REINHOLD ENVIRONMENTAL Ltd.

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Impacts of Sodium Sorbents on Fly Ash

Reinhold Environmental NOx PCUG Conference

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Fly Ash Basics

- **Ash content of coal ranges from 2%-30%.**
- **Around 85% of coal ash becomes fly ash. The remaining 15% is bottom ash.**
- **Fly ash consists mostly of silicon dioxide (SiO_2), aluminum oxide (Al_2O_3) and iron oxide (Fe_2O_3). It also contains heavy metals, including selenium, arsenic, nickel, vanadium,, beryllium, cadmium, barium, chromium, copper, molybdenum, zinc, lead and radium.**
- **Dry sorbent injection with sodium sorbents introduces additional sodium compounds (Na_2CO_3) and desulfurization product (Na_2SO_4).**

Chemical Composition for Fly Ash (without FGD)

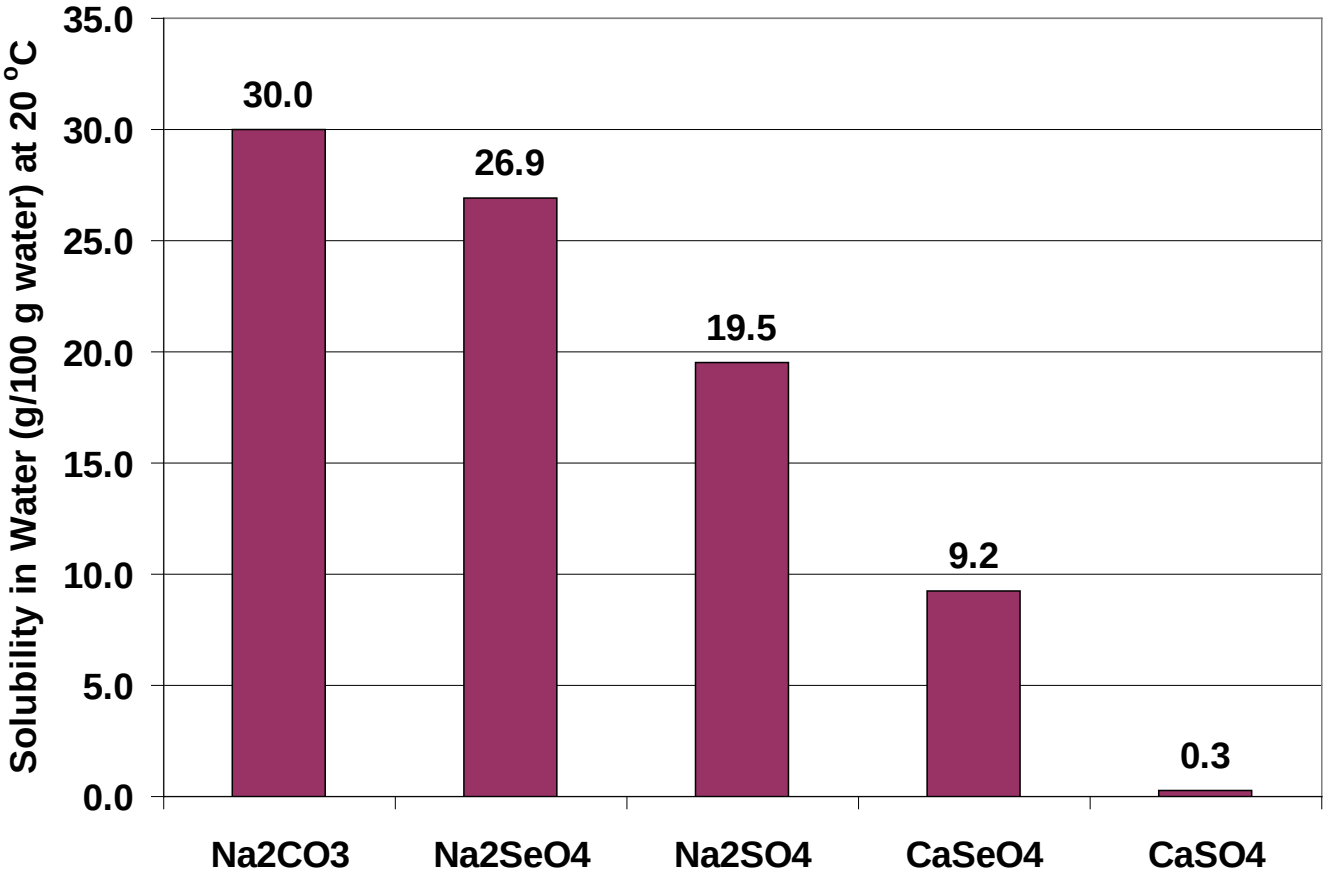
Compound	Bituminous	Sub-bituminous	Lignite
SiO_2	20 – 60%	40 – 60%	15 – 45%
Al_2O_3	5 – 35%	20 – 30%	10 – 25%
Fe_2O_3	10 – 40%	4 – 10%	4 – 15%
CaO	1 – 12%	5 – 30%	15 – 40%
MgO	0 – 5%	1 – 6%	3 – 10%
SO_3	0 – 4%	0 – 2%	0 – 10%
Na_2O	0 – 4%	0 – 2%	0 – 6%
K_2O	0 – 3%	0 – 4%	0 – 4%
Unburned Carbon (LOI)	0 – 15%	0 – 3%	0 – 5%

***Source: Ash at Work, 2006**

Impacts of Sodium Sorbent Use

- Desulfurization products Na_2SO_4 and un-reacted Na_2CO_3 are water soluble, which can affect many traditional fly ash usages:
  - Concrete
  - Cement
  - Construction applications
  - Mining applications
  - Landfills
- Use of any sorbents increases the amount of fly ash to be disposed: ~ 30% more for SO_2 mitigation.
- Potential for increased selenium and arsenic leachates. Selenium in the flue gas reacts with sodium carbonate or trona and is incorporated into the fly ash as water soluble sodium selenate (Na_2SeO_4).
- Sorbents used for MATS compliance will capture mercury in fly ash

Solubility of Sodium Compounds



Toxicity Characteristic Leaching Procedure

- **TCLP simulates leaching in the acidic environment of a municipal solid waste landfill. It may not be good predictors of the potential for selenium and arsenic to leach in the alkaline conditions of fly ash with sodium compounds (Na2CO3).**
  - **At present, the only EPA-acknowledged test for concrete and brick building products is the Toxicity Characteristic Leaching Procedure where the fly ash concrete is ground up into pea-sized fragments and then soaked in acid. However, the EPA itself has stated that the test was outdated and not the most appropriate way to determine leachability of coal combustion waste constituents, according to Widawsky.**
  - **As an alternative, the EPA is currently developing the Leaching Environmental Assessment Framework (LEAF) test, but some industry stakeholders question how fair LEAF will ultimately be as the current platform allows the tester to choose the level of intensity to which the product will be exposed.**
    - The Truth About Fly Ash By Barbara Horwitz-Bennet | 2/29/2012

TCLP on ash containing sodium sorbent for SO_2 control

Element	EPA Limit (mg/L)	TCLP Leachate (mg/L)	ASTM Leachate (mg/L)
Arsenic	5.0	0.117	0.212
Barium	100	0.435	0.425
Cadmium	1.0	< 0.05	< 0.05
Chromium	1.0	< 0.04	0.045
Lead	5.0	< 0.01	< 0.01
Mercury	0.2	0.0046	< 0.001
Selenium	1.0	0.324	0.349
Silver	5.0	< 0.035	< 0.035

Summary

- Fly ash sales when using sodium sorbents are possible when used for SO_3 control if the sodium content can be held under 2%. HCl and SO_2 applications generally preclude ash sales.
- Sodium sorbents can contribute to higher mercury removal, but as a result cause higher mercury contents in the fly ash.
- Sodium sorbents capture more selenium and possibly other heavy metals such as arsenic and barium from flue gas into the fly ash.
- TCLP extractions while not necessarily indicators of leachate concentrations, rarely show issues that would preclude land fill options.
- New effluent and CCR regulations are driving more work to be done to understand how we can control ash chemistry.

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