated
  - Objective to reduce chloride purge rate and/or WWT cost

# Topic #1: On-line ORP Monitor Performance

How accurately do in-line ORP measurements reflect sulfite oxidation rates in the scrubber?

# What is ORP and Why is it important?

## Oxidation/Reduction Potential (ORP)

- “measures an aqueous system’s capacity to either release or accept electrons from chemical reactions” [Hach]

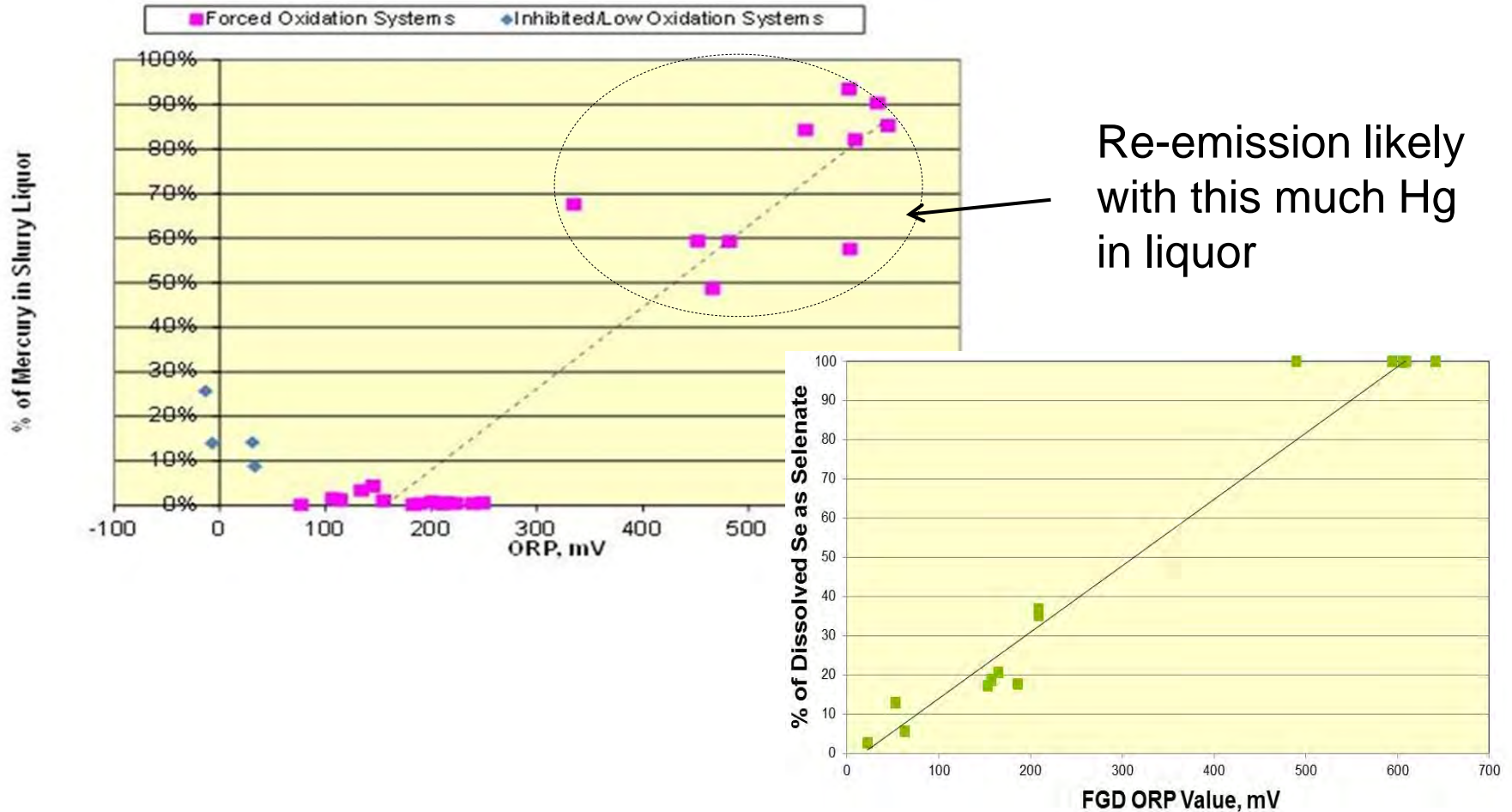
## Why is it important?

- Measure of sulfite oxidation rate
- Provides insight to trace metal behavior in scrubber slurry (Hg, Se, Mn, As in particular)
- Can indicate the presence of oxidants in FGD wastewater

## Useful tool to help troubleshoot:

- Compliance issues (MATS & WWT)
- Process chemistry issues (corrosion, sulfite oxidation)

# Example ORP Relationships with Trace Metals



The % of dissolved mercury and selenium increase in highly oxidized slurries (ORP values >300 mV)

# How is ORP measured?

- Easy measurement using a probe, in units of mV
- Handheld or in-line probes available



# What AECOM Sees When We Sample FGD Systems

1. Plants don't have in-line ORP meters, generally don't measure slurry ORP with handheld meters
  - Sometimes have stack Hg excursions that are unexplained!
2. Plant has in-line ORP meters, probe is not cleaned or QC checked regularly, report stable readings
  - Checks reveal in-line probe measurements don't match handheld meter
  - Probes scaled with Mn oxides or scale (sluggish response to changes)
3. Plant has in-line ORP meters, plant has cleaning and QC plan, in-line and handheld measurements match (less common)
  - Plant regularly cleans and checks in-line probe

# Obtaining Accurate Measurements

## 1. Inspect and clean in-line probes regularly

- Frequency = weekly? biweekly? Similar frequency as for pH probes

## 2. Perform QC checks to check probe accuracy

– Take measurement in QC standard

- Use standard with a value in the same range as slurry measurement

– Check in-line probe vs hand held meter

– Frequency of checks included in QC plan

- base on pH experience for buffer checks



## Topic #2: FGD startup/shutdown

Best practices for FGD startup/shutdown  
to maintain MATS compliance

# FGD Shutdown/Startup Background/Outline

FGD reaction tanks often drained during unit outage for maintenance inside absorber

Problem: Mercury re-emissions can result during FGD re-start after draining reaction tank

Outline for topic #2:

- Describe scenarios for filling reaction tank prior to startup
- Results presented for two startup scenarios
- Recommendations for best practices

# FGD Startup/Shut Down Strategies

- Two scenarios for drained slurry:
  - Store slurry in tank or pond for reuse
  - Discard slurry (to pond, or dewater)
- Varied scenarios for absorber reaction tank slurry on startup after draining:
  1. Only limestone slurry and makeup/reclaim water
  2. Aged slurry reclaimed from storage tanks
  3. Mixture of some aged slurry, fresh limestone, and makeup/reclaim water

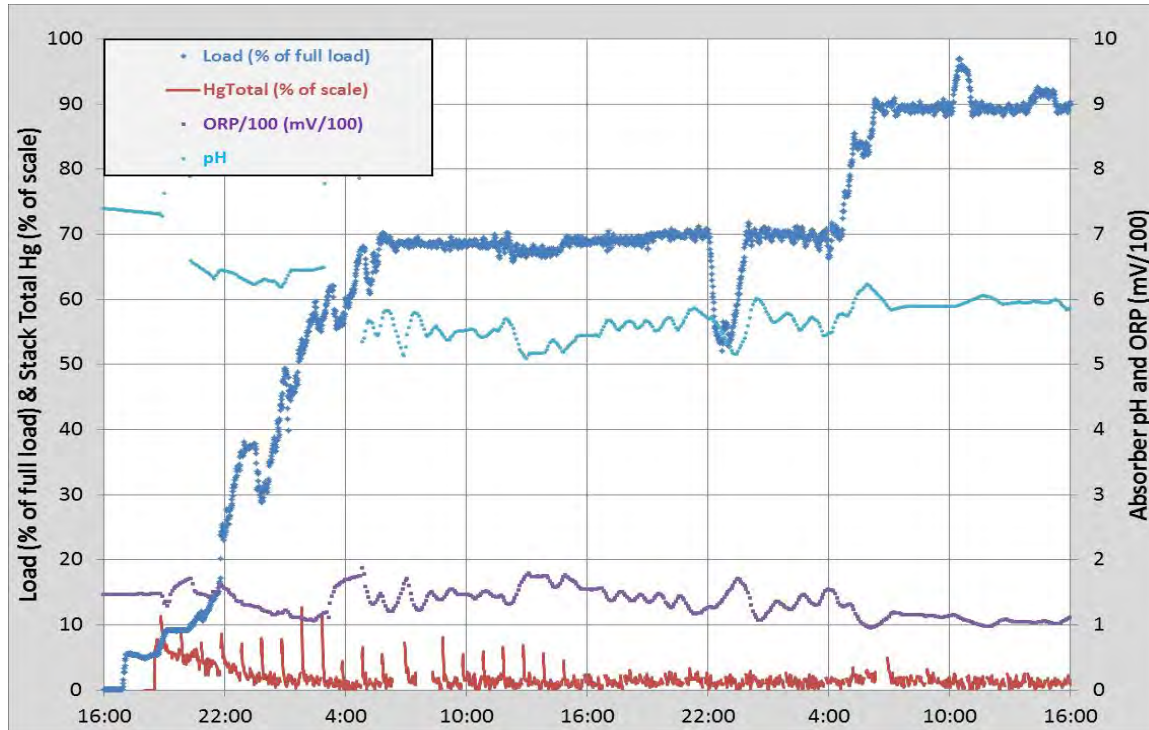
# Scenario #1 - Shutdown

- FGD system was not drained during outage
  - Absorber slurry dewatered to low wt% solids
  - Reclaim water brought back during dewatering
  - Some limestone slurry makeup prior to startup

# Scenario #1- Relevant Details for Startup

- Unit load ramp was slow (~36 hrs to reach 90% of full load)
  - Potentially helped startup go smoothly with respect to mercury emissions
- Excess limestone represented 5-6% of slurry solids
  - pH stayed relatively high, ORP stayed low
  - Hg in liquor phase remained <5 ug/L (ppb)
- High concentration of inerts from dissolved limestone
  - Supported Hg partitioning to solid phase (avoid re-emission)
- Observations:
  - Stable pH and ORP
  - Stack mercury emission remained relatively low and stable

# Trend Plot for Scenario #1

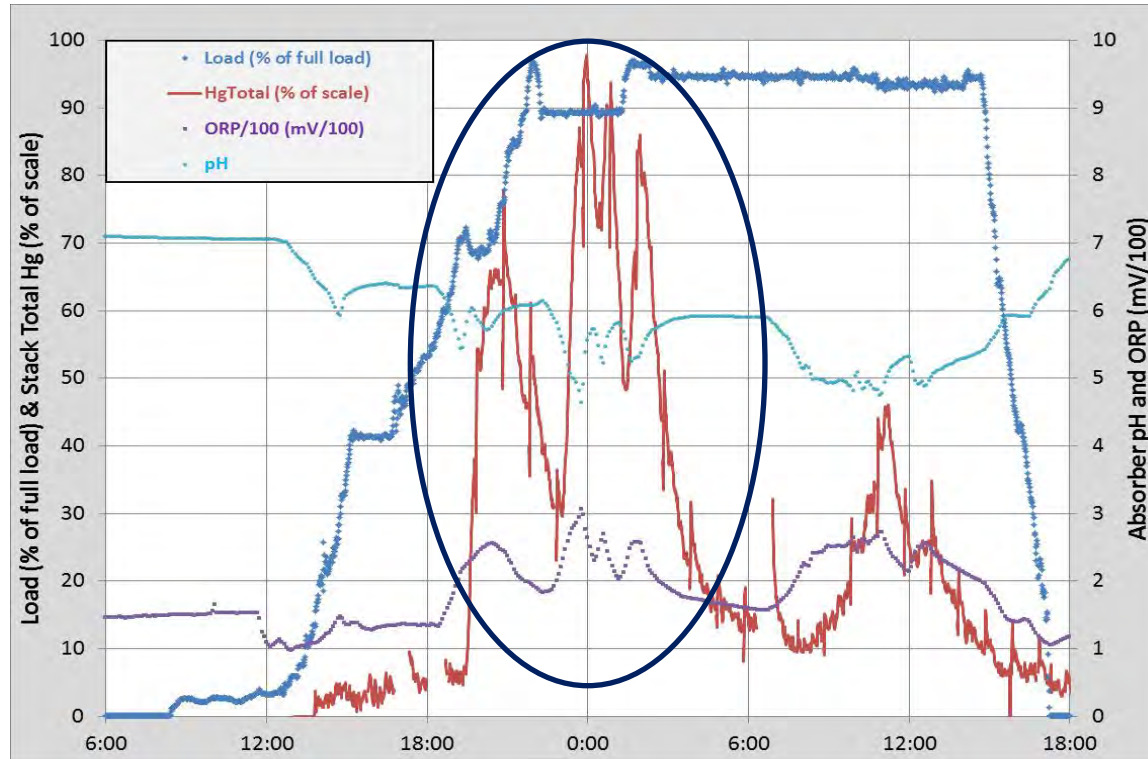


pH, ORP, and stack Hg emissions remained stable

# Scenario #2: Relevant Details

- Reaction tank was drained for outage
- Filled with mostly reclaim water for startup
  - Limestone inventory (~15-20 % of that in previous startup)
  - Lower TDS in slurry than first FGD system
- Forced ox air started at 100% of full-load rate as soon as coal firing started
- Start up observations:
  - pH dropped during initial load ramp
  - ORP spikes occurred
  - Stack mercury emissions varied

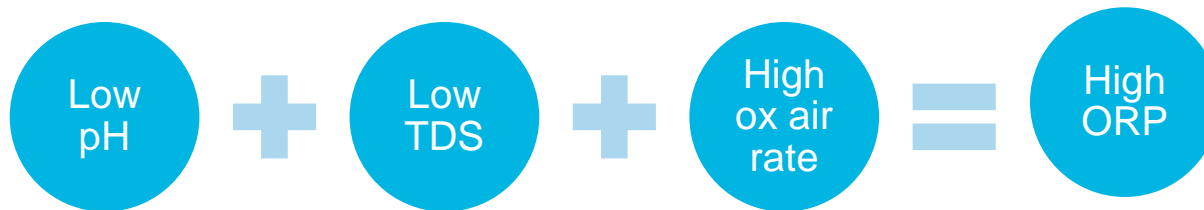
# Trend Plot for Second Unit Startup



pH fell, ORP increased, and stack Hg emissions increased

# ORP Spikes Occurred During Second FGD System Startup

- Observations made during ORP spikes:
  - Liquor-phase Hg increased to >70 µg/L (ppb)
  - Stack Hg emissions were variable
- Low pH + low TDS + high ox air rate likely exacerbated ORP spikes



# Recommendations for Smooth FGD Startup

- Bring back absorber solids from reclaim water tank and/or filter feed tank whenever possible
- Avoid pH drop during initial load ramp:
  - Add fresh limestone to the reaction tank slurry prior to startup
  - Raise pH set point to ~5.8-6.0 during startup operations (even if over-scrubbing)
    - Return to normal control algorithm once unit and FGD operations steady
- Avoid diluting the TDS in the initial slurry with excessive makeup of fresh water
- Ramp forced ox air rate with unit load/flue gas flue rate and inlet SO<sub>2</sub> concentration until nearly full load

# Topic #3: Tightening FGD water balance

Potential impacts of tightening FGD water balance to reduce fresh water consumption and/or lower wastewater flow rates

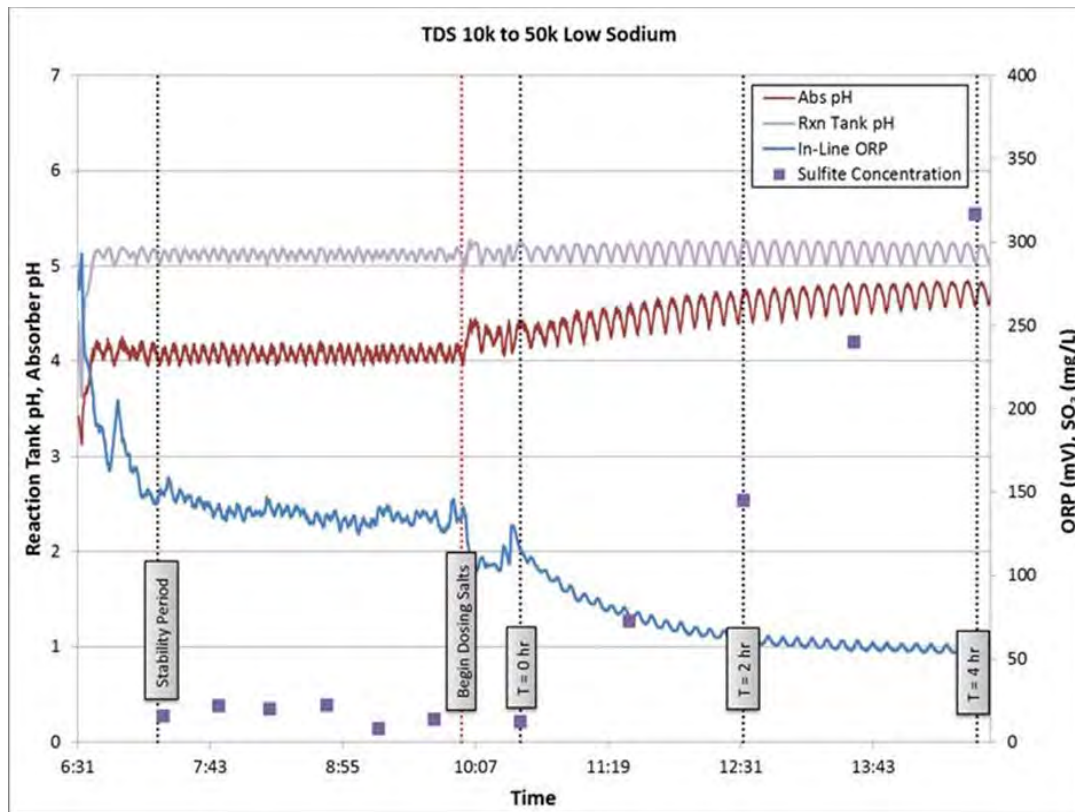
# Effects of Tightening FGD Water Balance

- Many plants looking to tighten FGD water balances to reduce fresh water consumption and/or FGD wastewater flow rates
- Operating more closed loop affects many parameters:
  - Increased TDS and Cl<sup>-</sup> concentration
  - Concentrations of constituents in makeup waters and of limestone impurities will increase due to more evaporation
  - Reuse of pond waters can bring increased levels of biological activity into the absorbers

# Potential Impacts on FGD Operations

## Insufficient sulfite oxidation

- O<sub>2</sub> pickup from forced ox air decreases with increased TDS



As TDS increases - ORP decreases, dissolved sulfite increases

# Potential Impacts on FGD Operations

- Increased foaming from absorber(s) as concentrations of some species increase
  - Organics from makeup water, biological activity, fines from limestone impurities, etc.
  
- Adverse effects on wastewater treatment
  - Biological processes do not like increased TDS and Cl-concentration
  - Increased concentrations of fine particles may not settle in clarifiers, increase Hg in effluents
  - Increases in dissolved organic carbon may inhibit Hg treatability

## Current EPRI Efforts on Tightening Water Balances

- Currently investigating foaming mechanisms on a full-scale FGD as they tighten their water balance
- Still wish to identify a site for characterizing an FGD system for changes, as efforts are made to close water loop and increase TDS in purge water

# Discussion Points – Participant Experiences

1. in-line ORP meters
  - Experiences with different probes
  - Cleaning/QC plan
  - Issues encountered
2. Hg emissions during FGD startup/shutdowns
  - Utility experience and best practice recommendations
3. Tighten water balance around FGD system
  - Experience with foaming?, gypsum purity? Other?
4. What else keeps you up at night regarding FGD operations?

# Thank You!



Name  
Title  
Email