FRONTIER GEOSCIENCES, INC.

FRONTIER™ GLOBAL SCIENCES

Metals Mobility in Coal Combustion Residues and Analytical Techniques for Monitoring Fly Ash Ponds

About Us

- Frontier GeoSciences was founded in 1991 in Seattle, Washington.
- Co-author of EPA 1600 series methods (Hg, As, Se, etc.).
- Designed/popularized principles of sorbent trap method for flue gas mercury measurements in 1993 which are now EPA Methods 30B and Appendix K.
- Continued analytical method development for metals in a variety of applications .

Study Overview

- Frontier GeoSciences, in conjunction with the Department of Energy, completed an exhaustive 3 year study to better understand trace metals in coal ash
- Our objective was to determine the following:
  - Measure metals accurately on CCR's
  - Assess metals availability and mobility through CCR end use processes
  - Measure the effect of mercury control technologies on CCR's

Our Goal Today…

- Our goal today is to briefly describe our CCR study, the science behind our examination of metals mobility and trends that we see in the results.
  - Start with total metal content in CCR's.
  - Look at the impact of the leaching of trace metals in coal ash.
- We will also describe other analytical techniques that can be used for monitoring of fly ash ponds including groundwater, ambient air, and particulate for low level metals.

Tests to Simulate Various End Uses

Test	Procedure	Purpose
Total Metals	Complete Digestion	Compare to Various Measures
Volatilization	40°C for 30 days	Soil fill / Landfill
Volatilization	190°C for 60 min	Asphalt / Wallboard
Volatilization	1200°C for 5 min	Cement
Microbial Leaching	Batch reactor with *D. propionicus*	Soil fill / Landfill / Impoundment
Chemical Leaching	Tumble @ pH 4.2, 60:40 H_2SO_4:HNO_3	Simulates precipitation/ runoff from any use

Basis of the Study

- 25 different collected the following types of samples for the study:
  - Fly Ash
  - FGD by-products
- Fly Ash and FGD by-products account for 80% of CCR's that are used in other industries
- Sites collected samples both before mercury control technology use and after

Issues Associated with CCR's

- Trace metals may contaminate end products
- Potential to release trace metals into the environment
- Mercury Control Technologies (MCT) can change properties and impact end use
- MCT can transfer mercury and other volatile metals from emissions to end products

Total Metals Results (Dry Ash Only)

Units: mg/kg	Ni	As	Se	Cd	Pb	Hg
Without Hg Control						
Average	49.3	35.1	27.0	0.925	36.3	0.664
Minimum	0.26	2.84	1.33	0.057	0.47	0.0053
Maximum	131	180	309	7.11	82.0	8.35
With Hg Control						
Average	53.3	41.5	86.9	1.04	38.9	3.95
Minimum	5.21	4.70	0.47	0.18	1.97	0.0189
Maximum	128	210	1720	6.56	92.6	80.8
Comercial/Industrial SSL*	23000	2	5700	900	-	340
Residential SSL*	1600	0.4	390	70	400	23
TCLP Limit	-	100	20	20	100	4

*Ingestion route

Chemical Leaching Metals Results (Dry Ash Only

Units: µg/L	Ni	As	Se	Cd	Pb	Hg
Without Hg Control						
Average	11.1	11.4	71.5	1.06	0.681	0.00395
Median	0.84	2.09	17.9	0.212	0.094	<0.00160
Minimum	<0.07	<0.22	1.05	<0.021	<0.017	<0.00160
Maximum	113	157	356	22.3	6.49	0.0412
With Hg Control						
Average	14.2	11.7	483	0.674	0.731	0.0489
Median	0.91	1.87	24.5	0.179	0.103	<0.00160
Minimum	<0.07	<0.22	1.02	<0.021	<0.017	<0.00160
Maximum	177	127	9980	9.95	8.21	1.65
National Drinking Water Standard	-	10	50	5	15	2
National Recommended Surface Water Criteria*	52	0.018	5	0.25	8.1	0.77
TCLP Limit	-	5000	1000	1000	5000	200

*Assumes Hardness of 100 mg/L

Potential Future Monitoring Requirements

- Groundwater monitoring for ash ponds
  - Metals, anions, pH, dissolved solids (not yet finalized)
- Ambient air particulate monitoring
  - Particulate matter possibly hexavalent chromium
- Wastewater discharges
  - Regulations still pending
- Hazardous Air Pollutants
  - Regulation still pending

Analytical Techniques Selection Critical

- In some case the required analytical techniques to be used for monitoring will be somewhat fixed
- The importance of accurate analytical data is especially important for regulatory monitoring
- Also in some cases require regulatory standards can be very difficult to meet because of the low level needs
- In almost all cases there are techniques available that are accurate and can see low enough to provide the necessary information

Tools to Help You with Analytical Monitoring Requirements

- Work closely with you laboratory service provider
- They can help with many aspects of your monitoring needs including:
  - Appropriate sample collection
  - Appropriate analytical method use for you precise needs
  - Interpretation of analytical monitoring requirements
  - Interpreting your analytical data results

Summary

- Chemical leaching of CCR's is very dependant on the type of coal, processing of the coal, and mercury control technology. Some are below drinking water and surface water criteria, some are not.
- Mercury control technologies increase the total concentrations of metals such as selenium and mercury but do not necessarily increase the leaching and volatility of these metals
- It is clear that an ever increasing amount of regulation is in the future that will most likely require additional controls and monitoring
  - Work closely with your laboratory to help you satisfy any monitoring requirements

Acknowledgements

- Lynn Brickett, United States Department of Energy
  - National Energy Technology Laboratory

Questions

Patrick Garcia Strickland
Laboratory Manager
Frontier GeoSciences, Inc.
414 Pontius Avenue North
Seattle, Washington 98109

(206) 622-6960
Patricks@frontiergeosciences.com