Characterization of Arsenic and Selenium in Coal Fly Ash to Improve Evaluations for Disposal and Reuse Potential

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DOE-NETL 2020 FE R&D Virtual Project Review Meeting – Sensors and Controls

Presenting:

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Motivation and Significance

Arsenic and selenium are coal ash constituents that can pose problems near disposal sites



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Brandt et al, ES&T, 2017

Motivation and Significance

Arsenic and selenium are coal ash constituents that can pose problems near disposal sites

TVA-Kingston coal ash spill disaster: River water and sediments

TVA Kingston (TN), Dec. 2008





Total Arsenic and Selenium Contents in Coal Fly Ash

- Widely variable amounts of As and Se in coal fly ash
- Depends partly on the type of feed coal

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Statement of Project Objectives

Overall Project goal: To improve methods to evaluate arsenic and selenium risk potential in coal fly ash

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Statement of Project Objectives

Work this past year: Factors influences leaching of arsenic and selenium in coal fly ash



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Today's presentation

- 1. Leaching potential of As and Se
- 2. Properties of fly ash influence As and Se leaching
- 3. Chemical speciation of As and Se



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1. Leaching potential of Arsenic and Selenium



Leachate composition:

- Deionized water (LEAF)
- 0.2 mM acetate/acetic acid (TCLP)



2 g ash

per 20 mL

Mix for 18 hr

Aqueous concentrations and speciation of As and Se

Compare with properties of fly ash

- Chemical composition
- Coal feedstock
- Combustion conditions



1. Leaching potential of Arsenic and Selenium



TCLP elutriate thresholds for Class C 'hazardous' wastes:



[As] > 5 mg/L

[Se] > 1 mg/L

1. Leaching potential of Arsenic and Selenium



Total As and Se contents in fly ash are poor predictors of leachable As and Se

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2. Properties of Fly Ash

Leachable Arsenic correlates with iron content in fly ash



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2. Properties of Fly Ash

Leachable Selenium correlates with Calcium content in fly ash





Relevance and Implications

On-site, rapid assessments of As and Se leaching potential



Charlotte Business Journal BizJournal.com, 2017

Example: Closure and recycling at ash ponds that hold a variety of coal ash

- Total Fe, Ca contents (in situ X-ray fluorescence analysis)
- Feed coal history





2. Properties of Fly Ash





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Boiler unit in start-up mode:

20 (Start-up Mode Fly ash) ² Se, mg/kg • Total Se ▲ Leachable Se 0 10 15 20 0 5 Se, mg/kg (Baseline Operations Fly Ash)

selenium

- Greater total As and Se in fly ash
- Moderate increase or no change in leachable As/Se

Relevance and Implications

Coal power generators are supplying peak load rather than base load electricity demand



Union of Concerned Scientists, 2020 ucsusa.org







3. Chemical speciation of Arsenic in coal fly ash



Arsenic: comparison of boiler operations

Arsenic is primarily in the • As(V) form

As(III)

As(V)

Subtle differences between ۲ **Baseline and Start-up** operating modes

3. Chemical speciation of Arsenic in coal fly ash



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3. Chemical speciation of Selenium in coal fly ash



Selenium

- Selenium is primarily in the Se(IV) selenite form
- Subtle differences between Baseline and Start-up operating modes

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Summary

- Total As and Se contents in fly ash vary widely across coal types
- Leachate concentrations of As and Se correlate with total Fe and Ca contents, not total As and Se
- Chemical speciation of As and Se in fly ash has a key role in controlling mobilization potential





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