Continuous Water Quality Sensing for Flue Gas Desulfurization (FGD) Wastewater

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY

EITD ENGINEERING AND INNOVATIVE TECHNICAL DEVELOPMENT GROUP

INTRODUCTION

- Wet Scrubbing of Flue Gas Produces Wastewater Stream
  - Remove SO_2 w/ Calcium Hydroxide Slurry
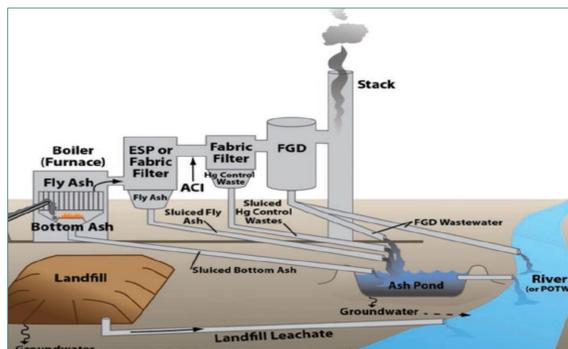 - Heavy Metals are also Removed

Figure 1. *Key Wastestreams of Coal-fired Steam Electric Power Plants.* Retrieved 19 March, 2017. https://www.epa.gov/eg/steam-electric-power-generating-effluent-guidelines-2015-final-rule

- FGD Wastewater Matrix Highly Complex
  - High Concentrations of Dissolved Salts

OBJECTIVES

- Develop Robust Online Sample Preparation Technique for FGD Wastewater Quality Monitoring
  - Facilitate Trace Metal Concentration Measurements with Existing COTS Devices

WASTE STREAM	PARAMETER	DAILY MAXIMUM	30-DAY AVERAGE
FGD WASTEWATER FOR DISCHARGE	As (µg/L)	11	8
	Se (µg/L)	23	12
	Hg (ng/L)	788	356
	NO3/NO2 as N (mg/L)	17	4.4
FGD WASTEWATER UNDER VOLUNTARY INCENTIVE	As (µg/L)[1]	4	
	Se (µg/L)	5	
	Hg (ng/L)[1]	39	24
	TDS (mg/L)	50	24

Figure 2. Numerical Limits for Steam Electric Power Generation Effluent Guidelines. *Water Research Center Book.* Southern Research.

- Initial Focus on Accurate, Repeatable Determination of Selenium Concentrations on Treated **and** Untreated FGD Wastewater

- Perform Extended In-Field Technology Demonstration with On-Line Monitoring System

KEY TEAM MEMBERS

SR SOUTHERN RESEARCH

- Southern Research providing expertise and utilization of unique research facilities at the Water Research Center

Ω Metrohm

- Metrohm providing significant cost share for access to expertise and COTS/custom trace metal determination systems

PROPOSED SOLUTION

- Proprietary Multi-stage Sample Preparation Methodology
  - Ultra-violet Digestion
  - Matrix Manipulation
  - Species Conversion

- Metrohm Voltammetry Systems
  - Parts-per-trillion Detection Limits for Se, As, Hg
  - Specialized Electrodes
    - Hanging Drop Mercury (Se)
    - scTRACE Gold (As, Hg)

APPROACH

- Verify all Results with ICP-MS Total Metals Analysis

- Develop and Validate Sample Preparation Methodology via Batch Processing in Laboratory

- Design and Implement Continuous On-line Sample Preparation Technology
  - Integrate with Automated 884 VA or 2045 VA Voltammetry Systems

Figure 3. Metrohm 884 VA Benchtop Voltammetry System (left) and 2045 VA On-Line Analyzer (right)

APPROACH (CONT'D)

- Perform Extended In-Field Technology Demonstration with On-Line Monitoring System
  - >1 week of intervention-free operation
  - Adjustable Measurement Frequency
    - <30min Latency (Max)
    - Lower Frequency to Extend Maintenance Schedule

RESULTS TO DATE

- Batch Process Identified for Untreated FGD Wastewater
  - Iterative Validation with ICP-MS on Multiple Samples Underway
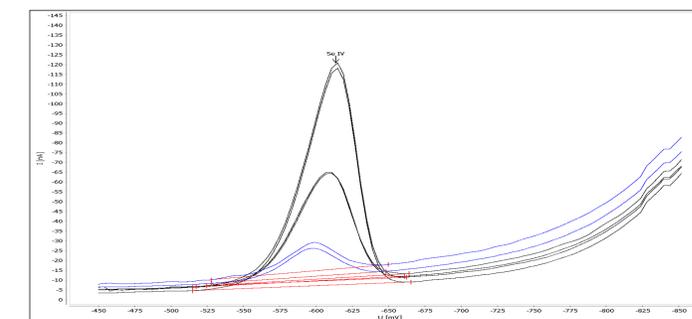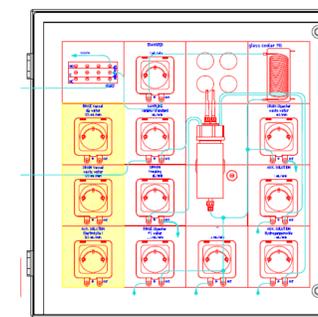

Figure 4. Selenium Concentration Determination in Untreated FGD Wastewater. Sample Concentration (blue), Standard Additions (black).

- Begun Design of Continuous Sample Preparation Prototype

NEXT STEPS

- Identify Batch Process for Treated FGD Wastewater

- Generalize, Optimize, and Validate Batch Process with Multiple Water Samples

- Explore Simple Options for Enabling As and Hg Determinations at Certain Points in Batch Process

- Design and Implement Continuous Prototype System

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