

REINHOLD ENVIRONMENTAL[®]



2022 Reinhold/PCUG Round Table Presentation

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2022 Reinhold/PCUG Conference

Scrubber Oxidation Air Control for Cost Savings and Reduced Compliance Risk

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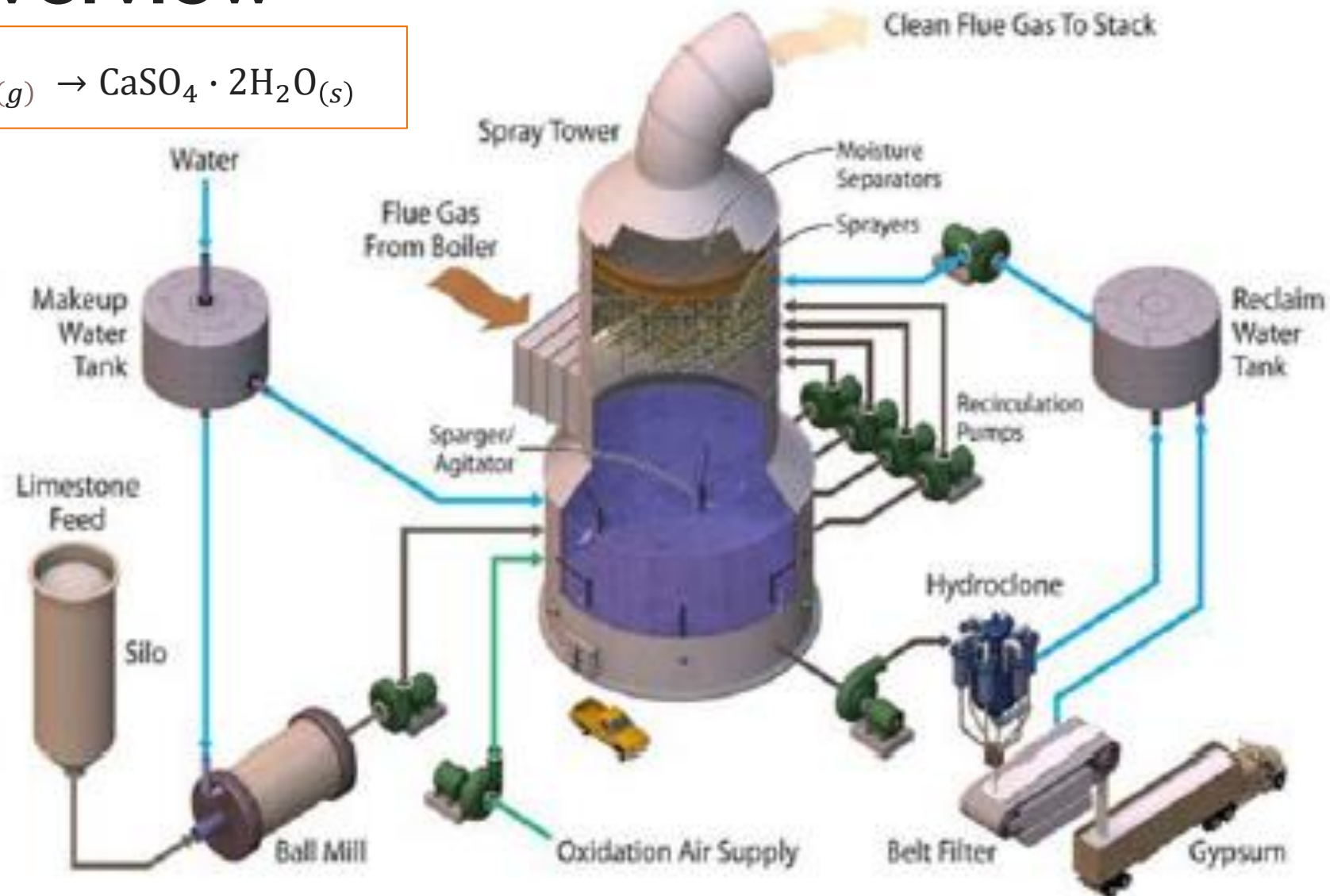
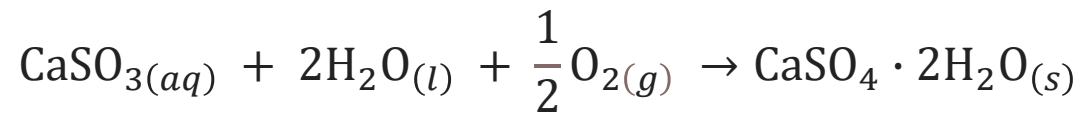
Overall Agenda

- Introduction
- FGD Overview, Definitions, and wastewater Effluent Limitations Guidelines (ELGs)
- FGD Process Control and Wastewater Treatment
- Study Design
- Results
- Operations & Maintenance Impacts
- Summary



Flue Gas Desulfurization (FGD) Overview, Definitions, & Effluent Limitations Guidelines

FGD Process Overview





FGD Wastewater – 2020 ELGs Definition

Wastewater generated specifically from wet FGD scrubber systems that comes into contact with flue gas or FGD solids, including:

- Blowdown from the FGD scrubber system
- Over/underflow from the solids separation process
- FGD solids wash water
- Filtrate from the solids dewatering system

The following are **NOT** considered FGD wastewater:

- Cleaning water from scrubber, solids separation, and dewatering equipment
- Cleaning water from “paste transportation piping”
- Floor drains in FGD process area
- Treated FGD wastewater permeate or distillate used as boiler makeup



EPA's 2020 FGD ELG Limits

Best Available Technology (BAT)* & Pretreatment Standards for Existing Sources (PSES)

Constituent	2015 Daily Max	2015 30 – Day Avg	2020 Daily Max	2020 30 – Day Avg
As (µg/l)	11	8	18	8
Hg (ng/l)	788	356	103	34
Se (µg/l)	23	12	70	29
NO ₃ /NO ₂ – N (mg/l)	17.0	4.3	4	3
As soon as possible beginning	November 1, 2018		October 13, 2021	
No later than	December 31, 2023		December 31, 2025 (Pretreatment – October 13, 2023)	

*As soon as possible date unless permitting authority allows later date based on site-relevant conditions.



FGD Process Control & Wastewater Treatment





FGD Process Control Using Oxidation/Reduction Potential (ORP)

First effort at process control - ORP implemented at many scrubbed sites

Measure oxidation and reduction potential – Provide gross estimate of how oxidized FGD scrubber effluent would be.

Pros: Relatively easy to install & operate

Cons: ORP sums + and – potentials for an overall value instead of a specific marker.

ORP may not be good indicator for gypsum purity or selenate oxidation



FGD Oxidation Air Control Using SulfiTrac™

Rationale:

FGD operations can be highly variable

Mitigation:

Process control for FGD will facilitate improved wastewater treatment

Measure inlet SO₂ + inlet load and obtains sulfite estimates to moderate selenate reduction.

Selenite amenable to chemical precipitation.

Pros: Feed forward and feedback control on a specific parameter enables more exacting control of process to prevent oxidation of selenite to selenate, allows FGD scrubber to better follow load and fuel variability

Cons: More expensive, need to retrofit scrubber and DCS control



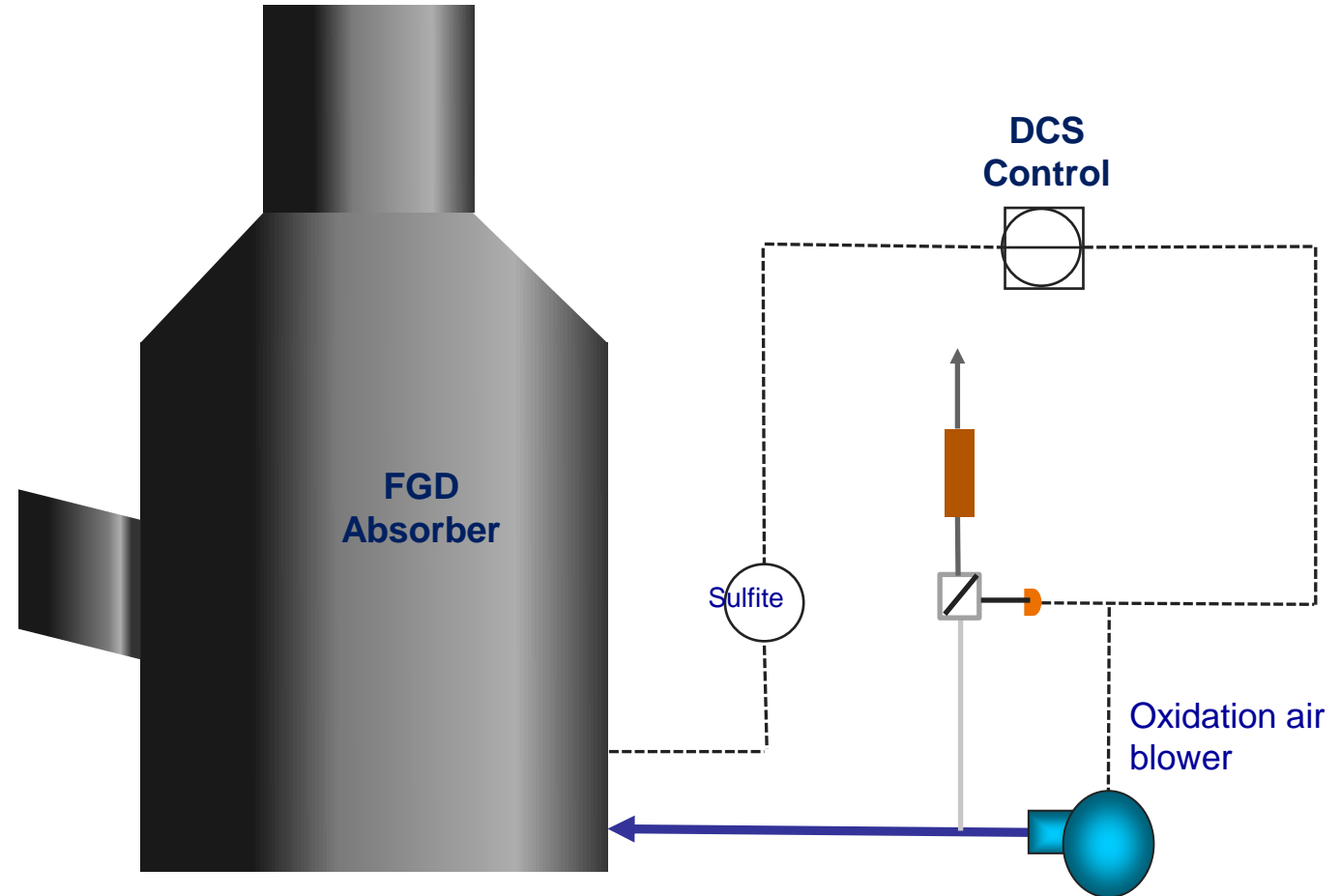
Simplified FGD Oxidation Air Control

Feed Forward:

Unit load, SO_2

Feedback:

Slurry sulfite

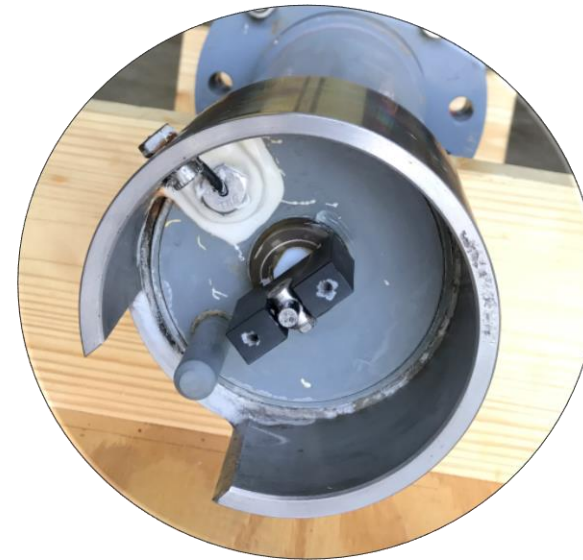


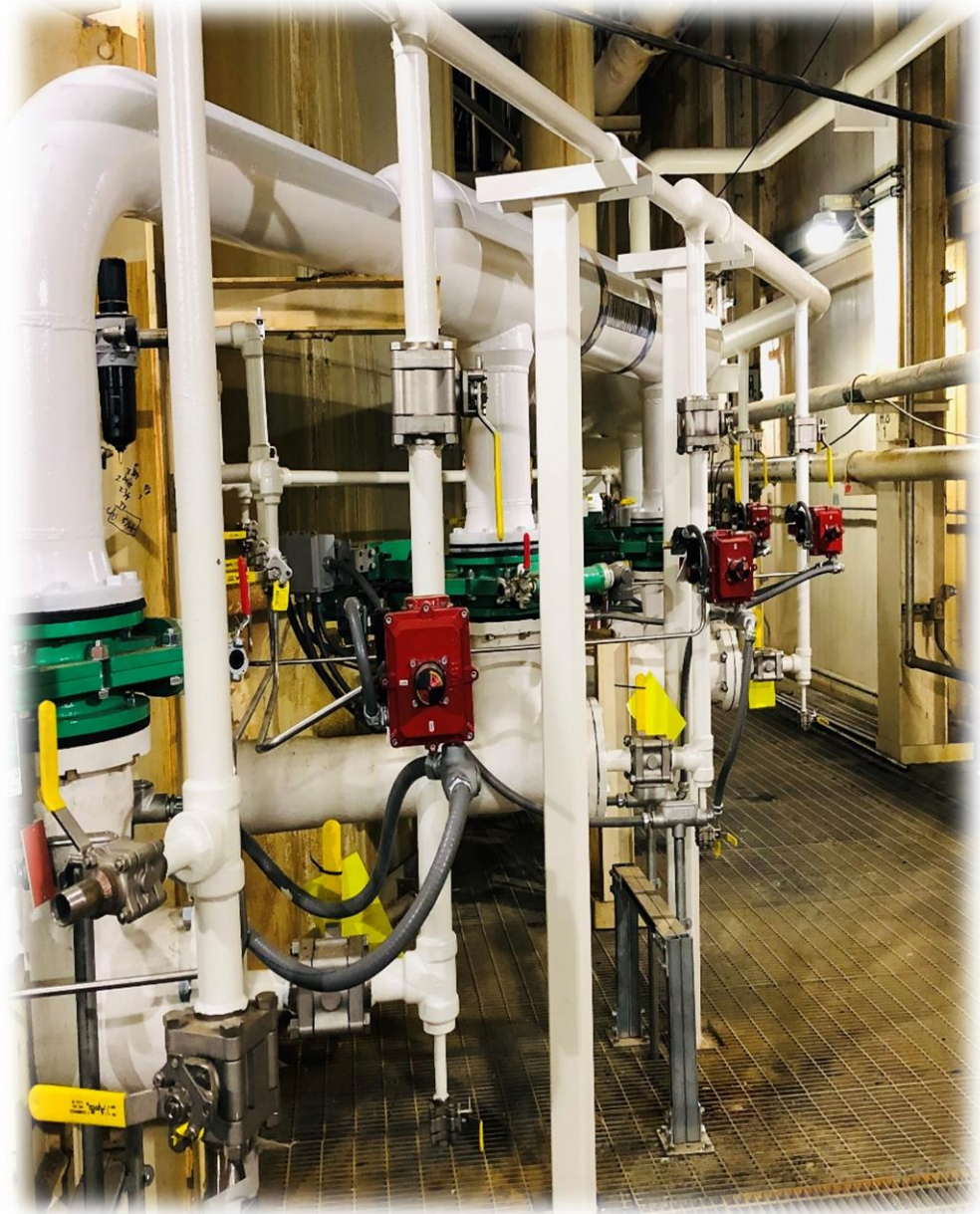


SulfiTrac™ Sulfite Analyzer in Service



- Analyzer sits in a continuous overflow “sink”
- Slow speed wiper for slurry service
- Low maintenance – monthly cleaning





Operational Considerations

- **Lower oxidation air demand may require mods**
 - “Blow-off” valve
 - Additional control valve
- **Shutting off systems may require flushing**
 - Slurry accumulation
 - Flush chemical additive lines if no longer in continuous service



FGD Wastewater Study: Experimental Design





Wastewater Test Conditions



- Full-scale sulfite control on 1 unit
- Collect/composite wastewater samples
- Maintain 110 °F sample temperature
- Mimic solids separation
- Chemical treatment: 10 tests/26 jars

Objectives for Testing Phys-Chem Se Treatment

- Examine pH/Se
- Ferric vs ferrous chloride, dosing
 - Ferric generally better
- EPA's BAT vs alternative
 - BAT generally better
- Cationic vs anionic polymers
 - Really depends on the wastewater
- Single- vs dual-stage
 - Not worth the added cost





Sulfite Controlled Influent Water Characteristics

Parameter	2017 FGD Gypsum Dewatering Effluent Average	2019 FGD Simulated Gypsum Dewatering Effluent
	May–October 2017	September 2019
	Without Sulfite Control	With Sulfite Control
ORP* (mV)	209	72.8
Arsenic (µg/L) (total/dissolved)	32.2 / 1.6	18.3 / 0.4
Mercury (µg/L) (total/dissolved)	19.7 / 0.5	15.4 / 1.1
Nitrate/Nitrite-N (mg/L)	4.1	2.3
Selenium (µg/L) (total/dissolved)	307 / 115	385 / 254
Selenite (µg/L) (dissolved)	26.3	235
Selenate (µg/L) (dissolved)	45.7	14.6
Selenite to dissolved Se %	23%	93%
Selenate to dissolved Se %	40%	6%

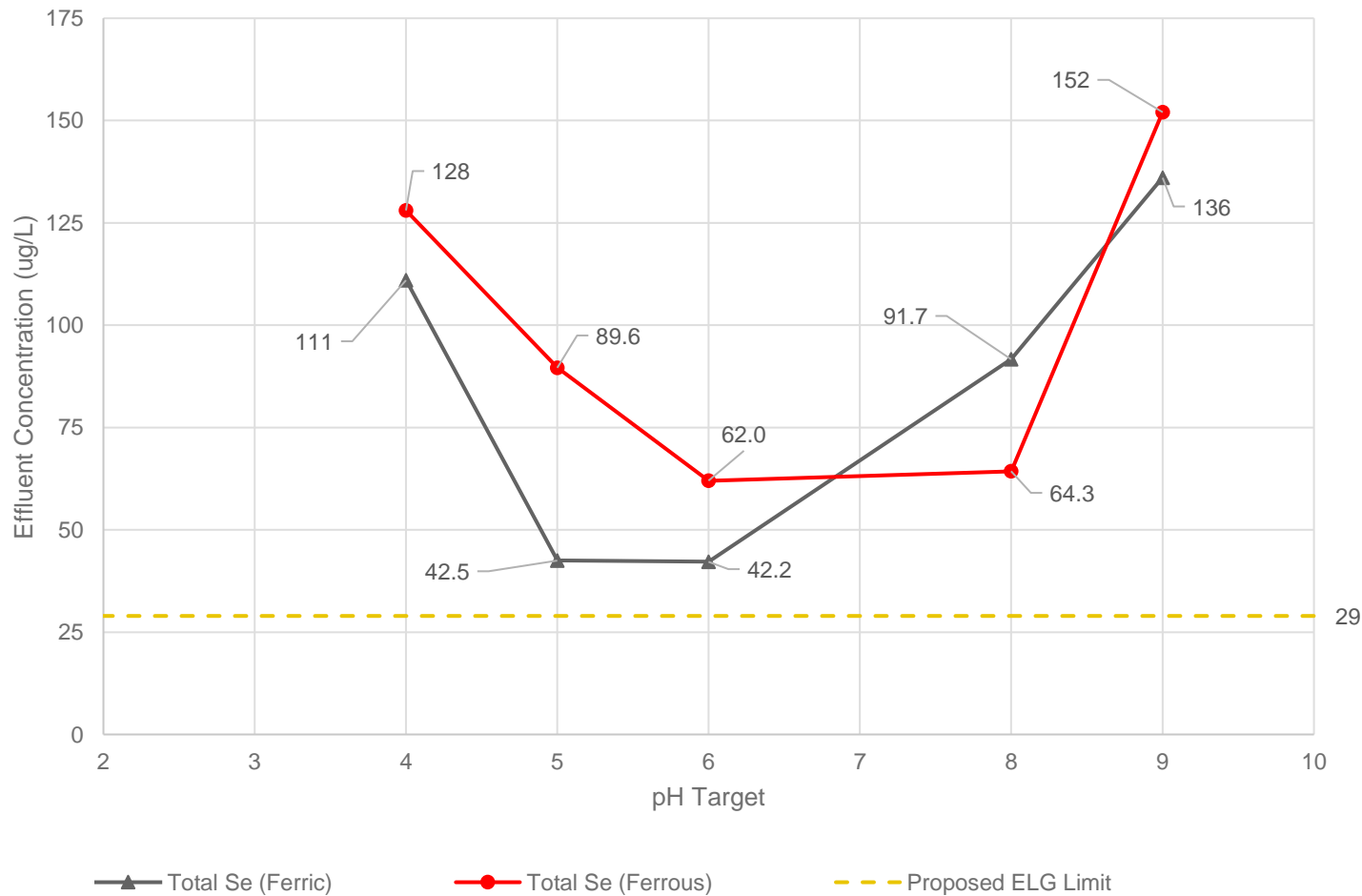


FGD Wastewater Study: Results





Results: pH & 25 mg/L Ferric vs Ferrous (As Product) Addition



- Inlet total Se 328 $\mu\text{g/L}$
- 25 mg/L ferric and ferrous
- Neither met monthly average Se



Results: Higher Ferric vs Ferrous (As Product)

Test	Coagulant; Bulk Dose (mg/L)	Fe Dose (mg/L)	Polymer Charge	Effluent Total Se (µg/L)
Ferric Chloride				
T1J4	25	0.7	Cationic	42.5
T2J1	75	2.1	Cationic	28.9
T2J2	150	4.2	Cationic	26.7
T2J3	150	4.2	Anionic	25.0
Ferrous Chloride				
T4J4	25	2.6	Cationic	89.6
T5J1	75	7.9	Cationic	53.5
T5J2	150	15.9	Cationic	50.0
T5J3	150	15.9	Anionic	37.2

- pH 5
- 25, 75 & 150 mg/L ferric and ferrous



FGD Operational Improvements with Oxidation Air Control

FGD Oxidation Air Control Operational Benefits

Air Compliance at Lower Cost

- Hg air emissions chemical
 - ↓ ~\$1.2 MM/year
- Parasitic load (excess oxidation air)
 - ↓ ~\$600 k/year



CCR Beneficial Reuse

- Gypsum marketability for wallboard not adversely impacted
 - Purity maintained to contract levels



FGD Oxidation Air Control Wastewater Benefits

- **Reduced compliance risk with selenium primarily in selenite form**
- **Reduced compliance risk with mercury**
- **Potential for reduced nitrate loading, reduced O&M cost (nutrient)**





THANK YOU!

Questions?

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