Flue Gas Desulfurization Effluent Management Using Innovative Sorption Treatment System

Joon H. Min, Ryan T. Brokamp, Jason Monnell

Crosscutting Research & Advanced Energy System Project Review Meeting
May 10, 2021

Project Team (Past and Current)

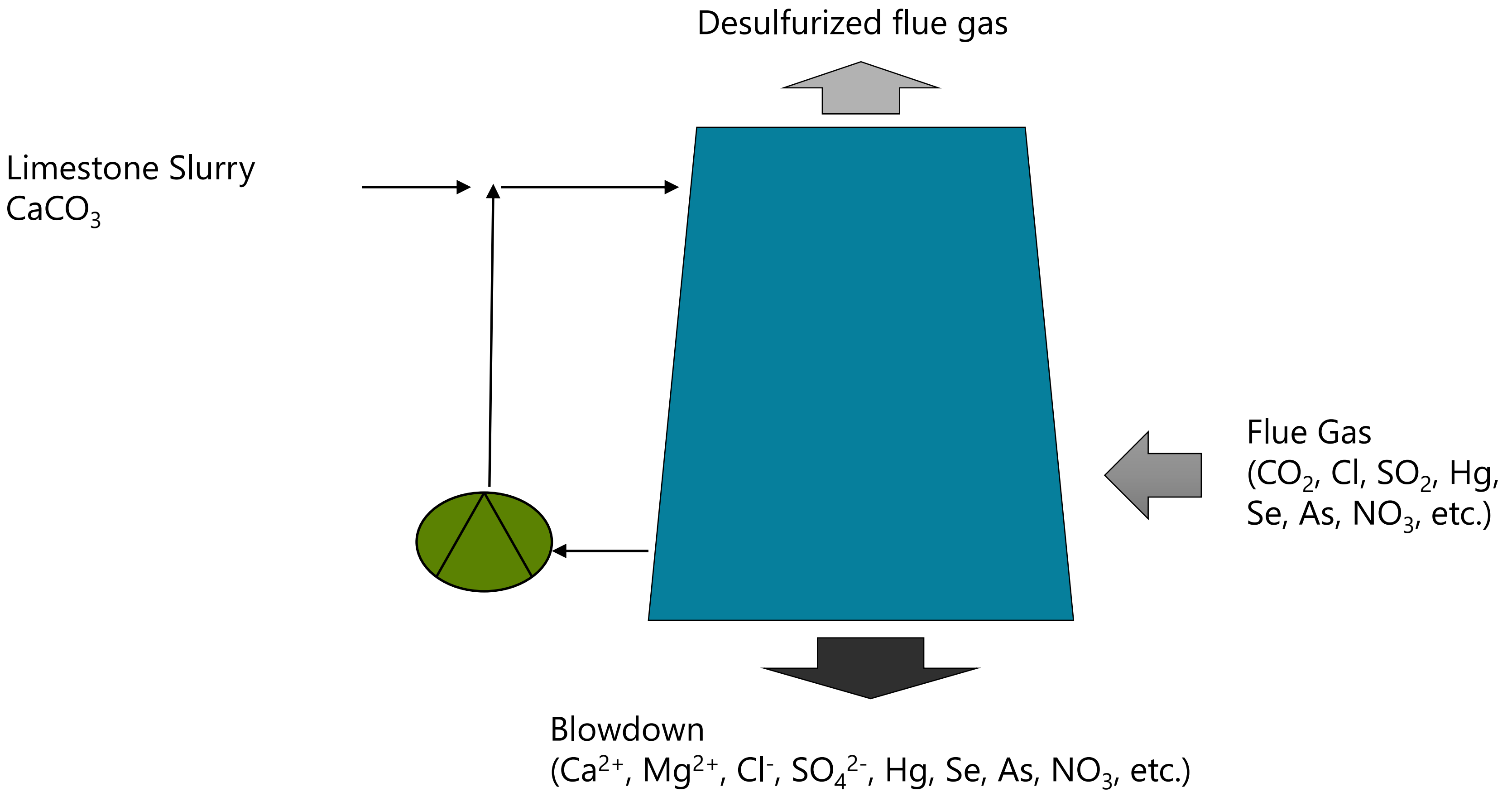
- Technical Team - JJ Wu, Ryan Eusebio, Hooman Vantankhah, Moh Ibrahim, Joon H. Min, Ryan Brokamp
- Operations and Site Support Team - Jeffery Preece, Jason Monnell
- Host Site Team – Chris Cagle, Riley Flowers
- Federal Project Manager - Omer Bakshi

Project Overview

- Effluent Limitation Guidelines (ELGs) for selenium, arsenic, mercury, and nitrate
- Flue Gas Desulfurization (FGD) wastewater from a wet scrubber for controlling gas emission needs compliance with ELGs
- A number of technologies have been tested, but some still have challenges associated with the implementation (footprint, cost, waste management, etc.)
- Selenate (Se(VI)) is the dominant species found in FGD wastewater, and more difficult to remove then selenite (Se(IV))

Project Background

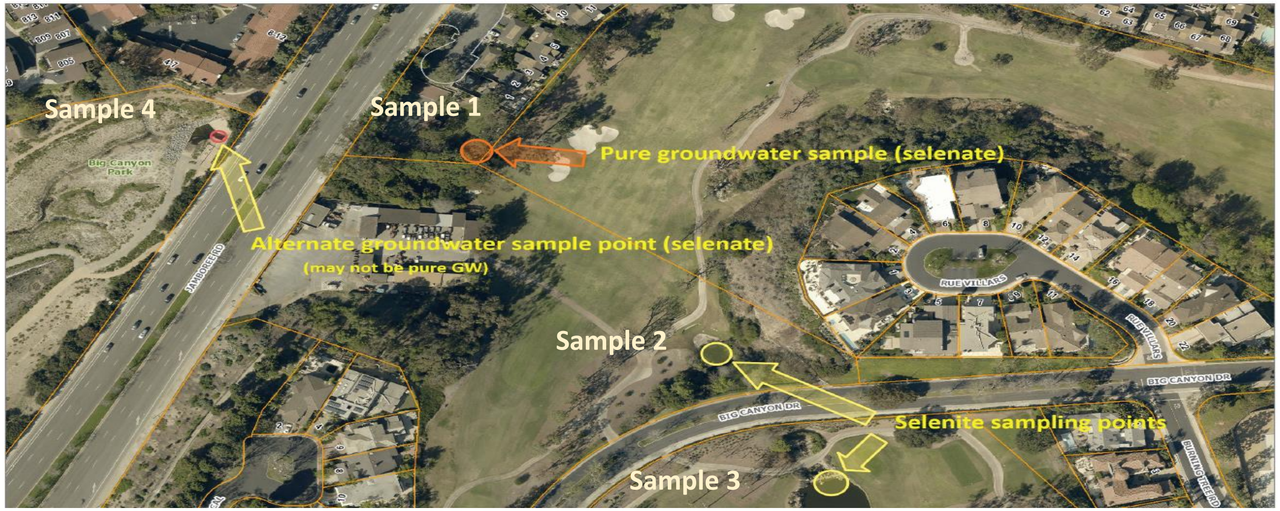
- Flue Gas Desulfurization Wastewater from Coal-fired Power Plants



Project Objectives

- Evaluate hybrid treatment process to effective remove selenium and other contaminants from FGD water
- Bench test various source waters including FGD, runoff water, mining water, groundwater, etc. with different types of custom media
- Field validate select media in a continuous pilot scale setting
- Develop cost estimate based on energy usage, media breakthrough, waste management, etc.

Surrogate Water Samples



Analyte	Unit	Sample 1	Sample 2	Sample 3	Sample 4
pH	S.U.	6.74	8.12	8.24	6.64
Temp. at Time of pH Meas.	°C	18.3	17.6	17.7	18.7
Total Suspended Solids	mg/L	5.8	5.5	5.2	5.7
Turbidity	NTU	6.2	4.9	4.8	3.8
Total Selenium, Se	µg/L	48.7	12.9	11.2	-*
Se (IV)	µg/L	3.74	2.88	2.84	4.51
Se (VI)	µg/L	25.3	4.97	4.85	43.2
Dissolved Oxygen	mg/L	5.7	8.3	8.9	7.9
Sulfate	mg/L	3150	676	669	3640
Total Phosphate as P	mg/L	0.202	0.117	0.11	0.148
Total Phosphate as PO4	mg/L	0.619	0.359	0.337	0.454

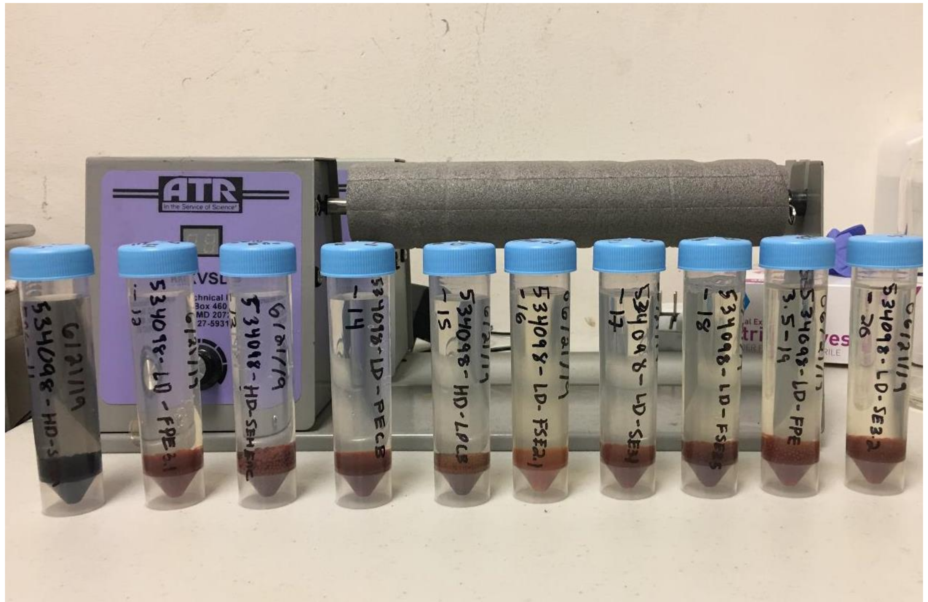
Water Quality for Source Waters Tested with Selenium

- Surrogate Sample Spiked with 50 µg/L of Se(IV)
- Raw power plant wastewater with mostly Se(VI)

Analyte	Unit	Surrogate Water	Power Plant Wastewater
pH	S.U.	6.64	6.54
Total Suspended Solids	mg/L	5.7	ND
Turbidity	NTU	3.8	0.72
Total Se	µg/L	98.4	172.3
Se (IV)	µg/L	53.7	4.43
Se (VI)	µg/L	41.1	147
Dissolved Oxygen	mg/L	7.9	9.2
Sulfate	mg/L	3,640	981
Total Phosphate as P	mg/L	0.148	0.011
Total Phosphate as PO_4	mg/L	0.454	0.034
Arsenic	µg/L		6.96
Mercury	µg/L		4.97
Nitrate, as N	mg/L		8.32

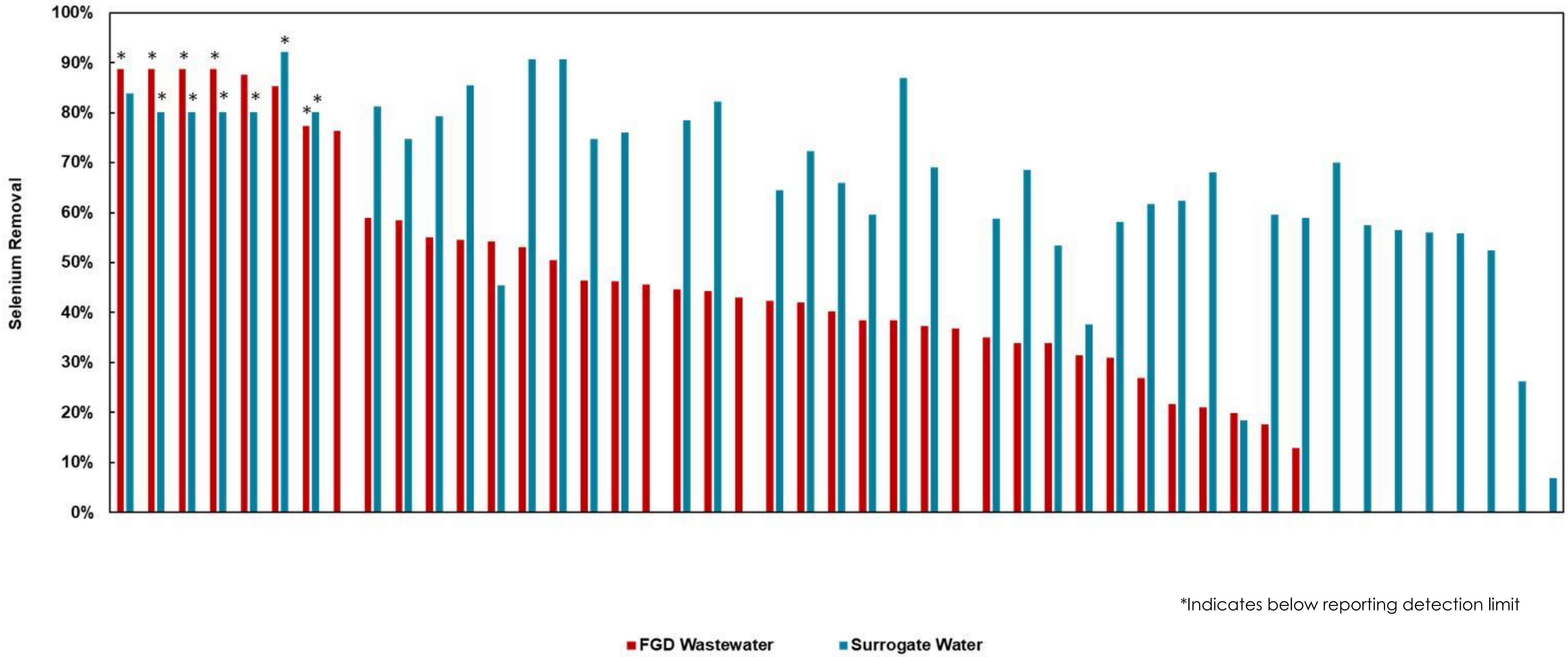
Bench Testing with Multiple Source Waters

- Media candidates with different Se removal properties (difference in functionalities, capacities, and selectivities) and control samples
- Adsorption experiments for media pre-screening
- Small reactor tubes were used
- Mixing at various test conditions
- Total selenium removal as evaluation criteria



Bench Batch Test Selenium Removal Results

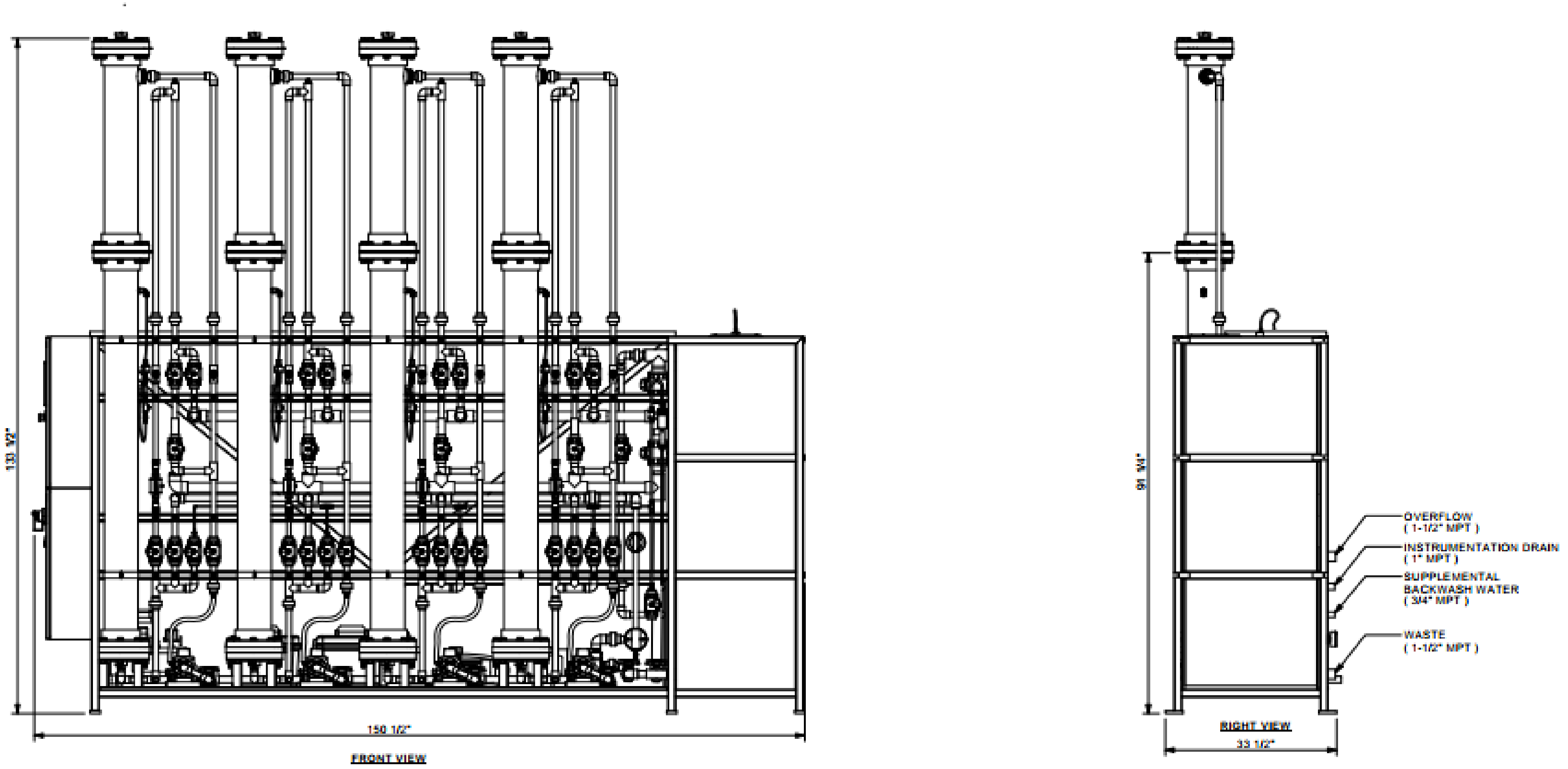
- FGD Effluent (mostly Se(VI)) and Surrogate Water (both Se(IV) Se(VI))



*Indicates below reporting detection limit

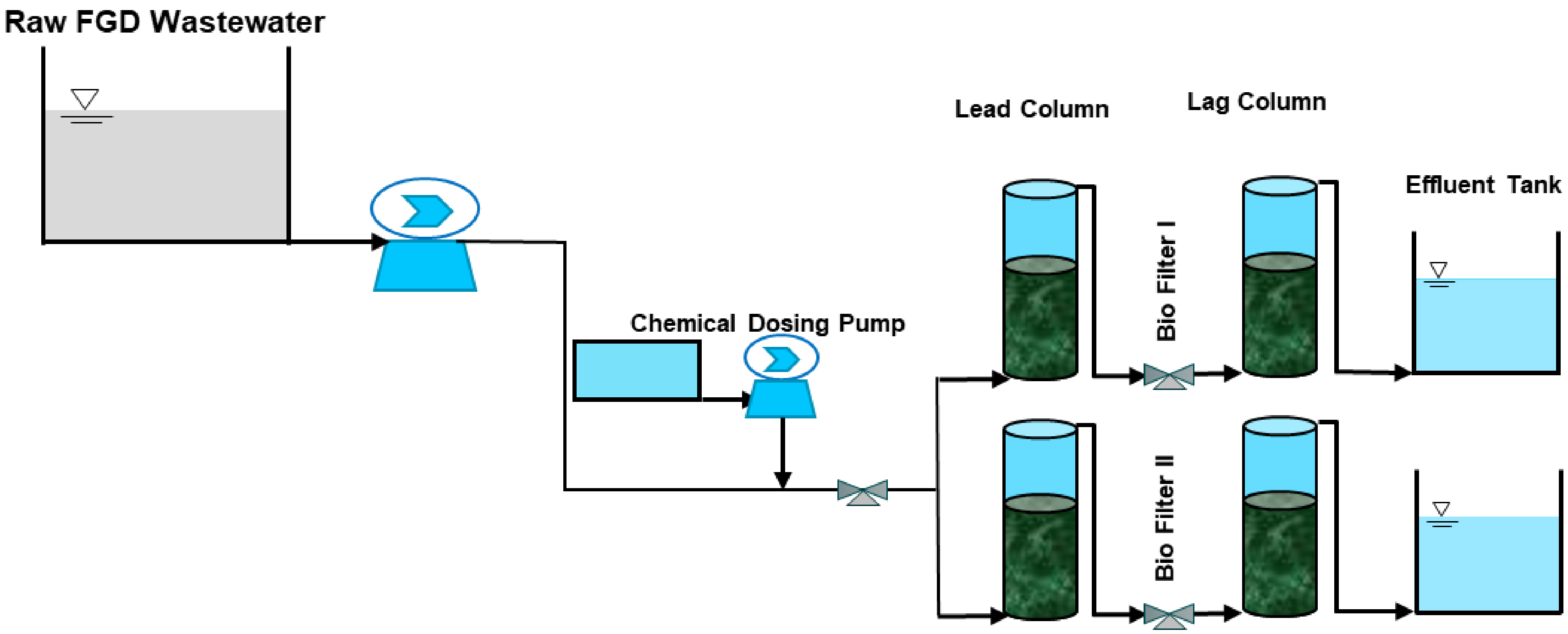
Pilot System Design

- Based on the bench test result, a few media were selected, and four independent columns were planned initially with 6 in column pilot system (overall height of 133 in)



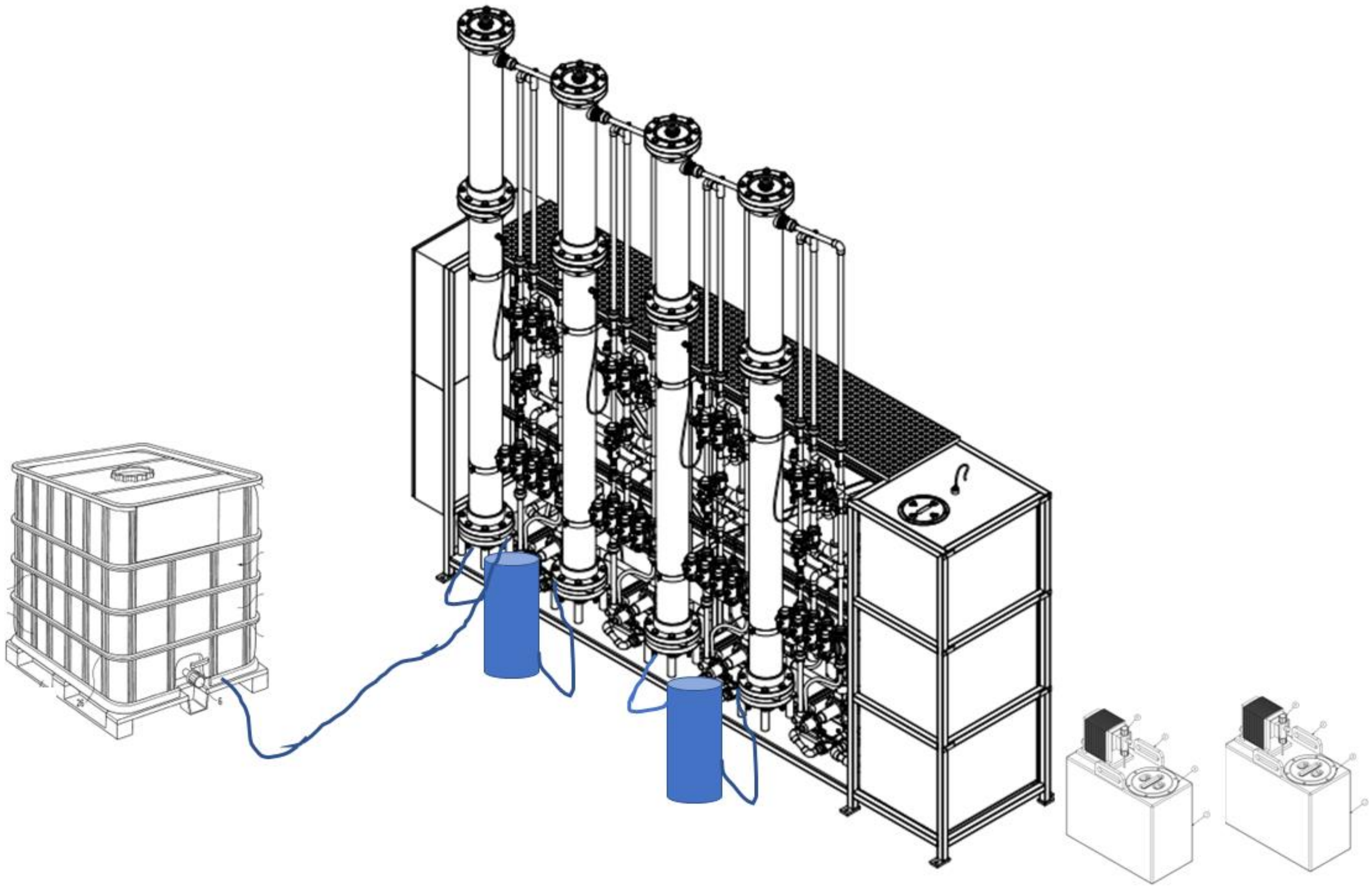
Pilot System Flow Configuration

- In order to allow flexibility during the operation and collect additional water quality samples, four columns are being re-configured to have two sets of lead-lag setup



Pilot System Integration

- The system was modified to have two trains of lead lag with an additional tank between the columns to allow lead lag operation (in series)



Pilot System Hydraulic Test

- Pilot system hydraulic tests were completed with automated backwash sequence, which is designed to trigger based on head loss, effluent turbidity, or time

Pilot System Effluent Monitor

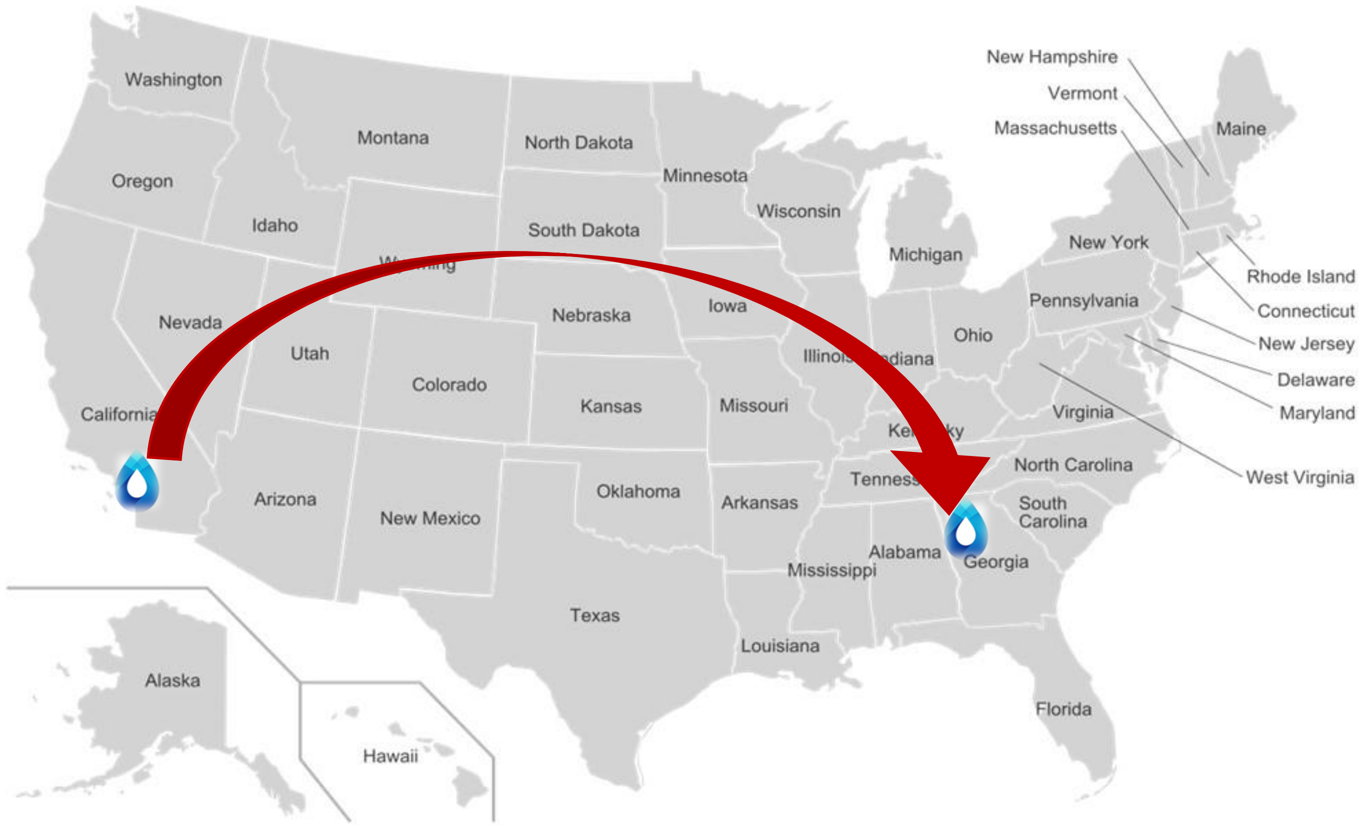
- Dedicated turbidity meter for each column will serve to check the performance of the filter during the operation
- Additional grab samples will be collected or metals, and other parameters

Media Preparation

- Large batch media preparation (1 ton reactor) is on-going to have enough volume to fill the pilot columns shown in white tanks in front of the forklift

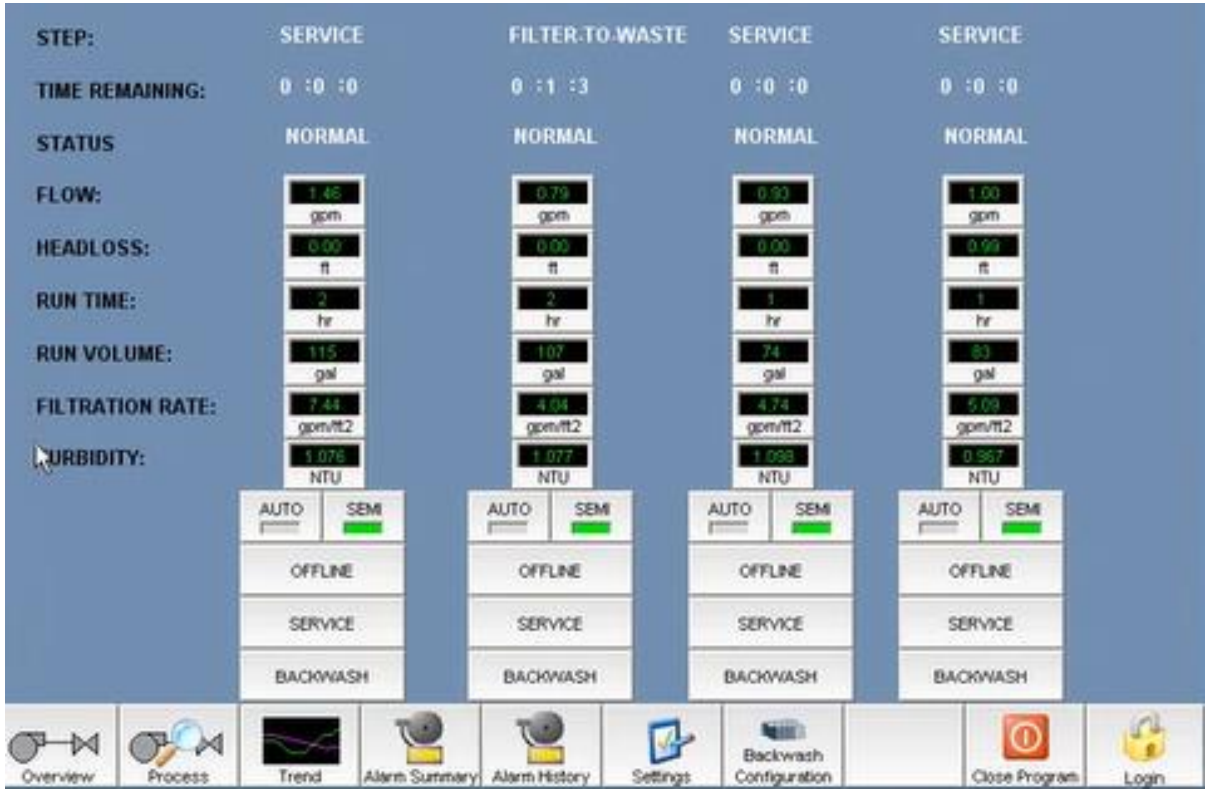
Remote Access Requirement

- The project location where the pilot system was planned and the technical team's location necessitated stable remote access to monitor and troubleshoot the pilot system to help the local operational team members



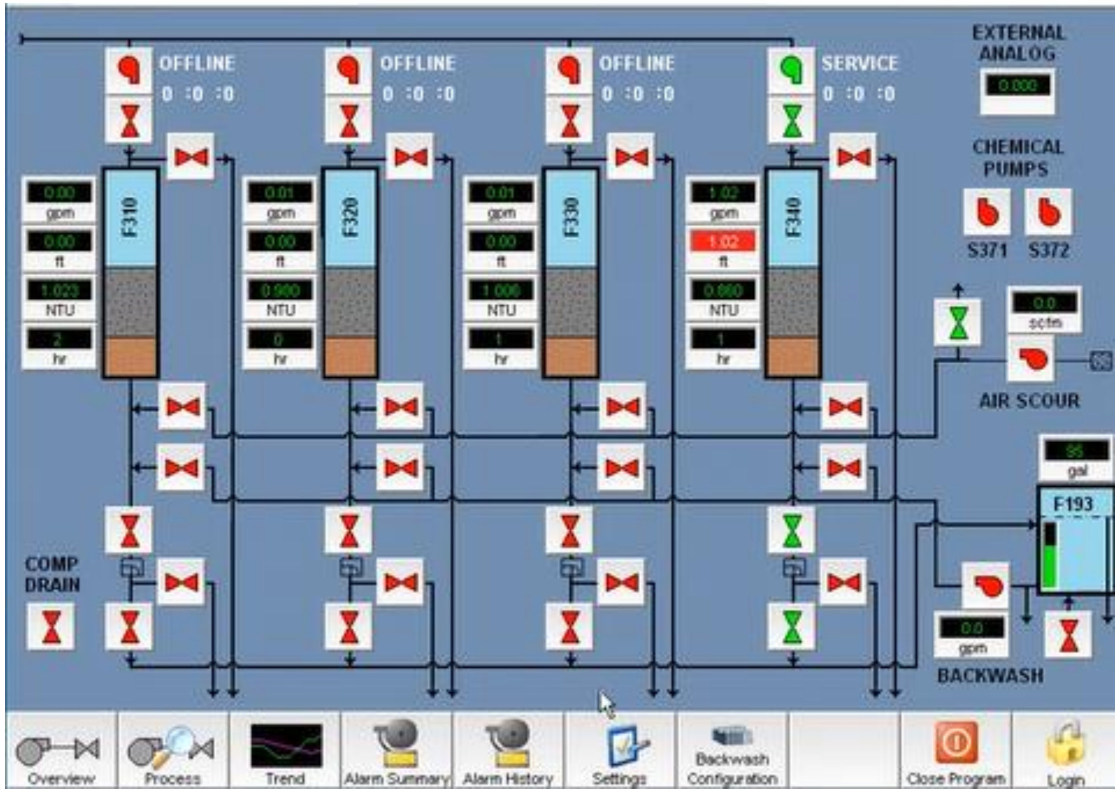
System Automation

- Each column has its own sensor, flow meter, monitor, etc. and can be monitored or controlled remotely to diagnose and trouble shoot any performance related issues on-site



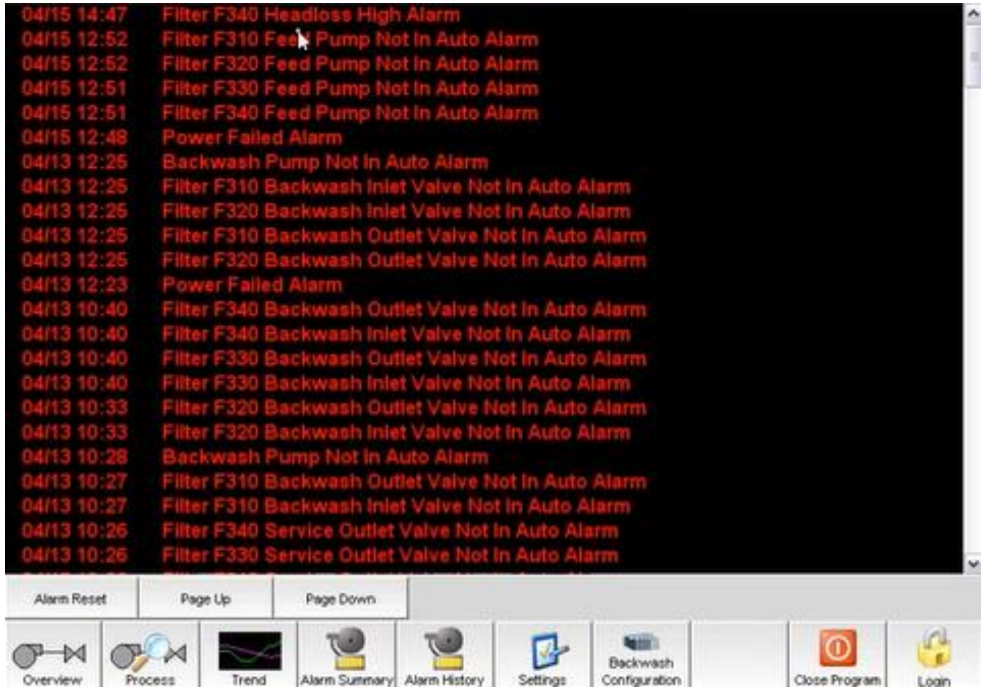
System Remote Control

- In addition to the set points for each column, individual valve operation as well as chemical feed pump monitor and control as well as backwash procedures can be established through for remote operation



System Access and Alarms

- Cellular based system remote access with dedicated IP address will provide stable connection for remote access
- Automated alarms based on the system set points customized will help optimize the system operation



Summary and Planned Work

- Pilot equipment has been configured to start the acclimation process
- Pilot scale media is being prepared to fill the media columns
- System has been wet tested, the pumps, sensors, and controls have been checked
- The parameters for the operating conditions will be finalized and setup within the program
- The stability of the remote access, control, alarms, etc. are continued to be tested
- Surrogate water for acclimation has been sourced
- After up to 2 months of acclimation period, the system will be collecting FGD treatment data

Acknowledgment and Disclaimer

- Acknowledgment: "This material is based upon work supported by the Department of Energy Award Number DE-FE0031676."

- Disclaimer: "This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

Flue Gas Desulfurization Effluent Management Using Innovative Sorption Treatment System

Joon H. Min, Ryan T. Brokamp, Jason Monnell

Crosscutting Research & Advanced Energy System Project Review Meeting
May 10, 2021